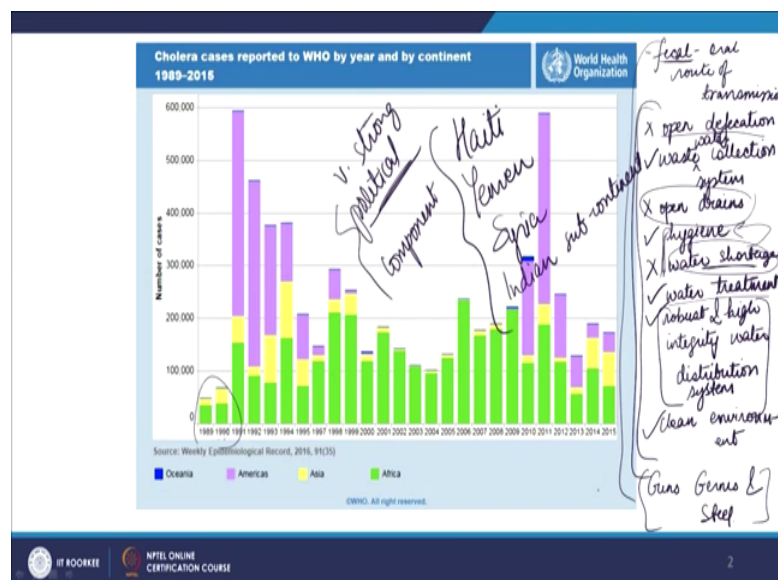


Applied Environmental Microbiology
Dr. Gargi Singh
Department of Civil Engineering
Indian Institute of Technology, Roorkee

Lecture – 52
Epidemiology II

Dear students, welcome to the second lecture on Epidemiology, today we are going to talk about other important outbreaks in near past and, then we are going to see how our environmental understanding helps us tackle with these human public health problems.

(Refer Slide Time: 00:47)



So, let us start about cholera cases the choleras are very infectious disease the sad thing about cholera is that it is very easily avoidable just by having proper sanitation. So, when we talk about cholera. So, when we talk about cholera it is very very important for us to understand that cholera outbreak is the result of failure of sanitation because, cholera has a faecal oral route of transmission.

So, let us say we have a carrier in a community who has cholera in their gut and, then when the person defecates in the faecal matter the cholera will be present. Now cholera lasts very long and it requires very little amount of cholera pathogens to cause someone healthy to fall sick. So, if we can effectively contain the faecal matter. So, we have a very good wastewater collection system first of all there is no open defecation because, if we have open defecation then the flies will pick up the colour of microbe and then Vibrio

cholera and then infect other people, the other thing we can we need to have is proper waste collection system, waste water collection system actually.

Next we do not want open drains. So, if there are *Vibrio cholera* in the open drains we do not want that. So, our correct waste collection system should be not open so, perhaps concrete or other pipe system through which our waste in a septic tank waste is collected next we need extremely good hygiene. So, people wash their hands after they poop.

So, because that is a I am a courier of cholera and are free defecating and cleaning myself I do not wash my hands and, whatever surface I touch I will deposit *Vibrio cholera* on them, and then if somebody else comes and touches them now that person has been exposed to *Vibrio cholera*, remember it requires very little infections to it of *Vibrio cholera* to infect a healthy individual.

So, hygiene standards are very high. So, means there is no water shortage because washing hands making sure our hygiene is good requires a lot of water, good quality clean water. Next we need extremely good water treatment facilities. So, let us say it is not a human, but it is an animal that has that is a carrier of a cholera and, then that carry animal defecates in the raw drinking water surface body source, the surface body that is a source of our raw drinking water.

And if you do not have adequate disinfection system adequate water treatment system, then the cholera *Vibrio vibrio cholera* can spread through water distribution network. Next is we require a very robust. So, we need robust high integrity water distribution system.

So, let us say we treat our water really well we collect all the faecal matter, we treat it perfectly there is no *Vibrio cholera* roaming around in our surface water bodies and, we put it in our what it after treating water giving adequate residual disinfectant, we put it in our distribution system and, there is a leak and guess what pathogens enter through the leak *Vibrio cholera*. And now people will fall sick get rebuked go get cholera. So, we need robust and high integrity water distribution system and, next thing we need after this after is that we need to keep in clean environment.

So, if we look at these factors that are necessary to make sure, there are no cholera outbreaks even note that most of them many of them are actually environmental

challenges, these are exactly the problems that the environmental engineers and environmental scientists in our country are trying to tackle, we have definitely and now our government is also promoting such power at the beyond, in a big part of it is sanitation, putting in into open defecation very good. Next is we need to have a very good waste water collection system many cities.

For example I am sitting and Roorkee right now Roorkee is now finally, after so many 100s and 100s of years is getting it is waste water collection system and, then we still have the problems of open drains in most part of the country. So, we need to get rid of this open drains are not only a problem when it comes to infectious diseases like cholera, they are also a problem for vector borne diseases such as malaria dengue and Chikungunya, then hygiene is very important and this is where India struggling a lot, our water shortage does not allow us to maintain a very good hygiene does, not allow us to use water judiciously and cleanly. So, this is something we really need to work on.

Next is our water treatment systems usually across the country in our cities we have good water treatment systems, the problem may be in their operation and maintenance. So, that is something we really need to look for we need really, responsible strong high integrity what are professionals environmental engineers, sanitation engineers, who work in our wastewater treatment system and water treatment system make sure they are being operated and maintained properly, also we need to do lot of research into understanding what are the factors that caused the deterioration of a water distribution network and we need to keep an environment clean.

If you do all of this then we would not have cholera case and, that is why typically developed countries they have already done all this business and have doing it really well even now, they do not tend to have cholera outbreaks. Now, in recent past cholera has come back into news because of it is re emergence after the refugee crisis in Syria in Yemen many of them have them got infected by cholera.

And in fact, I encourage you to go ahead and read a book called guns germs and steel, I think that is what it is called I will have to confirm I share it in my notes later. So, in this in this book people have shown how many of the walls were actually born not on basis of the combat potential and the combat power of the countries, but on bases of the diseases that they spread.

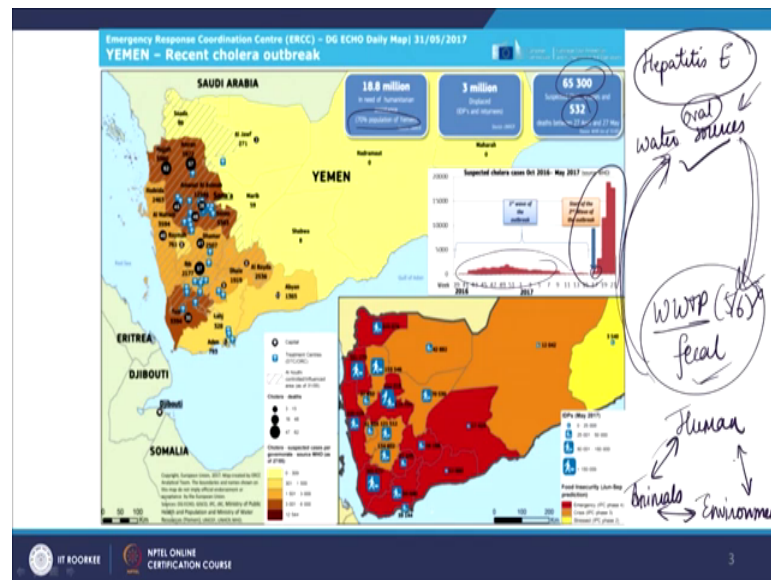
For example many I think it was the world war 2 maybe world war 1, when Germans were invading Russians, by the time they reached Moscow and by the time they covered the important parts of Russia many of them had perished in the cold and because of diseases. Same thing is happening right now in Yemen and in Syria, where we have an unprecedented amount of refugees running away and going to refugee camps, the refugee camps do not have sanitation facilities, they do not have enough water for people to maintain the hygiene, we do not have a good feel connected system a treatment system. So, as a result we have a lot of waterborne diseases that spread and one that is making rounds right now is cholera.

So, let us look at the recent past of cholera, we note that in 1989 1990 peaceful years by the way mostly peaceful, we had a very low level of cholera and, then from 1991 to 1999 we noticed that the a global incidences of cholera increased and we have not gone back to pre 1990 levels of cholera even now. So, in purple we have Americas and yellow have Asia in green we have Africa. So, this is when the violence escalated in Africa, we had refugees and you see the incidences have topped the same thing in America South America is very very violent even now.

And whenever it is very interesting whenever, if you have large displacement of people, they do not have access to adequate facilities and, we have an outbreak of diseases such as cholera it happened in Haiti, it is happening in middle east and Syria and Yemen and India right. Now I am recording this lecture is suffering from not India, but this part of our Indian subcontinent is suffering from mass displacement of running gas from Myanmar. Now there is a very high chance that in Bangladesh and, wherever there refugees go will have cases of diseases such as cholera.

So, if you look at this is definitely an environmental challenge, as I have mentioned here environmental problems, but it has a very strong political component to it. Now this is very important for you to understand that, whenever you have some kind of political problem going there is a very good chance that our environmental systems are failing and, that is when the environmental engineers step in and that is when we start taking precautions to make sure people do not fall sick all righty.

(Refer Slide Time: 10:14)



So, this is Yemen the recent cholera outbreak and this is a map showing, how the cholera incidences have increased the first wave happened in 2016 when we noticed that there was a persistent level of cholera, but recently in 2017, the second outbreak when it started now the number of cases are very very high very very high.

So, look here some seventy percent of population of Yemen who got displaced that is an extremely high population 188.8 million people were displaced and, some of them returned some of them went elsewhere and, then we had cases of 65300 incidences of cholera and 532 people lost their lives because of cholera not because of war all righty.

(Refer Slide Time: 10:58)



So, now let us come back to our epidemiology and well before we get here I like to stay here and talk to you about a little bit more about this infectious diseases. So, in case of cholera the faecal oral route is very well recorded and reported. So, we know if this is not cholera outbreak, we need to look at our wastewater treatment, we need to look at our water disinfection and hygiene, get these three in order and then you put an end to cholera outbreak, but in certain diseases we are still investigating what is the source of pathogen here.

For example in Shimla in 2016 2015 winter there was an outbreak of jaundice and when national institute of virology Pune typed the virus that was causing the jaundice it was found it was hepatitis E virus. Now hepatitis E virus has a faecal oral route. So, if a person is sick or a mammal is sick has hepatitis E in their faecal matter and, contaminates the water contaminates the food or just practices poor hygiene, then other people will fall sick by consuming the materials that are contaminated, but it is water or food.

Now, in this outbreak it was very very important for us to figure out, where is this hepatitis E source coming from because, when there was a full blown outbreak in at least two thousand people were reported confirmed cases of hepatitis E, were at least 2000 cases were confirmed to be of hepatitis E and, we do not know how many more we we need to know where did the infection start from and, then the question is well how do we

find out. So, national institute of virology they had the ability to detect hepatitis E virus, which is very hard to culture to grow and they found it in the water system, the drinking water everywhere in the drinking water system there is hepatitis E virus.

And now where did it how did it enter the water distribution system. The water and the question is well it is a faecal oral route. So, we knew that is present in the waters not necessarily the food that is being sold in the market, or maybe even that, but the water. So, now it getting the water from; from the faecal matter, so let us look at our wastewater treatment plants so, that was the next step they looked at the wastewater treatment plants and they found that 5 out of 6 wastewater treatment plants were not working well so; obviously, now faecal oral route has been confirmed. So, you looked at the water sources and they found yes there is virus in that.

Now, this is your oral the oral part of the faecal oral route. Now let us look at the faecal part which is your wastewater treatment plants and, they confirm that 5 out of 6 were not doing their job. So, this is where the faecal matter in Shimla interestingly at least for Malayan one particular part of Shimla, the waste water the treated wastewater is put into a stream occurred (Refer Time: 14:06) occurred and then few kilometres downstream the same water is taken as a raw drinking water source.

So, this is your faecal oral route confirmed right. So, the wastewater treatment are not working properly disposing faecal matter in a stream, 6 kilometres down the lane, around the flow, the same water is the source of drinking water treatment plant now the question is all right, we have established the faecal over a route, where did the first virus come from now in order and, in order to understand that the current research with select scientists are doing in the country right.

Now, related to have already see virus outbreak in Shimla is that well did the virus first entered the water distribution network, made some people fall sick, which increase the amount of virus loading in wastewater treatment plant, which increased the loading in stream and, then increase the loading in water distribution system, did the contamination happen first on the wastewater treatment plant part.

So, that is still being investigated in this outbreak this part of the outbreak problem is a total environmental problem environmental challenge. So, again this brings us to a very important part that human health is very closely intertwined to environmental health.

Now in case of MERS that we started just from in last lecture, we also note that animals can infect humans, can be a courier and source of infection and where do animals get the infection from environment, thus there is a very close relationship between the humans, animals in the environment and our environment all righty.

So on the same note, we notice that 60 percent of existing human infectious diseases are zoonotic. So, 60 percent of diseases and animals also get them the animals that are in our community like rats, cattle, chicken, dogs, cats, 60 percent of our diseases we get from them (Refer Time: 16:13), this is the where the pathogen. So, pathogen goes in the human body affects human body, we know that at least 75 percent of emerging infections. So, which are not always a problem, but now they are increasingly become more problematic like Ebola HIV and human an influence that they have an animal origin.

For example swine flu, first isolated traced back to swine bird, flu traced back to Morris trace back to camel. So, at least 75 percent including HIV trace back from certain monkeys, of human diseases that are becoming increasingly problematic and dangerous have zoonotic origins, 5 new diseases for humans appear every year.

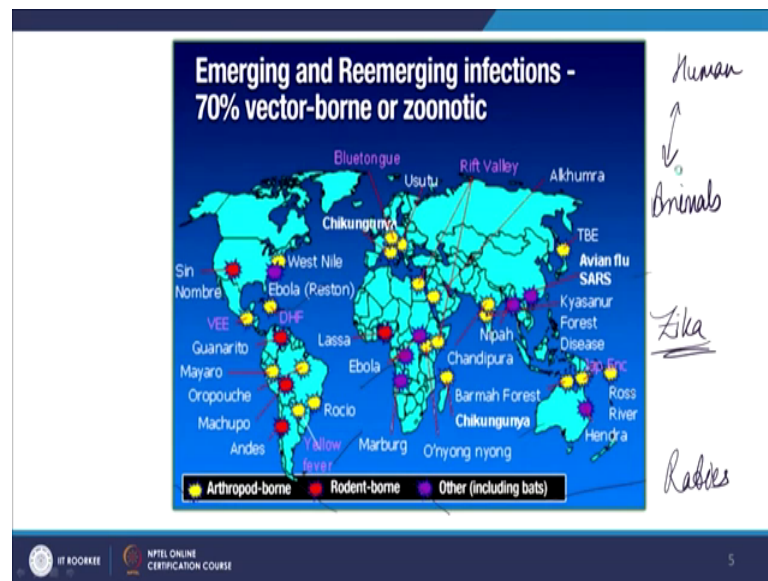
So, tremendous rate three of which are of animal origin 80 percent of agents with potential bioterrorist use are zoonotic pathogens, which brings us to another concept bioterrorism which is when I can remember I talked about how many wars were actually when, then the Europeans came to north America and sort of invaded the continent, it was not necessarily their artillery that one then the north American continent, but they in fact, were I would say cruel enough to conscious intentionally spread diseases.

So, they would bring the blankets that were used by patients of smallpox and, give it away to native north Americans and they native not American north Americans, were never exposed to smallpox did not have these infectious diseases and, they fell sick and the entire communities were wiped out, it was a very effective and cruel mass genocide.

So, this is bioterrorism I use a biological agent to terrorize and kill entire populations same thing happened when world wars same thing is happening in Yemen where 65000 people have died not because of war, but because of cholera and same thing was attempted after in the September 9 by 11 attacks, when certain important officials in u s were mailed anthrax, the powder the anthrax anthrax bacteria because Americans are

sensitive to anthrax because Indians are immune to it, but not most of us in India are immune to anthrax, but anthrax is a big challenge for Americans so, North Americans. So, this is bioterrorism eighty percent of microbes that can be used for bioterrorism are zoonotic pathogens. I hope the slide helps you understand the strong link between the animals and humans.

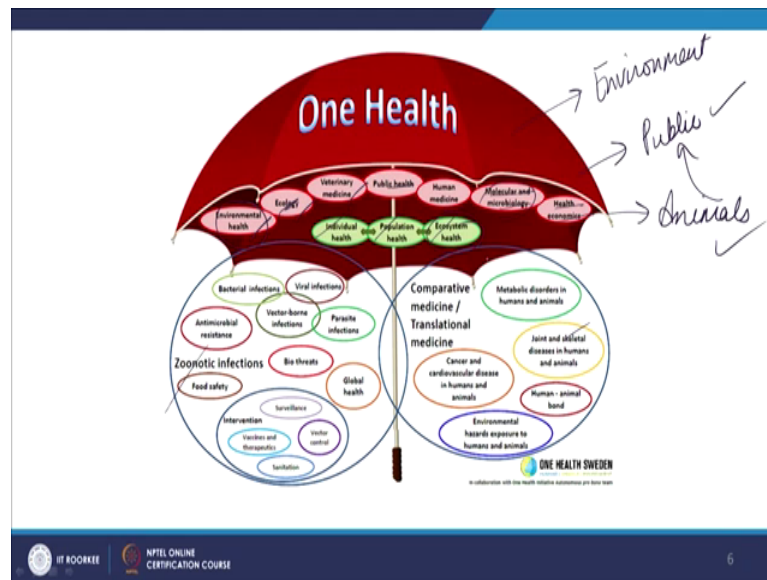
(Refer Slide Time: 19:00)



All right so, when you are talking about emerging and re emerging infections 70 percent of vector borne or zoonotic. So, they are spread either through insects like Chikungunya and dengue malaria, or they are zoonotic like swine flu bird flu and now camel flu MERS. So, we have Chikungunya and all of the diseases in different parts of the world even flu, Chikungunya again yellow fever, Ebola, Zika this is an old map.

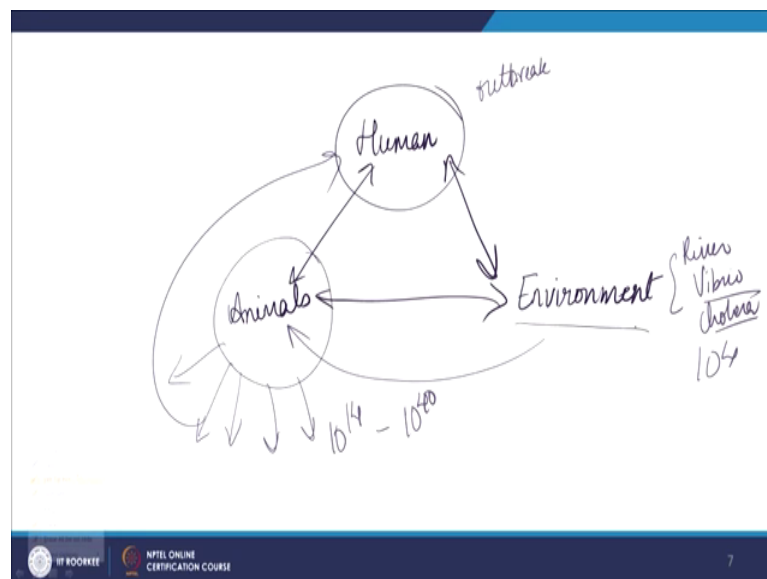
So, we do not have Zika here Nikka is also a vector borne disease. So, we have arthropod borne diseases we have rodent borne diseases and, we have other diseases that are also spread through bats for example, rabies already. So, again I hope you understand that human health many for infections are we shared them with animals all righty.

(Refer Slide Time: 20:00)



So, this is the concept of one health.

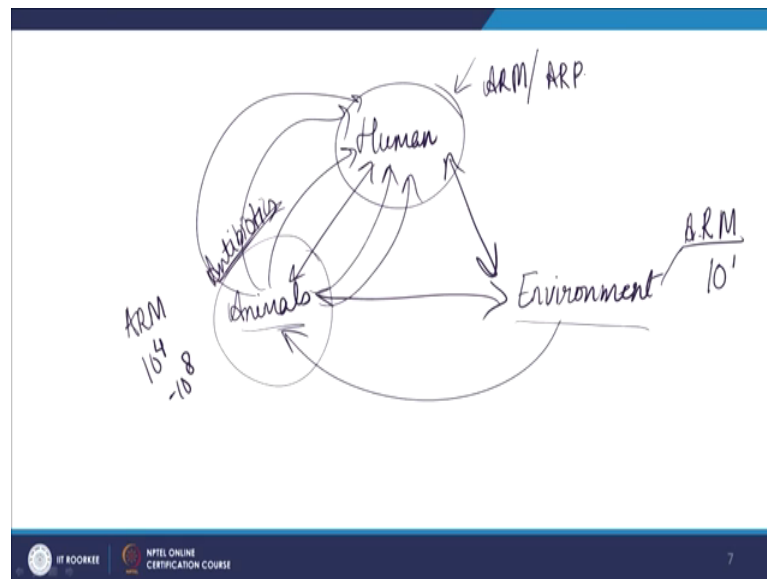
(Refer Slide Time: 20:06)



In one health, we are bringing together human health with Environment and, we appreciate the close link of human health with animals. And now we also know that animals where do they pick the disease from environment for example, our environment like our surface water river, has *Vibrio cholera* in it which in cause cholera disease and some animals pick it up, they drink water from lake from river, or from a small puddle that has *Vibrio cholera* microbes in it.

Now they get cholera and when they defecate the *Vibrio cholera* has increased here, let us say we had only 10 to power 4 cells of *Vibrio cholera*. Now we might have 10 to power 14 or maybe corrective pull might be very large and, now humans will get infected and now we have a full blown outbreak here. Another example is an environment we have as I mentioned earlier; we have always antibiotic resistant microbes.

(Refer Slide Time: 21:18)



So, antibiotic resistant microbes are naturally present in environment like soil because the antibiotics, they produce them they are used to their presence. Now the animals in many countries including India are given a prophylactic dose of antibiotics. So, animals become the reservoirs that actually select out only for antibiotic resistant microbes.

So, when animals are grazing, or eating, or lake drinking water from environment they are interacting with environment, they are actually selecting antibiotic resistant microbes. So, where it was 10 to power one let us say just 10 microbes in a small sample, now we might have much higher number depending on the dose of antibiotics and how we are giving them, and now when humans interact with animals because humans are rearing them, or when you consume their meat or when you consume their poorly treated milk, or the other body parts.

Now, humans or we just interact with them because remember, 70 percent of emerging diseases in humans are zoonotic, when these and we share lot of pathogens with animals.

Now congratulations are pathogens that resistant and, now we have a major problem for antibiotic resistant microbes pathogens antibiotic resistant pathogens, this is the reason why one health is very important what it does is it brings together environmental health ecology veterinary medicine public health, human medicine molecular microbiology health and, health economics under 1 m 1 umbrella to take care of individual health population health and ecosystem health.

So, now in one health our intention is to make sure that our environment is safe, it is our intention to make sure that our public health is ensured, public is safe and then our animals are fine too in their growing well enough for us to feed us. So, in under one health, we want to ensure all three different kinds of health and we are bringing them together this is translational medicine and so, men human medicine veterinary science environmental science all together come together to ensure 1 half.

So, students in this course I hope that you are read not, this course has been designed to prepare you for environmental health part of it somewhat ecology part of it ecosystem, and molecular microbiology part of one health. So, dear students this is all for today.

In this week's homework you will have a lot of questions from one health and one particular case study of an infection that was traced back to a particular animal, all the best for the homework that is all for today.

Thank you very much.