Pierre Rollin,

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MH: *Good morning, very nice to meet you.*

PR: Good morning.

MH: *Could you just, for the listeners of this tape, tell me who you are, what your job title is, and a bit of biographical information?*

PR: My name is Pierre Rollin, I'm originally French, trained as a physician in France, and I'm working in the Viral Special Pathogens Branch here for the last 23 years on haemorrhagic fever including Ebola, but other haemorrhagic fever too.

I work in the lab; I did in the different outbreak a little bit of everything so I can work on what is needed for an outbreak when you have one in any condition.

MH: *Could you just give me a sense of your deployment and experience in previous Ebola outbreaks, previous to 2014?*

PR: So I start for Ebola in '89 but that was Ebola Reston in Virginia here, that was purely lab work with non-human primate. And then in '95 I went to Kikwit doing at that time clinical management of patients. At that time MSF was not involved yet in the treatment of Ebola patients or haemorrhagic fever patients; they provided us the resources to supply but with Philippe Calain that was in the branch at that time, we took care of patients in the ward. Follow up outbreak in Gulu for example, in 2000 I ran the lab for two months and was working in the lab; a little bit of clinical but mostly lab work. In other outbreaks I've done some ecological studies such as capture of rodents, capture, of bats. I also work in communication training of healthcare workers and communication with the general population.

MH: *Okay, so prior to the 2014 outbreak, where would you have ranked Ebola on a list of infectious disease threats, global infectious disease threats?*

PR: It's a very rare disease; it's still a very rare disease. It's mostly in central Africa with Congo, Gabon, Republic of Congo, Uganda and South Sudan the main place where we found Ebola before and we will find it later. Nothing in West Africa except that single case of Ebola that happened in the Ivory Coast in '94, but all the time we were there it was always a short-term outbreak when people start to respond, international teams start to respond, it was a few months only, maybe before the response there could be several months of an unknown disease found in some place but no specimens collected and no exact diagnostic made. But it was always short … in all other areas the population don't move very much so even if you had

evacuation of patients from the epidemic area to other cities, it was very limited. We had for example in Uganda in several outbreaks in patients that went up to the capital in Kampala but that was one or two patients, no transmission at that time and very rare. So this outbreak, 2014 and 2015 has been special because of the duration of the outbreak and obviously the number of cases.

MH: *Before we get to that, where were you when you first heard that there might be Ebola in Guinée Forestière? Were you surprised and do you think it could have been anticipated?*

PR: I was in the office, we got a phone call from people in the laboratory in France, and also a phone call from some people we know at MSF saying it seems to have an Ebola outbreak apparently it was confirmed, so it was just a few hours before it was officially confirmed on the 21st March by the Ministry of Health of Guinea. I think I was surprised obviously because I didn't expect an outbreak there but there was some old paper, and I like old paper, published in French in '82 showing antibody to Ebola in some patients in Guinea. And we also know that the bat reservoir, if we all agree on that bat reservoir could have exist in that place of Africa, so the distribution range of these bats includes Central Africa and along the coast of West Africa.

So it was a surprise but when you think about it, yes it could have happened there. One thing with Ebola is you never know exactly when it will show up. It will rarely go back to the same place, and it's linked obviously to the bat behaviour and the human behaviour, and the non-human primate in Central Africa.

MH: *So can you just take me through what happened next from your perspective? I'm interested in the chronology of your visit to Guinea, what your objective is and what you assessment is of how the response is going and the degree of the risk or the degree of the threat that's being presented.*

PR: So at the beginning of the outbreak, when we learnt about it, obviously I'm always interested in responding to outbreaks so we knew at that time that we would respond. In addition at that time it is in a French speaking area, so I like it. The branch had some work in Guinea before for Lassa Fever and I was in Guinea in '94 and '96, for a short period of time, but I knew the location. We also had new software that was developed to manage the outbreak, to manage the case and the contact that was developed so we developed it after the four outbreaks that we saw in 2012 in Uganda and the Democratic Republic of Congo. So we said that is a good place to try to see if it works, unfortunately it was in English and by the time we arrived in Guinea we translate the programme, we translate the questions, but it was still a work in progress so we took with us also the informaticien that was involved and also a programmer that was involved in that programme and we changed version every night more or less for the first month, because he was improving and correcting the mistake.

But when we arrived there it was obviously an outbreak … so we arrived 31st March, the first team. Diagnostic confirmed 21st, and we arrived the 31st. We cannot go into a country just like that; we need to be invited and have visa and all the system. So we arrived and it was already an outbreak that was in two different areas; in Guinée Forestière but also some cases Conakry already with a transmission in one hospital

in Conakry, Donka Hospital [in fact transmission occurred in two hospitals, first in the Guineo-Chinese hospital, then in Donka hospital. *Note added by Rollin*).

So it was already in two places. Some of the team went to Guinée Forestière; I went just to check what's going on …

MH: *So did it alarm you that it was already in Conakry because it was a major city?*

PR: Yes and no because it arrived before in major cities like Kampala or Kinshasa and it never went to transform in a big outbreak. But we still have, even to this day, Guinea and Conakry behave differently than Freetown or Monrovia. We never saw in Conakry what we saw in Monrovia with that huge transmission. Conakry was a place where you had case transmission but normal way of transmission like we used to see in previous outbreaks, and multiple re-introduction in Conakry and we don't have explanation for that, but it's never been like it was again in Monrovia.

So it's always a problem when it's a capital, it always adds another layer of political administrative problems because it's the capital. Obviously it has a huge impact on the economy of the city already with the number of visitors coming from overseas limited; not really tourists, there is not a lot of tourist, but businessmen and people involved in the mining mostly that cancel trips and stop. The hotel was more or less empty besides our team so there was …

MH: *How many was your team?*

PR: We were five or six. Two epidemiologists, Craig, the informaticien and myself, I think five. And so there was the capital and mostly Guinée Forestière where there seems to be more people but when we arrived, the WHO response team, obviously some of them were there, MSF were there, so it was not that, how to say? It was an outbreak like any of the other outbreak that we have seen before – starting, or having started already for a few weeks, but it didn't seem like anything that would happen in the future in that place, so it was not a big deal.

MH: *Just to summarise, as I think this is important, so you're saying at that stage, having had experience of other outbreaks and seen these deployments before, it would be fair to say this is business as usual?*

PR: Yes, it looks like, tastes like, smells like regular outbreaks in previous areas. So the equation of that maybe I didn't put, or nobody else put, was the fact that in Guinea people are travelling a lot, within the country, or eventually outside the country, but within the country. That the place in Guinée Forestière where that outbreak happened, it's not the most developed part of Guinea. People are considered quite often a lower class of Guinean. They're in the Forestière, so when they say "C'est Forestière" there's always a pejorative connotation with that, so they don't have a lot of interaction with the Ministry and the capital, and when they have interaction it's not always good, from both sides, the people in the capital don't like too much the people from the forest, and the people from the forest think only trouble comes from the capital. So there was that history that was not put in the equation of mistrust between the forest and the main response team from the Ministry of Health

or the international responder, so that was something. But because of this mistrust retrospectively, we found that people were hiding a lot of the fact. So we go a bit further, but when I left Guinea, we thought at that time that there was no case going on in Conakry anymore, and that in Guinée Forestière the number was reducing a lot. So we didn't … there was a replacement team that arrived from Atlanta, from the CDC that went to Guinée Forestière and stayed there so we never left an empty spot …

MH: *When did you go back then the first time?*

PR: I think it was around the 9th, 10th or maybe mid-May. I stayed more or less six weeks.

MH: *So that's important, so in May 2014 your impression is that … you've no knowledge there are cases going on in Guinea?*

PR: Yes, but I think it was not finished, but it was the trail of the outbreak and it would finish soon. And I think everybody has that feeling, I think most of the responders, international. And to go in the same direction, we had at the same time in April a small flare of case[s] in Liberia and also that case seems to have, or the number of case reduced and this flare vanished. So we thought, "Okay we had an introduction in Liberia, it was taken care of and that part is over also."

So we had several points that made us think that it's not finished, but it's going to finish soon and that's it. Obviously we were wrong but …

MH: *I just want to ask you specifically on that … you're being very frank about what you did know, and the assessments you made. You gave an interview in the New York Times in December 2014, I'll just quote from it, you said "It was an unprecedented outbreak, it had never happened before, there were a lot of things we didn't know at the time, no one could have imagined that there would be what we have now." So my question for you is, what didn't we know at the time that we should have known?*

PR: So we don't have all cases I'm not sure we're going is we thought, again, like Liberia was over, there was no more case. I think there was certainly a misinterpretation, there was certainly case but they were not recorded and known. We think at the same time it could have been already some cases in Sierra Leone; nobody reported them, the population at this corner between Guinée Forestière, Sierra Leone and Liberia are only one population – the Kissi people and they speak the same language whatever the country is, for them the border doesn't exist, it's either a river you cross every day and nobody cares about it or it's not even a river, you just walk or drive and you cross the border. So for them it's only one country and it's the Mano River area following this Mano River population, so for them it's … And I think at that time we didn't know that the three countries were already seeded and the outbreak would start.

And I think that for me, that's the only explanation for this tsunami of case we saw in Liberia and Sierra Leone that suddenly we had this wave of case coming from

everywhere and it was nearly impossible to track and even to do a chain of transmission; it was chaos everywhere. And that could have been possible only by sitting in different area before, and everything being undercover and then suddenly exploding at the same time.

MH: Another way the question might be put, you're a virologist …

PR: *Yes, partly.*

MH: *So at the beginning of this outbreak, one of the questions was essentially has the virus changed? Is there something different the virus is doing? Is it mutating? Is it spreading more effectively in a different way? Or do other factors account for the scale of this epidemic? What is your view?*

PR: I don't think it's the virus. In fact, very early, the virus that was found was found to be from the Zaire species of virus, a little bit different as expected but not that different. There was a misunderstanding unfortunately, and that's my position, the taxonomy of the naming of the virus changed, someone decided to change it, I don't think it's a good idea. Before we used to have Ebola Sudan, Ebola Zaire, Ebola … but there was always Ebola, and then the taxonomy changed and now the only Ebola virus is the formally known as Zaire. The other one is called the Sudan virus, the Reston virus or the Ivory Coast virus. So when the paper was published, it was done according … the first paper in the New England Journal of Medicine … it was labelled according to the new taxonomy. A new species of Ebola virus was found, a new Ebola virus was found. In fact it was understood by everybody normal, that it's a new species and we have something really different there, where in fact it was just saying it was still what was known as Ebola Zaire, but now it's called Ebola and it's a different Ebola virus.

MH: *Essentially you're saying that it was the same virus?*

PR: It's the same virus with a few change. And what we learnt during all this outbreak that the virus changed slowly, evolved in the different countries, and now we have a family tree of virus that showed this evolution. But there was not a lot of change, and not a lot of mutation, a lot of transmission. The only difference with this virus compared to other combination virus and human of this virus compared to the previous outbreak is that this virus gave a lot of diarrhoea. Diarrhoea had always been in the clinical spectrum of patient … in patients infected by any of the Ebola virus, but in this case you have diarrhoea that looks like cholera in some time. And we know that this diarrhoea could be infectious, and when you have that amount of diarrhoea it's very difficult to manage for the patient and for the family or for the healthcare worker. So that's certainly one clinical factor, or one sign or symptom that could be responsible for the large amount of case. But we still have … we used to measure the r node so how many patients are infected by one patient. We are still very low. There's not a big change in that when you compare that to other disease like measles/flu [?] or other infectious diseases where you can have twenty case coming from a single one. In Ebola it's not the case, it's just around two, three maximum, so it's still limited but certainly this diarrhoea has a huge impact on the rate of transmission.

MH: *The area did you say?*

PR: In all this … because that huge diarrhoea have been seen only in this outbreak in the three countries because it's more or less the same virus, there is difference in the same country. And we still don't know what the cause of this huge diarrhoea, the few animal models that I've made since with [?Marcona 01:07:28] virus never showed that kind of diarrhoea so we don't know what the role of that.

MH: *Okay so I take it that what you're saying is there are some clinical differences that may be significant in explaining the transmission, but that would only explain part of why the transmission was so great. So what factors do you think …*

PR: So the other factors is the movement of people. And we saw for example in Liberia, when we had this small flair if someone is sick in Lofa county in the north, west county of Liberia, and she seek treatment in Margibi or in the other place of the country, a completely different district, and in Guinea I used to say that the case, the contact and the corpse are travelling, everybody's travelling and people have been arrested in the complete far eastern prefecture of Guinea with a dead body in the car that was already dead when they left Conakry, and they travelled for twenty hours with the corpse not in a coffin, but seated in the back seat with other people, alive, travelling that way just to get buried somewhere else.

MH: *Taken back to their ancestral burial …*

PR: Yes. People keep moving a lot. Now in Guinea there was also another factor that goes maybe against that, there is still something we don't understand, every time the virus and patient left either the Guinée Forestière or the coastal Guinea where the outbreak is still right now in Forécariah, the virus never stays very long and there was only two or three generations of patients, and then the outbreak stopped. And we don't explain that. So we had several flairs that went to [?Kurimale 01:09:36], Telimele, Boffa, even Conakry where you have two, three, maximum four generations and the outbreak stops. When it went to Mali it was the same; in Mali there was four generations maximum I think. And there is something different when in Guinée Forestière or the Basse Côte in Forécariah, in Guinea or in Sierra Leone or in Liberia, the virus and the generation keep going one after the other and it is very difficult to stop. And I don't think we have an explanation for that. There is certainly a behaviour of the people; anthropologists should look at that; something happening that is making that virus stop.

It is true that in all these areas of Guinea that I'm talking about, the majority of the people are Muslim, it is true that the Imam have a lot of power and are listened to by everybody, so if we succeed to convince the Imam that they should do some kind of behaviour to stop it, he will say that at the Friday prayer and it will stop.

Some people also make the point that the Muslim wash their hands five times a day because of the prayer, and that could also have an impact on secondary transmission. There is strictly no data to prove that yet, we know they wash their hands five times a day, but there is no data saying it has a role in transmission. But

we're trying to find reason and excuse to try to explain why it stopped there and didn't stop somewhere else.

MH: *That's fascinating. So what you're describing is it could be a combination of the religious structure of Guinean society, but also because it's a more rural, agricultural country, I don't know the road networks but …*

PR: Very poor. People keep travelling even with very poor roads. The other thing is the Muslims bury corpse very quickly, it has to be done within 24 hours if you can. Whereas in other area especially in Guinée Forestière, the bodies are kept several days before they are buried; it could have an impact on the transmission and the number of people that are involved in touching or washing the body after the fact. So that certainly has also a role and that would explain why it stayed in Guinée Forestière

MH: *I just want to take you out of Guinée Forestière for a moment and talk about your interactions when you come back here to Atlanta CDC in this period in May. So what conversations were you having with your colleagues at the CDC, and also with other infectious disease experts who might be advising the WHO and other organisations?*

PR: I think within CDC, but I'm sure other people within other organisations also like WHO, I had certainly the impression that the outbreak was not finished, but it was just the end of the normal outbreak. There were still people from CDC in the field taking care of it, and it will finish or might talk about that and say "Well it's another outbreak, and if we're lucky it's going to stop quickly and that's it", but I never thought it will be persisting such a long time. And again besides some clinical signs were different, the fact that in Liberia apparently they also had this flair and they succeeded to clear it very quickly. Everything pushing in the same indirection – it's a normal outbreak.

MH: *As you know, there's been a lot of criticism of the WHO's role, their lack of action, timely action. I'm just wondering, given what you've said, do you have a certain sympathy for the position they were in trying to assess the risk of Ebola, given that there were also lots of other diseases presenting a global health risk in this period?*

PR: I think it's always nice to have someone you can blame for something, but I think everybody is to blame. Everybody has the same assessments. Some organisations are more or less disorganised, so we can say WHO was disorganised. The big misunderstanding is everybody put a sign; so you have MSF, WHO, CDC. In fact there is several MSF, there is several WHO, okay there is only one CDC, but there is different level in the organisation to respond. It is always true and that remains a big problem in this outbreak, is that the people with experience of Ebola are very limited, we don't have that many people because the outbreaks have been limited, the number of people involved have been limited. We don't have a lot and the size of the outbreak required to have thousands of responders, and some of them are reinventing the wheel every time, and when you have to maintain a long-

term presence in one place, you are forced to have a different group going one after the other, and there is always the risk of loosing information in between and that happened for everybody.

So I think WHO was responsible, okay everybody could be also responsible for not having helped this country before, they all came out of civil war more or less, they all have political problems, so that's everybody's fault and nobody's fault.

MH: *I wanted to ask you retrospectively as I understand it, there have been some critical, if I can out this way, pinch points, identified in the epidemic. Places … so Kailahun and Kenema would be one in Sierra Leone. So when the virus entered the argument is there was an opportunity, if action had been taken, if resources had been mobilised quickly enough, to stop it there before it came to Freetown. One can make a similar argument about Lofa in Liberia, Guinea for the reasons you've just explained is more complicated because it's already in Conakry and it seems to move around the country differently. My question essentially is, do you think enough resources had been mobilised in May/June to these areas, or was it already too late by then?*

PR: My gut feeling is it was already too late. The problem is that none of these countries have a surveillance system so we don't know exactly what's going on anywhere. Obviously before the outbreak there was no lab doing the diagnostic, after there was a bit more. But I think it was very difficult, it came from Kailahun and it went to Kenema while there is not a single path to go from one to the other, people are going also from the neighbouring district in both countries, district, prefecture or province depending on the country, were already there and there was no system to detect them, take care of them, block them and doing that so I don't think there was … and in all the country, it's a place where you have difficult roads, difficult place to go, no organisation to rely on. Even if there were no surveillance but there was already a public health system and you can just graft people on the system and help to take care of it, but if you have nothing, you cannot rely on anything so it was difficult.

The response could always have been faster, you could always say that, but then it's made very difficult when you have different organisations, different structure, different way of reporting in place. So the Ministry of Health is responsible for the country, the health of the country but has to be supported by other people, but then when you have several different WHO, you have CDC, you could have some NGO, you could have the British Army helping in other things, it just makes it very difficult or impossible to manage in my view.

MH: *It's very interesting … just as an aside, it's very interesting the way the international response broke down along lines of the former colonial interest, so the French essentially had Guinea, the British had Sierra Leone, the Americans had Liberia.*

You go back to West Africa at some point. Can you just take me through the next time you're in and where you're going?

PR: So I went back in June, I don't remember exactly the date, I can confirm that, but I went back in June to Guinea and I stayed seven weeks, so it was June/July.

The situation was different obviously, there was much more case in Guinée Forestière, there was some case, but again I'm not really concerned by that. Like I say small flairs going one place or another but then it stops, and then at that time Guinée Forestière was really … we saw the problem; the fact that we had really no connection in the village, it was very difficult, a lot of the village were closed and didn't want us to come. There was a lot of so-called resistance, and it's resistance that was obviously triggered by Ebola but it was more than that. The resistance people tried to put everything "Oh it's Ebola's fault". They don't want us to intervene on the mortality, the dead people, the contact. But it's … the way I see it is the team responding go in the place and then seal the dead people, put them in a body bag, remove them very quickly and we always had trouble with burial practice because we don't follow the rules, we follow our rule, we think we are better but they think they are better so it's one on one.

And then we come back, we ask questions, we follow people every day for 21 days. In exchange of that we bring strictly nothing. So these people have other trouble than Ebola. They have malaria and we know now for example that the excess mortality of malaria in Guinea during the Ebola time killed more people than Ebola, because people had no access to health system. So they have malaria, they have no school, and no road, they have no water or electricity. And suddenly you have people that come from everywhere to help them but we haven't fixed anything; they still have no water, they still have no electricity, they still have no school or teacher in the school, we're just a pain in the neck. And Ebola came and went in some area and they're still in the same trouble.

So the resistance to Ebola, or to Ebola responder is a big shield that covers a lot of things and we haven't fixed. At one time our thinking … I think it was the end of the first tour or the second one, we were thinking we should respond differently and we should for example provide each health centre with a package with regular drugs and treatments, some help for the village, some help for the school, maybe digging a well so they don't have to walk a long time to the river to get water. And if you do that you restart a health system locally that doesn't depend from the capital. In these villages even if you have a health centre, you have no drugs, you have nothing so the nurses that are in charge of that have no respect from anyone as they don't even know that local drug used by the traditional healers. And the traditional healer just took over because the one that at least was not trusted or feared by the population, but they had some tools that the nurse don't have. And I'm thinking if we can do that in different areas we can provide them … costs not a lot of money much less than what's spent in this outbreak and it would help at the village level. That's what Guinea asks a lot, help at the village level more than rebuilding a university hospital in the capital which they definitely need, but that's not on the top of the list for them and that's something that I think it's much nicer for the population.

MH: *Can I ask you, was there a difference that you noticed between the resistance to, or the distrust towards western health workers and their social messaging that you encountered in Guinea, as opposed to other outbreaks in DLC or Uganda?*

PR: No I think it was the same. And it's not only to western people; it's people also from the capital, or people from another tribe. In Gabon for example, when you have Ebola in the pigmy population, they don't trust people from the capital, because they know that it's trouble coming. They don't know which trouble, but they think there will be trouble. So it's exactly the same thing; it's people coming and they will say "On the pretext of Ebola you're impose on us more rules, regulations and trouble". So it's

not only the western world. It's obviously easier to spot someone from CDC or MSF or WHO coming from Geneva than someone coming from Conakry, but it's the same. It's more trouble to the outsider of the area.

MH: *I'm going to ask you to shift again if we can, I'm not sure how long we have, but I wanted to ask about the tail end, where we are now, getting to zero. We're not at zero yet, why is it that reducing transmission to zero has proved far more difficult than anyone has anticipated?*

PR: So I think it's still … it's my view, linked to the behaviour of the people. The three countries have a more or less different approach to each other. Liberia, that finished first, we can certainly take the credit for responding, but I was in Monrovia end of September 2014 when it was really the peak with a lot of cases everywhere. So the US Army arrived and started to build some isolation, or treatment centres which retrospectively they didn't build all the ones they wanted to build because there was no need. Most of the ones that they built where not used completely because there was less patients. I think at that time they saw a change in the population response, so they started to, I would say, abandon patients or leave dead bodies unattended without doing anything with them. And that's something I saw in Kikwit in '95 when we arrived there was already that fear of the sick and the dead. We were told "If you go to that village, that house where there are sick people, nobody goes there, we quarantine them there." And when you arrive some of them were already dead and some of them were dying because nobody took care of them. I found in the hospital in Kikwit some dead people in the hospital with some money on the top for someone, and small note "Please take care of the body, we don't want to do it." And that's very bad for the patient, but that's very good for the transmission because people are scared.

So I think in Liberia in the peak of the epidemic in September/October people start to have that, or blocking the access of the village saying "No you don't come to our village if you're a foreigner."

MH: *Why? What accounts for the Liberians suddenly getting this … ?*

PR: I think it was the number of deaths and the fact that when you walk in the street and you see dead people, you start to be scared and then it goes further. Monrovia is a big city but in fact it's a combination of small villages. That area they all come from that village, that area they all come from the other village, so people live in a city but as a structure that is more repeating what they have in their own village. So that's what happened in Liberia, I don't think that happened in the other two countries. Sierra Leone … I haven't been deployed at all in Sierra Leone. In Mali it was a small outbreak so it was short, but in Sierra Leone I was not deployed, but what we saw is we saw really that wave of cases coming from Kailahun, Kenema, Bo and then going to the Western province of Sierra Leone.

The response is also different in Sierra Leone. It's more military like, it's organised by the military. People, when they are put in quarantine, they are really locked in the house or in the compound where they live which has also an effect of fear; people don't want to declare a case because they think "Okay we don't to be blocked in the village or the house."

Guinea, the number of cases was large in some areas, but it really took some time and some understanding at each and every village to pass the message and to be able and they doing that. The problem is they keep travelling. So we have all the recent cases that we have, the ping pong between the Forécariah area and Conakry to the Forécariah area, and they keep moving there … it keep going the number of cases very low. You have a few case every week, or you have three case and no case for ten days, and then two case and no case for ten days, so it keeps going and prolonging the duration of the outbreak but the number is not very high, and apparently we think there is no case and there is still some surveillance in some other district, and there is no case in other district. But we're not away from someone moving from one place to another and travelling in another prefecture of Guinea is case and it's difficult to block.

In addition to that, you have the election and the fact that in the Forécariah area the authority is not that different, there is a lot things that are sold in Forécariah that are not officially sold, or allowed. The control is very difficult.

MH: *So last question Pierre, that is how can the world avoid a repeat of this sort of catastrophe and ensure faster and better containment of Ebola next time?*

PR: So the best way to avoid it is to put in place in these countries and in the other countries, because if it was in Sierra Leone there is no reason why you will not have the next outbreak in Ghana or in Ivory Coast, is to put a surveillance where you know more or less what is going on. In none of these countries do we know how many people died every day. There is no record, there is no statistic on that. It will be impossible to detect the first case, we can forget about that. What we would like to detect is clusters of cases. So one case will infect the next generation and then you will have several cases and that is what you want to detect. But in order to do that you need to have surveillance in place, you need to have a laboratory not in every village, but at least in every country. You need to have a response team that will be able to go and respond and see what's going on, or investigate every time you have a cluster.

Again the problem is to remove that from the background noise. Because Ebola is a rare disease, there is a lot of other reason to die. So even if you look at the cluster of unexplained deaths you're still going to have very few of them that will be Ebola, maybe you will have none of them. The other country where we know there was Ebola before, let's say Gabon, the last case in Gabon was '99. The last case in the Republic of Congo … Congo Brazzaville was 2005 and since there is no case at least that we know of. The surveillance in the Republic of Congo is more or less the same, so people are following wildlife and big apes; they are looking at the mortality of these animals and they haven't seen anything. It's a very rare event and because it's rare, it's very difficult to do that. But unless they have a system of surveillance and response and diagnostics, it could happen again. Okay now we can say we have more people trained to respond and all of that, but every time we have to reinvent the wheel. So I think the only response is that, and it's partly what global health security is based on. Now it costs a lot of money, so someone is going to have to pay the bill. These countries can't really pay the bill – they have the personnel but they need the training of the people, they need the salary of the people, they need the supplies and the logistics and everything.

MH: *Thank you very much, I think that's a good spot to end it on.*

PR: You're welcome.

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