Introduction to One Health
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Lecture – 2
Introductory Concepts in One Health and Global Health

Hello and welcome to the Introductory Session on One Health and Global Health. My name is Pranab Chatterjee and I am affiliated with the Department of International Health at the Johns Hopkins University's Bloomberg School of Public Health in Baltimore, USA. I trained as a physician in India and my research interests span one health, infectious diseases both emerging, re-emerging ones and zoonotic infections and antimicrobial resistance.

I hope you enjoy this basic concept that I am going to present in this session. Because you are going to need these concepts as you go along the course and in further and further deep into the other modules. Let us dive right in on today's session on introductory concepts in one health and global health.

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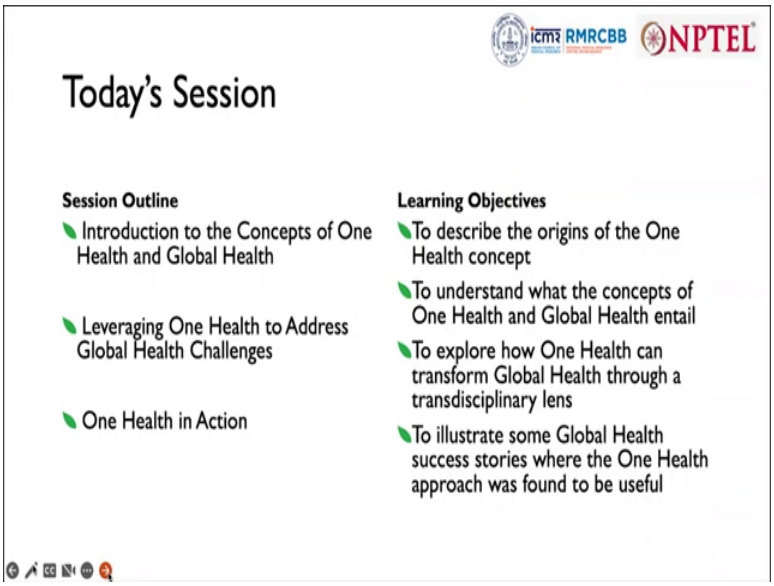

In today's session we will go through three sections, in the first one we will have a detailed introduction to the concepts of one health and global health. In the second section, we will have a session discussing and experiencing examples of how one health approach can be leveraged to

address global health challenges. And finally in the third section, we will see some examples of one health in action.

The learning objectives for this session are quite modest, I expect that after going through this session you will be able to describe the origins of the one health concept. To understand what the concepts of one health and global health entail. To explore how one health can transform global health through a transdisciplinary lens. And to illustrate some global health success stories where the one health approach was found to be useful. So, on that note, let us move in to the first section of this session.

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In this section, I will walk you through the concepts of one health and global health. One thing you need to remember going in is that the one health is an approach; it is a paradigm for addressing public health problems. It is not a specific methodology as such. So, although I will present some pre-set definitions with the expectation of outlining the ambits of one health.

Please remember that this approach can be used in many other connotations. In fact the flexibility of the one health approach makes it quite suitable for addressing many complex problems. Further in today's session, we will see some such examples.

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So, I am sure by now you have come across this formal definition of one health. So, I will not read through it if you want to go through it feel free to pause the video and read on. The UN's one health high level expert panel, something which I will henceforth refer to as OHHLEP for convenience is basically, the standard setting organization now as far as the one health approach is considered.

So, keep an eye on their products, documents and press releases to stay updated about the latest and greatest happenings in the world of one health.

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I was wondering, how I can best show you how the interest around one health has been escalating in the past few years. So, I went on Google trends and decided to check out how the search trends for one health performed over time. Now, just for background, the day the highest number of searches were conducted, Google trends takes that as a 100 level score and scales everything else in comparison to that.

So, as you can see from 2006 to around 2019 or 2020, the interest in one health was quite modest and quite stable. But something happened in 2020 which made the interest in one health trend upwards rapidly and eventually by mid-2021 the interest has peaked and it continues to remain at a high level. So what happened? Yes, you guessed it right. The Covid-19 pandemic happened and the interest in one health exploded in the subsequent months, not surprising at all.

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The interest in one health has grown so much that lately it has exceeded the interest in the term global health as far as Google Trends are concerned. From 2006 to around late 2020, both these trends were running neck and neck. And in the pandemic world, one health took off leaving global health behind by a large margin.

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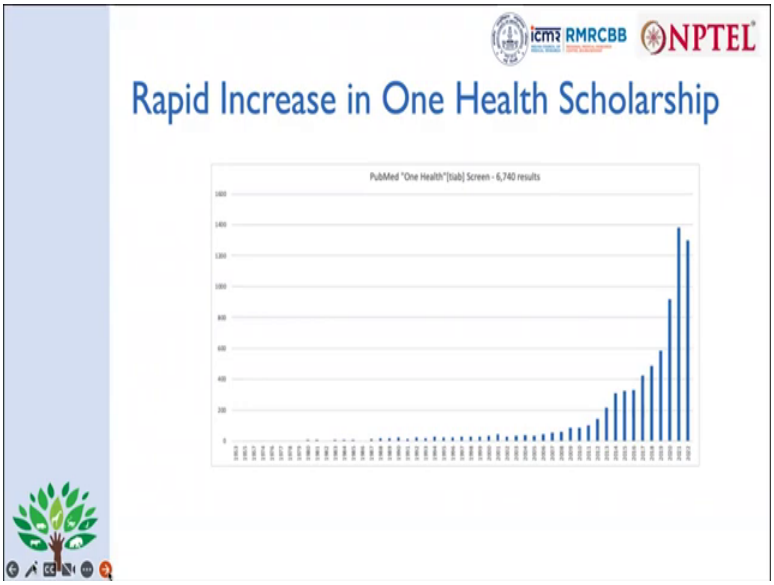

You may say that global trends of search strategies which is reflected through Google Trends is the pattern on the internet. And increasing Google search may not actually reflect a rise in scholarly interest around this area. So, to address that concern, I went on PubMed, the most popular database for aggregating medical research outputs and search for the term one health, only in the titles and abstracts of published articles.

Till around 2017 or 2018, the frequency of publications mentioning this term was quite low. Only hitting around 400 outputs each year but since 2019 the interest has just skyrocketed and it has increased by over 3.5 times in just a couple of years. So yes, there seems to be a rapid increase in the interest around one health even within academia and research communities.

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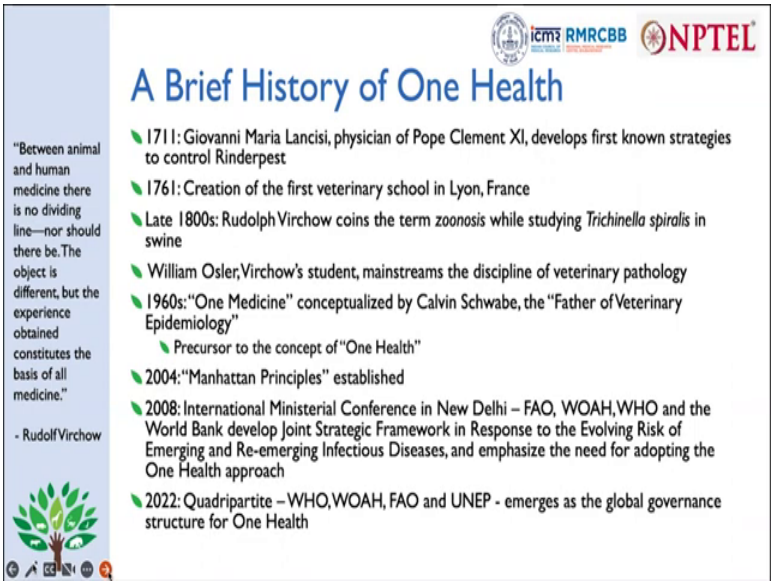

So, with that I want to spend a couple of minutes tracing the emergence of one health. Rudolf Virchow, the polymath physician was perhaps the earliest to recognize the fact that there should be no dividing line between human and animal medicine. However, a century and a half before work show in 1711 Pope XI th tasked his physician, Giovanni Maria Lancisi to stamp out rinderpest. Rinderpest was a disease which inflected great economic burden by destroying herds of cattle in Europe.

By the way just a quick medical trivia, do you know what is so special about rinderpest? Pause this video for a moment and think about it, I will give the answer in a few seconds. So, did you get it? Rinderpest is the only disease other than smallpox to have been completely eradicated from the world. Anyway, coming back to the history of one health again. The efforts of Lancisi in controlling rinderpest eventually led to the development of the very first veterinary school in France a few decades later.

The term zoonosis a word deeply entrenched in the one health lexicon was introduced by Virchow, when he was studying the occurrence of Trichinella in pigs. In the late 1800s and early 1900s William Osler, the legendary physician emerged as an unlikely champion for the cause of veterinary pathology. He is one of the most iconic physicians in the western world and is a personal hero of mine.

On a side note, I would like to say that he was very clever at coming out with aphorisms and for those who are interested in pithy bits of medical wisdom, I would recommend reading the book called The Quotable Osler. However, the true one health movement began in the 1960s when Calvin Schwabe, the father of veterinary epidemiology coined the term one medicine, it was the precursor to the concept of one health.

And in 2004, when the Manhattan Principles were outlined it brought more structure to the concept of one health. One health finally arrived in the mainstream of the global policy discourse, when the International Ministerial Conference elected to support the one health approach as a response option for emerging and re-emerging infectious diseases. However, a truly global governance structure for one health has been a long time coming.

We had the tripartite before comprising of the World Health Organization, The UN Food and Agriculture Organization and The World Organization for Animal Health. The very important concept of environment championed by the UN's environment program was only brought in formally in March of 2022 converting the tripartite into a quadripartite. The quadripartite has emerged as the global governance mechanism supporting the one health approach and it is espousal to address complex public health challenges.

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The concept of one health is quite multifaceted and many layered. In the paper referenced at the bottom of this slide, the authors attempted to create a word cloud to represent the keywords most commonly associated with one health. As it was defined or discussed in the documents of different global agencies working in the area. Now, I personally find word clouds hard to read, especially if there are many prominent terms.

But even I can clearly appreciate that the major terms associated with the one health concept at least in this word cloud are human animal environment interface and collaboration. This is important to note because one of the basic tenets of the one health approach is to break the disciplinary compartments. Which limit our ability to work across sectors when dealing with wicked problems, evolving within complex adaptive systems.

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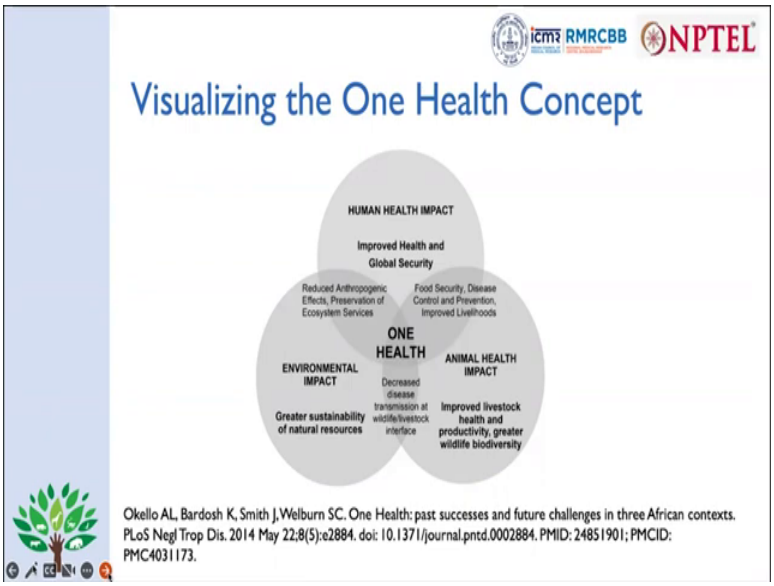

This is yet another figure that you must have become very well acquainted with by now. So, I will not label the issue and will not spend a lot of time explaining this. If you want to have a closer look at the figure, feel free to pause the video and go through it, back to the session again. If you are interested in reading the original paper from which this particular figure is drawn, feel free to check out the reference at the bottom of the slide.

Although this overlapping Venn diagram format is perhaps the most well-known depiction of the concept of one health, I actually have several issues with it. This is quite a static representation

for one thing and it does not capture the dynamicity inherent in the conceptual understanding of one health. So, let us go, take a look at another depiction that I find to be more accurate.

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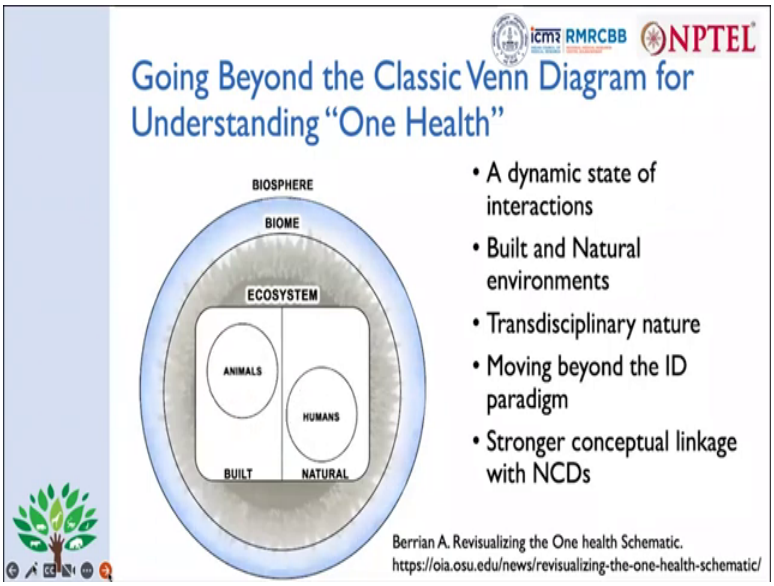

(Video Starts: 11:24) I hope that this GIF is moving around properly on the video, if not you can access this graphic through the link provided at the bottom of the slide. I find this representation to be a more accurate version of the one health approach. I feel that there is a need to move away from the static unidimensional Venn diagram format of one health and instead look for a more dynamic model.

While this model still has it is shortcomings, I feel that it captures the dynamic state of interactions between humans, animals and the environmental compartments more accurately. In addition, this model takes into account both the built and natural environments which is a bonus. Because this can help in moving beyond the infectious disease paradigm and build a stronger conceptual linkage to explain the emergence of non-communicable diseases as well.

Some non-communicable diseases like chronic obstructive pulmonary disease which is a chronic inflammation of the lung that may lead to obstructed airflow are linked to alternations in the built environment, such as through air pollution or exposure to toxic chemicals. So, this model in my opinion captures the dynamic transdisciplinary nature of the one health approach much more succinctly than the traditional Venn diagram can **(Video Ends: 12:55)**.

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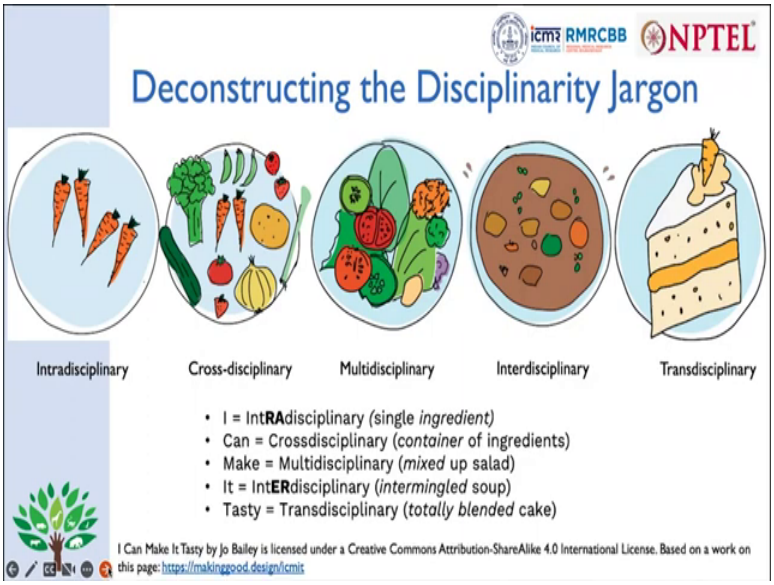

In the prior slide, I reference the word transdisciplinary. Now, this is one of the many terms that we struggle with within the jargon of disciplinarity when talking about one health. During the course of this series of lectures, you will come across these terms time and again intra-disciplinary, cross-disciplinary, multi-disciplinary, inter-disciplinary and transdisciplinary. On first glance, one may feel that cross-disciplinary, multi-disciplinary, interdisciplinary and transdisciplinary are interchangeable but that is not the case.

Although sometimes in colloquial parlance, these terms may be used interchangeably, they have very distinct connotations in the technical sense. But rather than run you through a maze of definitions which I admit are quite hard to understand, let me walk you through what these concepts mean. And if you are like me you probably enjoy learning through mnemonics. So, let me introduce you to the terms through the mnemonic, I can make it tasty.

I intradisciplinary, can cross-disciplinary, make multi-disciplinary, it inter-disciplinary and tasty transdisciplinary. To further simplify the concepts, let me borrow a brilliant imagery which represents these concepts quite well. Intra-disciplinary working is working within one discipline like a single ingredient, clearly distinguishable. So, it is like a bunch of carrots. cross-disciplinary working views one discipline from the frame of reference of another, it is like lots of different vegetables on a plate.

But you have not chopped them up or mixed them up, it is as if you just laid out a bunch of different vegetables that you have just purchased from the market. Multi-disciplinary work brings disciplines closer together so that they can learn from each other drawn the mix of disciplinary experiences. So, in a sense it is like a salad, the original ingredients are there, you have cut them up and mixed them up but the flavours begin to mix up as well.

We have chopped up the vegetables sliced and diced them mixed them up with dressings and made a salad out of it all. Inter-disciplinary working starts to take a new form in this there is integration of knowledge and methods from different disciplines and it starts getting synthesized into a new version. So, it is like a vegetable soup, the original vegetables are still partly distinguishable but the overall is a blended mix of different flavours.

The vegetables are starting to melt together and their individual structures and flavours are starting to amalgamate into the taste of the soup. And finally transdisciplinary, transdisciplinary working produces a completely new form or way of working which is beyond the original disciplinary definitions. So, it is like a carrot cake or if you are like me Gajar ka halwa.

You can no longer see the individual ingredients or vegetables as they have all taken on a different shape and flavour. All the carrots and spices and sugar and everything else has lost their individual structure and taste and instead, we have created this new wonderful product a plate of yummy halwa or a beautiful carrot cake. I hope this light-hearted explanation was helpful and now, you can remember what these different terms mean.

As you come across them in different lectures, papers and projects, I would recommend going to the site from where I source the image. They have a lot more fun and interactive ways to understand these concepts, hope you enjoy them too.

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Now, the one health concept comes on the heels of several other similar concepts. I will quickly walk through the meaning of each of these concepts. So that when they crop up in papers or discussions about one health, you can refer back to this video and consider their meanings. Environmental health is concerned with all aspects of the natural and built environment that may affect human health.

This discipline addresses all the physical, chemical and biological factors external to a person and all the related factors impacting behaviours. It includes assessment and control of those environmental factors that can potentially affect health. It is targeted towards preventing disease and creating health supportive spaces. The eco health approach focuses above all the place of human beings within the larger ecosystem.

It recognizes that there are inextricable links between humans and their biophysical, social and economic environments. And that these links are reflected in a population state of health as they strive to achieve sustainable health for people, wildlife and ecosystems. Ecosystem health is a metaphor used to describe the condition of an ecosystem, the ecosystem's health can vary as a result of fire, flooding, drought, extinction, invasive species, climate change, farming, deforestation, chemical spills and a host of other reasons.

And finally planetary health. Planetary health is the newest kid on the block; it is defined as the achievement of the highest attainable standard of health, well-being and equity worldwide through judicious attention to the human systems, political, economic and social that shape the future of humanity and the earth's natural systems that define the safe environmental limits within which humanity can flourish.

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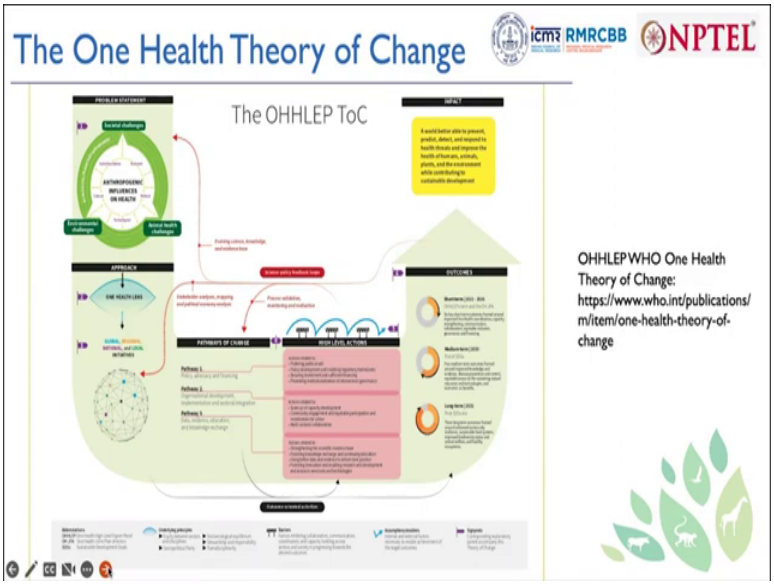

Whew! going through the definitions was quite a heavy task but unfortunately, I have yet another heavy and somewhat busy slide lined up for you right now. This is the one health theory of change which was published by the OHHLEP, the same group that came up with the modern definition of one health. But before we delve into this particular model, let me just tee up what a theory of change is in case you are not familiar with the concept.

Those who already know about it, feel free to let your mind wonder for a few seconds. A theory of change is a model which provides a comprehensive description or explanation or illustration of how a desired change takes place within a given context. This model outlines the process of change and explains how that change will take place. It identifies different steps in the change making process.

Such as causal linkages, resources required, activities to be undertaken, barriers to be overcome, facilitators to be empowered and so on and so forth. They describe how these factors work in

lockstep to make sure that the desired outcomes are achieved. This approach can also be helpful in addressing complex challenges, especially those which are multi-layered or have multi-disciplinary roots.

It is also helpful in identifying underlying assumptions and risks which may hamper the achievement of the final outcome. So, you can identify which factors to strengthen and which ones to dismantle. If you are to achieve the final goal. That said, let us take a quick look at this particular theory of change. The OHHLEP has developed this theory of change to facilitate the development of a world better able to prevent, predict, detect.

And respond to health threats and improve the health of humans, animals, plants and the environment while contributing to sustainable development. This is the final outcome, the change that the global one health movement desires to achieve. I know this is a busy slide and you may not be able to read all of the details on the video screen. So, I would encourage you to visit the link on the right-side to check out the document elucidating this theory of change.

In fact, they have explained it step by step and outline potential barriers and facilitators and strategies for reaching the ultimate objective. The main takeaway, I want to get out of this slide is the fact that this model recognizes that human activities have a major impact on the health and well-being of humans, animals and the environment. And it identifies a series of pathways which operate through social, animal and environmental challenges.

It also outlines specific actions which can help in countering the adverse health events of human, animal and environmental health. For more details, I would encourage you to refer to the linked document. Understanding the one health theory of change can also help in reconciling the interlinkages between global health and one health some of examples of which we will discuss shortly.

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So that concludes the part about the concept of one health. Let us now move on to the concept of global health. I am not a great fan of wordy definitions but sometimes reciting a definition can be the best way to summarize a complex and multi-layered concept. I think global health is one such concept, it takes on different meanings and connotations depending on the context from which you were viewing this.

It has this historical roots in the colonial form of tropical medicine which was developed to protect the soldiers and citizens of the colonizing countries when they travelled to the colonized countries. In these colonies they were faced with a plethora of infectious disease challenges that they had never ever faced back in the western world. The rise of tropical medicine led to the emergence eventually of international health, an approach which focused on health for all within nations and across nations.

It encouraged transnational cooperation and multi-disciplinary collaboration. Global health is a more recent and equity oriented approach, it is defined as an area for study, research and practice that places a priority on improving health and achieving equity in health for all people worldwide. Global health emphasizes transnational health issues, determinants and solutions.

It involves many disciplines within and beyond the health sciences and promotes interdisciplinary collaboration. It is a synthesis of population-based prevention with individual level clinical care.

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If you are interested in understanding more about the history of global health, I would strongly recommend checking out Randall Packard's masterpiece called the history of global health, interventions into the lives of other people. I know for many of us the very term history conjures a terrifying nightmares from high school days. But trust me, when I say this this book is an incredibly detailed, yet quite lucid and readable exposition of global health.

If you are interested in learning about the practice of global health then I would recommend two excellent books. One on the life of Dr. Paul Farmer, an incredible global health physician who has shaped and inspired thousands of global health enthusiasts, myself included. Tracy Kidder, mountains beyond mountains is a biographical look at Dr. Farmer's life and it explains the principles of the practice of global health through his work and philosophical outlooks.

If you are interested in a more academic treatment of the practice and delivery of global health services. I would recommend that you look for Joia S. Mukherjee's excellent book on the Introduction to Global Health Delivery, it is one of the more detailed discussions around the

nuances of global health services and delivery. Finally, I would also refer you to a link on the global health now.

Website which is basically a post written by Dr. David Peters who was until recently, the chair of the Department of International Health at Johns Hopkins Bloomberg School of Public Health. In this piece he argues that the dichotomy between international health and global health is a false distinction. And these two terms refer by and large in an interchangeable fashion to a similar philosophy and set of actions, it is a short and very interesting read.

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Now that I have given you a peek into my library back to global health again. I know one health and global health sounds like they share several common key concepts such as improving health, achieving equity, addressing transnational health issues, involving many disciplines, working within and beyond the health sciences and promoting collaborations. But it is not just a rebranded version of global health, it is a unique approach which enables us to deliver global health interventions in an effective manner.

The World Health Organization acknowledges that the one health approach is the best way to transform how global health is practiced today.

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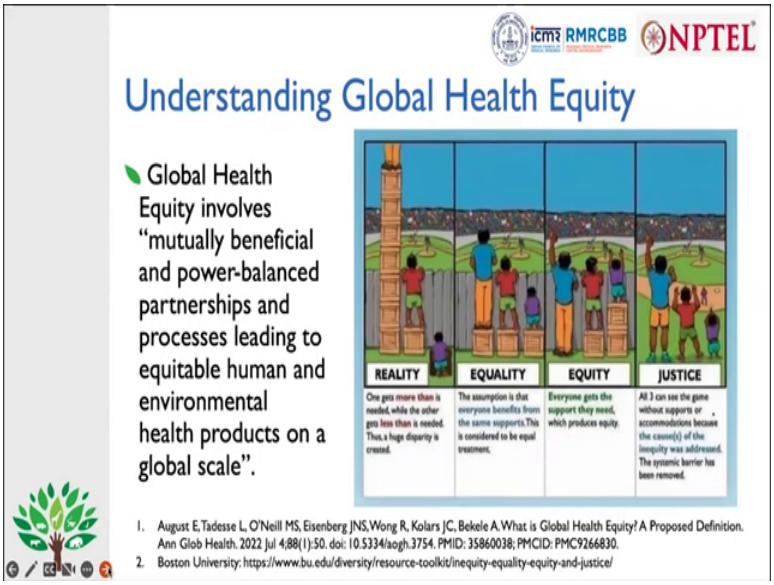

A key tenet within global health is equity, global health equity involves mutually beneficial and power balanced partnerships and processes leading to equitable human and environmental health products on a global scale. I will refer to the figure on the right to walk you through the concept in an easier fashion. Imagine that a cricket match is going on and we are standing outside the stadium.

Today's reality is that a person who is a little bit richer is a little bit more affluent they will bring a bunch of boxes, stand on them and enjoy the match. Some of us will be left behind, unable to look over the fence and see what is going on, equality happens when each of us is given one box to stand on. However, a shorter friend of ours will not be able to benefit from this one box approach because he still cannot see over the fence.

Now, when we take away the one box from the tallest guy, who can stand on his feet and still watch the game. He is tall enough to look over the fence and we take that one box from him and give it to the shortest guy, it seems like it is a win-win. Everyone can now watch the game, everyone gets the support that they need and the final ultimate concept is justice. When we completely remove the fence and the tall and short friends all can gather around together to watch the match without requiring any boxes to stand on.

The underlying cause of inequity in this case the fence has been removed and we can all enjoy the game. Now, these underlying factors may be many different types, issues like race, cost, gender, socioeconomic status just to name a few. All of the other factors within the social determinants of health, all of these can lead to inequities. One of the ultimate dreams and desires of all global health practitioners is to be able to remove all of these systemic barriers and make a just world for all of us.

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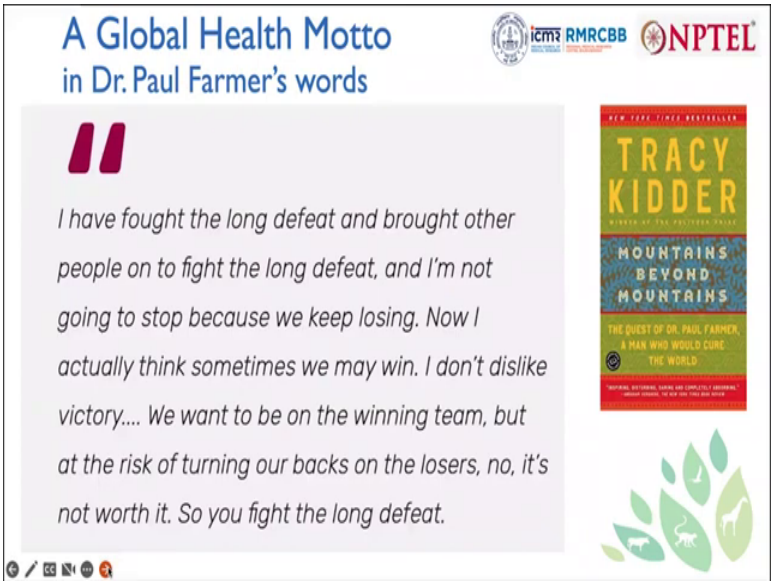

One last slide, before we conclude the first section on introduction to the concepts of one health and global health. Both these approaches went their way towards health equity and social justice. As we just saw in the last slide, the challenge is to remove the fence to break down all the systemic barriers so, people can enjoy the best healthy lives that they deserve. However, for realists and pragmatists like me, this sometimes feels like a utopian dream.

So, in times when I feel demotivated by the huge challenges that we have to work against, I look back to Dr. Paul Farmer's incredible words in the book, mountains beyond mountains. He says, I have fought the long defeat and brought other people on to fight the long defeat and I am not going to stop because we keep losing. Now, I actually think sometimes we may win. I do not dislike victory.

We want to be on the winning team but at the risk of turning our backs on the losers, no, it is not worth it. So, you fight the long defeat. What he means here is that? Yes, it is quite likely that we will not be able to overcome all the huge challenges and systemic barriers and burdens that stand in the way of global health equity and justice. However, the nature of the practice of global health is such that we cannot give up.

We have to keep fighting on knowing full well that we are most likely to lose. No one person is likely to solve the conundrums that global health poses before the world today. But we just keep fighting on, we keep fighting the long defeat, Dr. Farmer, whose work and life has been an inspiration for thousands upon thousands of global health warriors across the world passed away quite suddenly last year.

However, like he said the struggle, the fight against the long defeat goes on that after all is the nature of all our global health enterprises.

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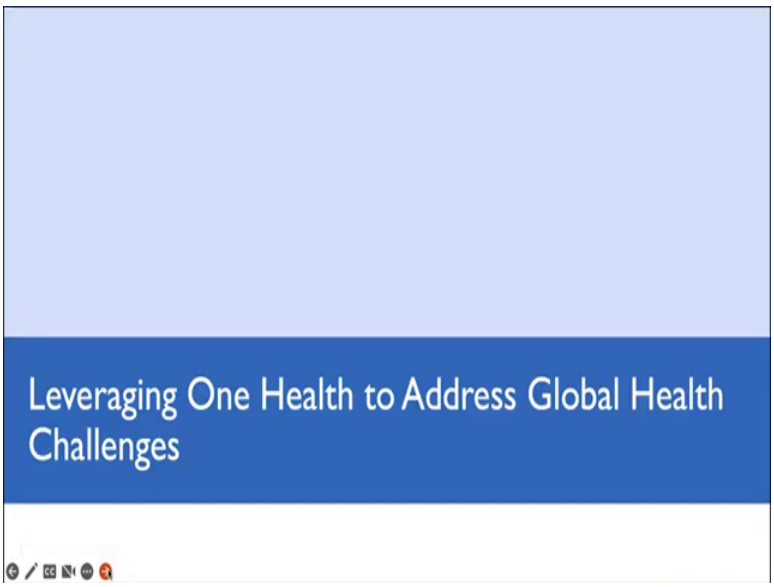

Now that I have given you a lecture on the philosophy of global health, it is time to come back to more pragmatic and real-world situations. We have talked about the concepts of global health and one health and spoken about the philosophical principles underpinning the concept of global health. Now, it is time to see how the one health approach may be used to solve global health problems.

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Like I have already said before, one health is a potent way of improving the way we deliver global health interventions and services in an effective manner. The one health approach gives us assistance thinking lens through which we can view the world in a very different manner. One health helps us to see the connections between human health and a myriad other factors stemming from the social, environmental, animal health, food and systems issues.

This is especially important because in healthcare or in public health, we are often predisposed to think in terms of vertical programming. And what do I mean by vertical programming? Take the issue of HIV program or the TB control program, or even the efforts to contain antimicrobial resistance. All these conditions are the result of multiple risk factors colliding.

Sometimes we are unable to address some of the non-health factors from our location within the health systems. For instance, when we think of controlling an antimicrobial resistance, we immediately think about antimicrobial use in hospitals or pharmacies or over-the-counter sales. However, the reality is that a major chunk of antimicrobials are actually used in food animals. Another example, when we think of TB, we have to account for nutrition and food security.

However, when we function out of the health system as a health functionary, we have very limited ability to affect the nutrition factors. Because these nutrition factors and food security

factors are deeply linked to social and economic drivers. One health allows us to apply the multi-disciplinary lens and not just treat a problem from the medical or public health angle. But look at it in a holistic manner and it allows us to deal with the ills that affect our world.

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It is only natural that the one health approach is integral to achieving the sustainable development goals or SDGs. As we already know, the SDGs are the foundation stone of all health and development related work. It is the goal we aspire to achieve. However, there is surprisingly little commentary on how the one health approach can potentiate our ability to improve our chances of reaching the SDGs.

I would strongly recommend the interested listeners to go and check out the paper I have referenced on the right-side text box. This is also the paper from which I have sourced the simple, yet powerful image on the left. I know the image may be a little difficult to read. So, I will just summarize the main potent of this figure. The key message is that different aspects of the SDGs are linked deeply with the various tenets or aspects of one health.

SDG is focused on human health and well-being are linked to the innermost circle. The human health and well-being factor within one heakth. There are several SDGs that are linked to the natural environment and built environment which is referred to as infrastructure in this figure. And finally, all of these are based on the foundation of SDG 17 which encourages collaboration

and intersectoral working which is, as we have already established, one of the key philosophies underlying the concept of one health. .

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I have been speaking for a long time and I am sure by now your attention span has started to waver. So, I will give you a break and send you off on an activity. I propose that we pause the video and then go on the activity. Do not worry this activity is linked to the one health approach. Your task is to go watch a movie. The movie is called contagion and I am sure it is available on one of the OTT platforms or on YouTube.

And if you have already watched it before, do not worry, you might want to watch it again. I have some additional tasks for you.

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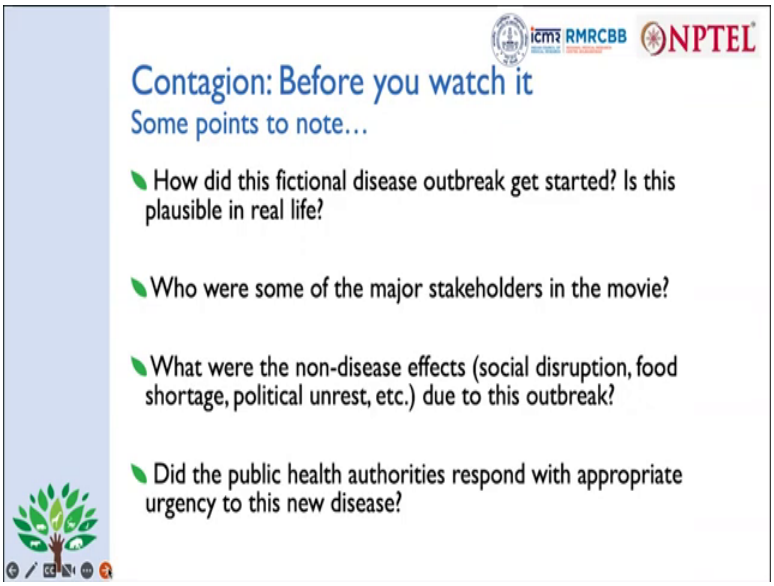

Before going to watch the movie, note down these questions and see if you can find the answers as you are watching it. These are your questions. How did the fictional disease outbreak get started? Is this plausible in real life? Who were some of the major stakeholders that were involved in the control of the outbreak in this movie? Can you identify some of the non-disease effects like social disruption, food shortage, political unrest that was caused by this outbreak?

And finally, do you think that the public health authorities responded with appropriate urgency to this new disease? On that note, pause this video and go watch Contagion the movie.

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I hope you have watched the movie and mulled over the questions I posed in the last slide. Unfortunately, we live in an era when real life imitates reel life all too closely. Remember the Covid-19 pandemic? Steven Spielberg famously said that there is no such thing as science fiction, there is only science eventuality. Unfortunately, for us we have had to live through a pandemic much along the lines of the movie you just watched.

So, why did I make you watch a movie in the middle of a didactic lecture? I kind of wish we were doing this in person. Because in that case we would have been able to think through the similarities and differences between the situation in the movie. And the covid-19 pandemic experiences we have seen. We could look at systems strengthening and the role it could have played in averting the pandemic related pandemonium, both in the movie and in the real-world.

And in doing so, we would have reflected on the need for one health in solving complex problems. But we are not in person and we are looking at this asynchronously. So, I would encourage you to undertake these thought experiments on your own.

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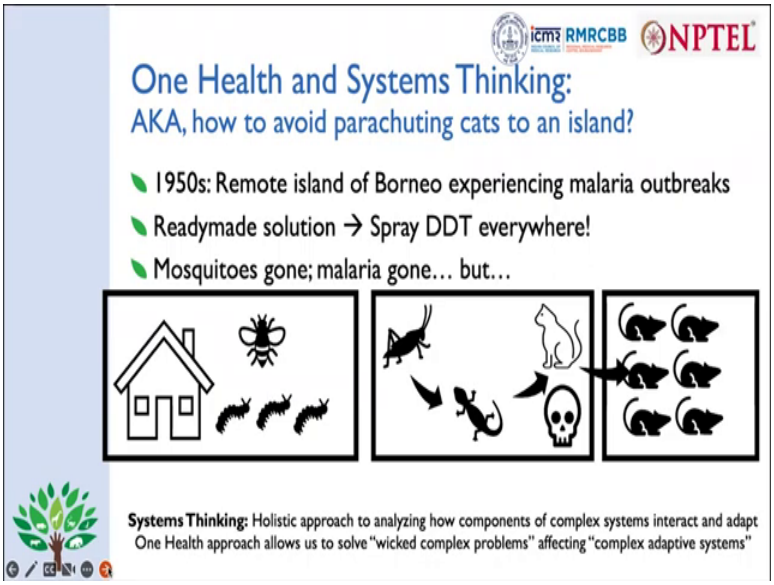

Since, I just talked about one health and systems thinking, let me talk to you about a real-world incident. This is one of those stories where reality is stranger than fiction. Let me take you back to the 1950s in the remote Islands of Borneo, where the local residents were experiencing intense

malaria outbreaks resulting in much morbidity and mortality. So, they approached the World Health Organization and asked for help.

And back then there was a ready to go solution DDT, the WHO are advised the residents to spray DDT everywhere. And so, they did and they were able to decimate the mosquito population. Naturally, the number of malaria cases also went down. But unfortunately, this also set into motion quite unwittingly a series of unfortunate events. A few days later, the local residents, who mostly lived in Kutcha huts with thatched roofs,

Started to complain that their roofs were caving in. It so, happened that the DDT not only killed off the mosquitoes but it also destroyed a species of predator wasps. These wasps used to feed on small worms and caterpillars. But with these predators, gone the caterpillars exploded in population. And these caterpillars happen to feed on the thatch with which the roofs were made of.

Naturally the roofs got weakened and then they came crashing down but that was not all. It was in fact just the beginning of the troubles. The DDT was taken up by small insects as well. And when the lizards that consumed these insects, the DDT started bio-accumulating within the bodies of these lizards. However, these lizards turned out to be incredibly resistant to the adverse effects of DDT. They remained hale and hearty.

Although, the content of DDT in their bodies kept going up and up. Now, the local cats used to feed on these lizards. And unfortunately, the cats were extremely susceptible to the adverse effects of DDT. So, what happened? You guessed it right. The cats started dying and what happens when cats die? Yes, the population of rats and other rodents explodes. Soon rats were overrunning the island and not too much later. There was a deadly outbreak of plague.

Now, the residents of the island were back again asking WHO for help and guess, what the WHO suggested this time? They suggested air dropping cats into the Island. So, soon after this cats were being parachuted into the Island. A bizarre solution for assistance problem that nobody appreciated and that nobody saw coming.

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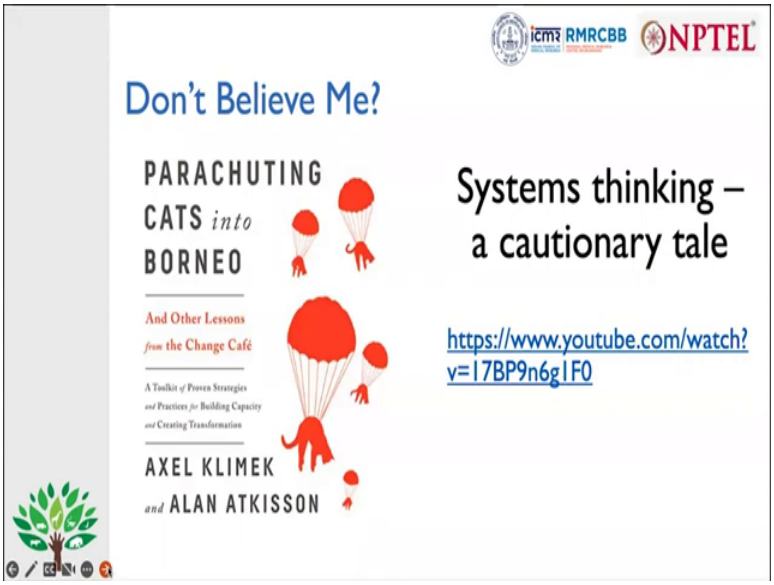

I know you may not believe me but there is a book about this story and other similar issues, parachuting cats into Borneo. And other lessons from the change cafe by Alex Klimek and Alan Atkisson. If you do not believe me, go check this book out. Alternatively, I would also recommend checking out the wonderful YouTube video that I have linked on the right-side panel. It uses the parachuting cats incident to explain how systems thinking works.

I think I have given you lots of definitions to digest in this session. And a YouTube break might just be needed right now. So, pause this video again and go check out the YouTube link. What once you are done watching the video, we can come back to the end of this second session. Second section of this session and pick up with the third and final section of today's session.

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Hope you pause this video and checked out the YouTube link and had fun watching it. Now that we are back again, I wanted to point out that we have had extensive discussions on the concept of one health and global health. And we have visited the idea of systems thinking and how one help can fit into the global health agenda. Having gone through all of that it is now time for us to start talking about some real-world applications of the one health approach.

This is where the rubber meets the road. Let us take a quick look at some examples of one health in action.

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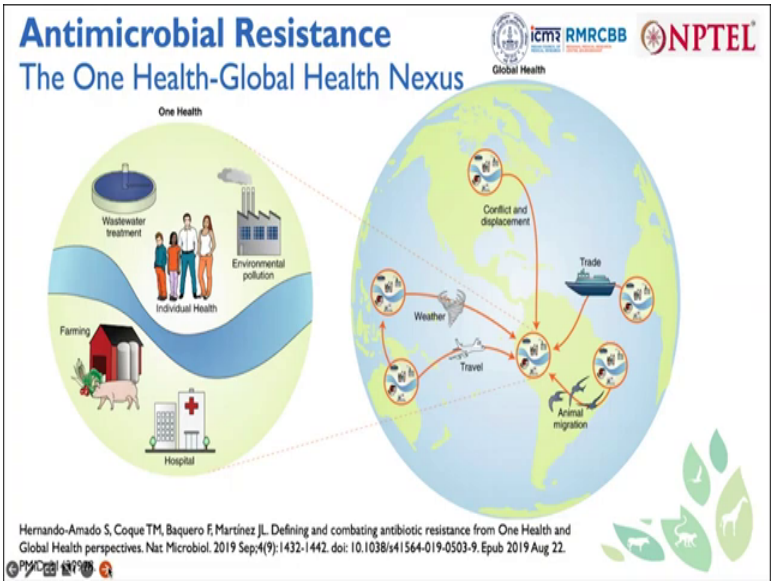

As I have told you, I am interested in antimicrobial resistance and I am a little bias to the world of antimicrobial resistance. So, I will start the stories about one health in action with the antimicrobial resistance experience. From this point onwards, I will refer to antimicrobial resistance, as AMR as it is quite a mouthful. So, AMR happens to be the quintessential one health issue.

It is one of those things that does not respect international borders and national boundaries. It can spread at a local level through water or food or infectious diseases. It can originate in the community or in the healthcare facilities or even in food, animal rearing farms and then keep spreading outwards. AMR can emerge as an aftermath of antimicrobial pollution of the environment from pharmaceutical plants.

Or even due to heavy metals being released into the environment, as some of these heavy metals can result in selection of resistant strains of bacteria. On a global level, we live in a hyper-connected world and AMR can spread from continent to continent through multiple roots that is why there is an adage which says AMR anywhere is AMR everywhere. In fact, some novel AMR genes that were seen to emerge in a particular local context were observed to spread rapidly across multiple countries.

One of these genes was noted to have spread to as many as 70 countries within a few months of it is first identification. This is a terrifying new reality that we live in but it is also an excellent example of how one health and global health problems intersect.

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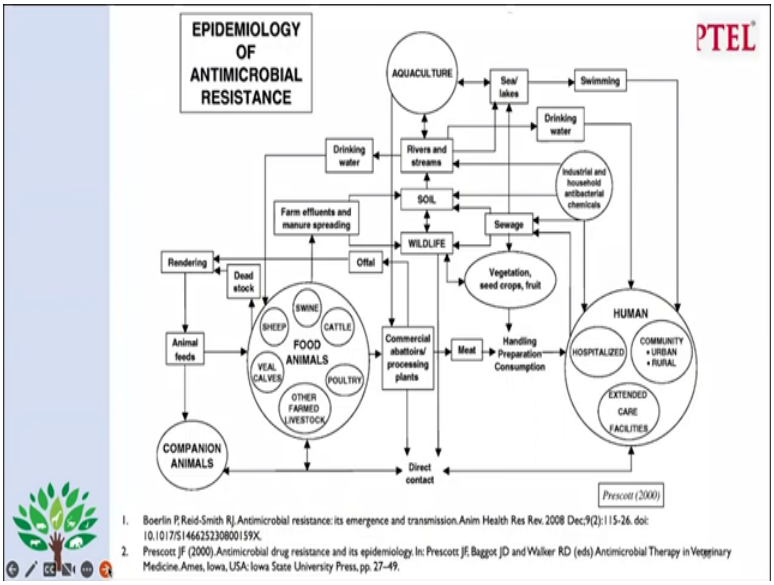

This model that we can see on this slide, sometimes called the AMR confusogram because it is pretty confusing, is a very famous one. It shows the complex reality of AMR. And how it transmits within and between different sectors food animals, companion, animals, environmental sectors, aquaculture, agriculture, human health. They are all interlinked in this web of causation and transmission of AMR.

I think this image speaks a thousand words about why we need a multi-dimensional approach to combat AMR.

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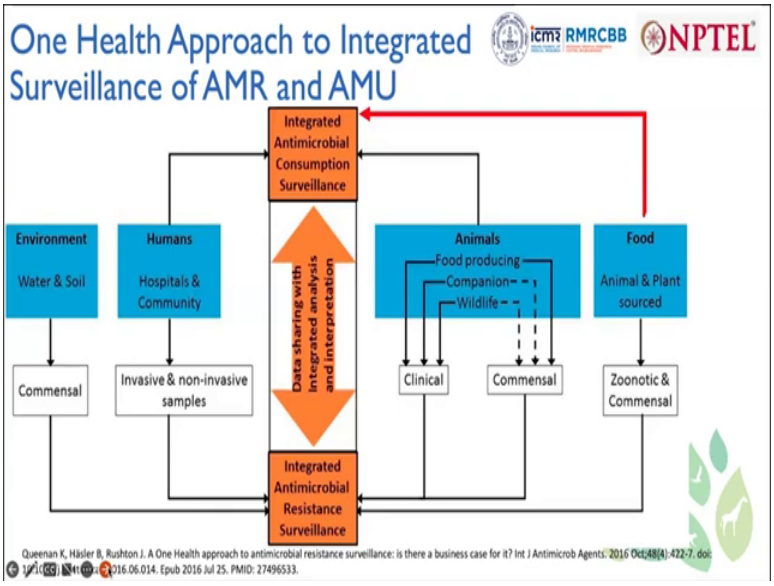

The one health approach is not only good for explaining the epidemiology of AMR but it is also a great tool to conduct surveillance for AMR and antimicrobial usage which I have shortened to AMU in the title of this slide. This slide depicts a model of integrated AMR and AMU surveillance, covering multiple sectors and risk pools. The lower flow indicates the different arms pulling in data about AMR from the different sectors.

While the upper flow indicates surveillance of AMU in the human and animal health sectors. I would also add an element of AMU surveillance from plant source foods because recent evidence indicates that a substantial amount of antimicrobial is used in crops as well. For instance, a study estimated that only in Southeast Asia, we use about 63 tons of streptomycin and 7 tons of tetracycline annually for growing just one crop.

Rice to put these amounts in context in the U.S for human health purposes, we use only about 7 tons of amino glycosides annually. Now, amino glycosides is the broader antibiotic class within which streptomycin is just one member. So, long story short I would like to include an arrow from the plant source food to the AMA box at the top. However, I have to admit that one shot coming of this model is that it might be susceptible to local contextual factors.

And as such, it might generate data which could be difficult to compare across different geographic locations.

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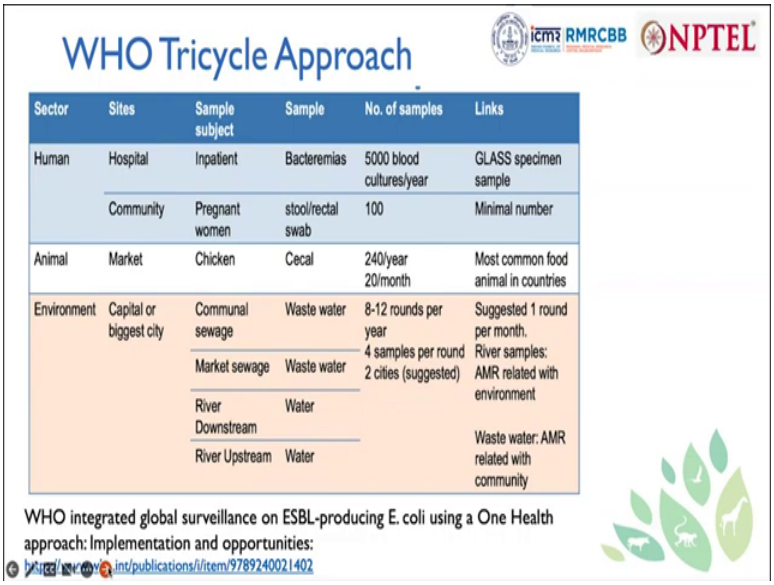

To address this issue there is another excellent example of using the one health approach to design a server less program for AMR. It is the WHO tricycle protocol. Basically, this approach simplifies the process of collecting information on the indicator bacteria, extended spectrum, beta-lactamase, producing E. coli or ESBL producing E. coli. The samples are sourced from hospitals and community settings on the human health side.

From the markets, for the food animal side and from urban waste sources and rivers in the environmental side. So, there are three spokes or sources of samples within the approach which is why it is called the tricycle approach. These samples are collected and processed according to a specific protocol, making the data coming out from the effort to be more comparable on a global scale.

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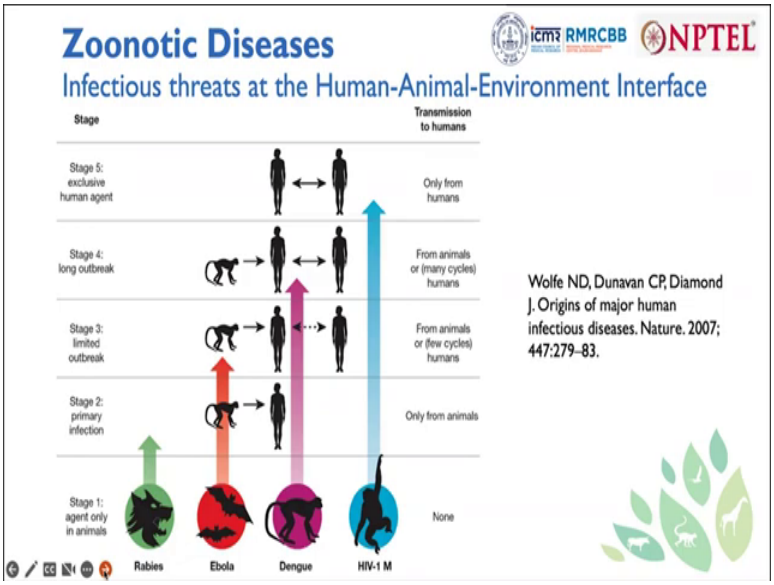

Another great example of one health in action is tracking and understanding the epidemiology and emergence of zoonotic diseases. Zoonotic diseases, as we already know, are those infections which spread from animals to humans. There are about 25 or so families of viruses which have the biological potential of causing human infections. There are an estimated 1.67 million unknown viruses within these 25 families.

And out of these 1.67 million viruses, around 631 to 827 thousand that is around 6.3 lakhs to 8.3 lakhs viruses are believed to be capable of causing infections in human beings. This is a substantial number, especially considering the fact that right now there are only around 219 or so virus species that we know as infection causing in human beings. So, the question is: how do we know which viruses are about to spill over?

In that context, it has also been noted that the likely origin of a novel pathogen which is sometimes referred to as pathogen X is from animals. Since the 1940s, 335 emerging and re-emerging pathogens have been documented with 60% of these coming from a zoonotic source. In the last three decades alone, 30 new human pathogens have been detected. In lay terms, we can say that on average there has been one new pathogen emergent every year in the recent past.

These numbers look daunting and modelling approaches have shown that there are specific risk zones for emerging and re-emerging infections. While these diseases are likely to be first reported from or detected in high income countries. Their point of origin is most likely going to be in low middle income countries, tropical countries which also have a high degree of biodiversity.

And are experiencing a large anthropogenic pressure leading to change in land use patterns. Given this risk of emergence from zoonotic sources. The next question that naturally sets up is which are the pathogens that are likely to spill over from animals to humans? To answer that, a multi-step evolutionary approach has been proposed which is outlined in this figure. And it explains how a pathogen which is limited to infecting animals exclusively.

At the stage one can become capable of infecting humans and eventually become capable of undergoing human to human transmission. However, the issue of identifying the optimal conditions under which a pathogen spill over from stage one to stage two that is the point at which it crosses the species barrier, remains poorly understood. This is an area where one health can lead to generation of new knowledge and understanding.

Just for background information, the probability of a pathogen crossing over from animals to humans depends on multiple factors. For instance, the probability of spill over increases with increasing population of donor hosts, higher prevalence of the infection in donor hosts, increasing frequency of interfacing between the donor and recipient hosts, closer phylogenic proximity between donor and recipient host.

And the ability of the particular microbe to evolve and become infectious and contagious. However, many pathogens do not fit very well into these models and one health is the key that will probably go unlock the fault where the answers to these complex questions are hidden away. Given the fact that there are multiple risk groups, reservoir hosts intermediate hosts and environmental reservoirs to name a few.

It becomes imperative to use a transdisciplinary lens to assess the risk of spill overs. One such effort in place is the global virome project which is a collaborative scientific initiative, to discover zoonotic viral threats and to stop future pandemics from happening. Remember all the lakhs and lakhs all the hundreds of thousands of unknown viruses that have the potential of spilling over into humans.

One of the aims of the global virome project is to discover these viruses and assess their spill over capability. Unfortunately, we are still living through a viral pandemic and the project was not really able to capture its spill over potential in time. So, despite the improvement in diagnostics and understanding of viral transmission, it remains difficult to predict how much success these very ambitious projects will enjoy.

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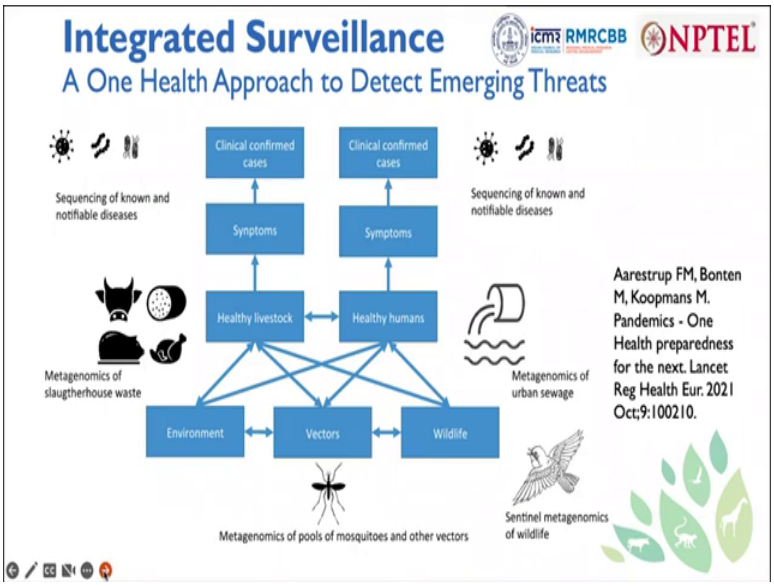

With these concerns in mind, the next piece of the puzzle is to design and devise integrated surveillance systems based on the one health paradigm. While the value of such an approach is broadly acknowledged, there remain a multitude of pragmatic issues. Especially, when it comes to implementing this integrated surveillance system. The emergence of technologies which have enabled undertaking genomic analysis on a large scale is quite encouraging.

And it opens up avenues such as integrating wastewater surveillance or vector pool testing to improve our ability to identify early warning signals of an impending spill over or zoonotic disease outbreak.

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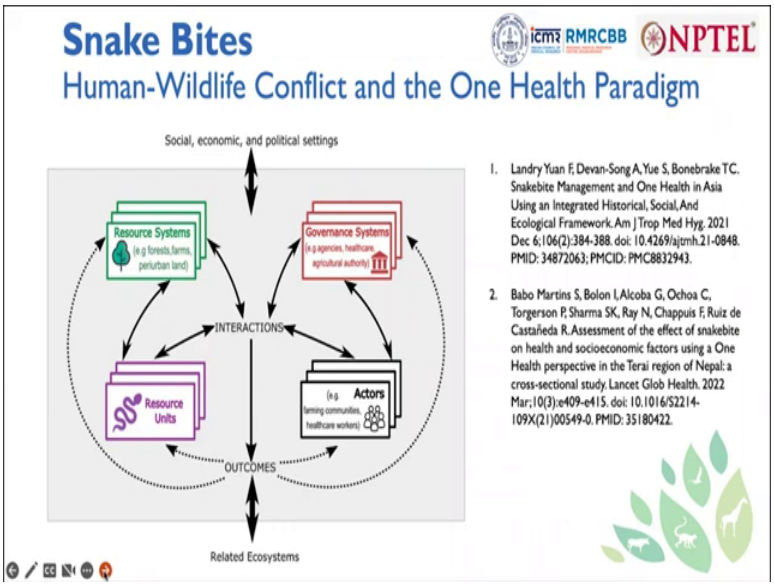

So far, we have just been talking about infectious diseases and how the one health approach can be used to inspire solutions to combat them. However, at the beginning of today's session, I had also stated that the one health approach can be deployed beyond the remit of infectious diseases. One such condition is the human wildlife conflict, a classic example of which is snake bites.

While this is still a growing field of research, snake and human interactions happen in the setting of social, economic and political factors within a specific set of ecosystem drivers and is modulated by a wide spectrum of risk factors. It is quite easy to appreciate the fact that one of the settings in which there may be an elevated risk of snake human interactions, is at the edge where growing human habitations and agricultural lands meet forests.

Degradation of forest clans, decimation of food chains, rapid increases in the peri-urban population and reclamation of forest covered land for agriculture. All of these are likely to affect the frequency of snake bites in a specific setting. Thus, the one health paradigm is able to provide an excellent window of our opportunity to not only describe this complex, multi-sectoral

epidemiology of snake bites. But also to develop, identify and test trans-sectoral solutions to address this problem.

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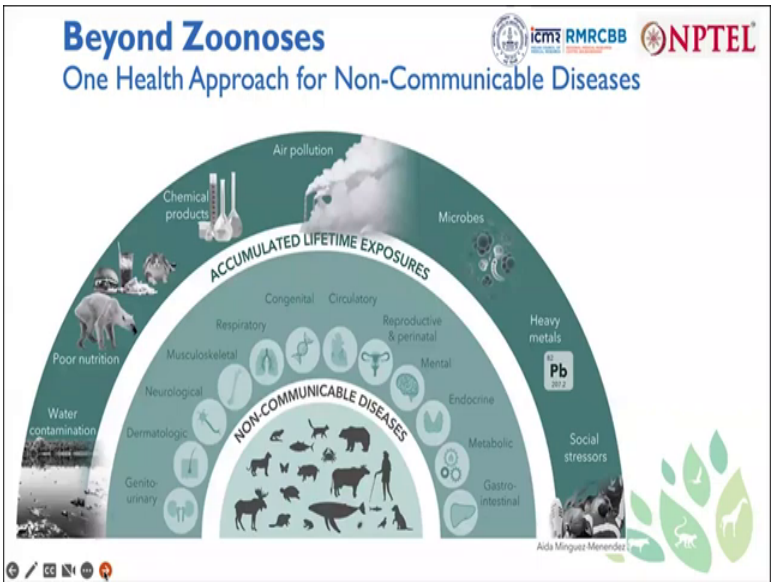

Finally, we also have to remember that the one health approach is a powerful concept and its reverberations can be felt beyond zoonosis, beyond infectious diseases and beyond AMR. In fact, for several non-communicable diseases, it can also provide a framework to explain the epidemiology and explore potentially innovative solutions, for instance, air pollution which is a form of disruption and degeneration of the physical environment around us.

And air pollution is linked with respiratory illnesses, like chronic obstructive pulmonary disease and emphysema. The alterations in built environment can result in increased sedentary lifestyles as the population increases and recreational spaces shrink. We become more and more unlikely to engage in physical activities and this can result in obesity, diabetes and hypertension.

If we live in a food desert where there are no viable options for obtaining affordable, healthy foods. We consume unhealthy diets and this can increase our risk of suffering from obesity, diabetes or hypertension. Again, living in crowded urban spaces, with limited options for recreation sports and physical exercise, has also been linked with worsening mental health, something which we came to understand a lot better in the last couple of years as well.

One final example where the built environment has a major impact on health outcomes is in the case of road traffic accidents. Unsafe roads, poor traffic conditions and other aberrations in the built environment can elevate the risk of experiencing a tragic road traffic accident. So, in summary, what I want to say is that the one health paradigm can be used to explain how the natural and built environment can interact with our lifestyles and other risk factors and result in the propagation of non-communicable diseases as well.

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We have been talking about transectorality and collaboration all throughout this session. But I will be the first one to admit that it is much easier to say that we should work in a transdisciplinary fashion than to actually do it. The enormity of the challenge of working across all the dimensions of one health, without letting individual disciplinary factors arise as impediments is exemplified by the facts.

That it was only in march 2022 that the four big organizations, the WHO, the FAO, the UNEP and the OIE came together formally to form the quadripartite the global governance structure for one health interventions.

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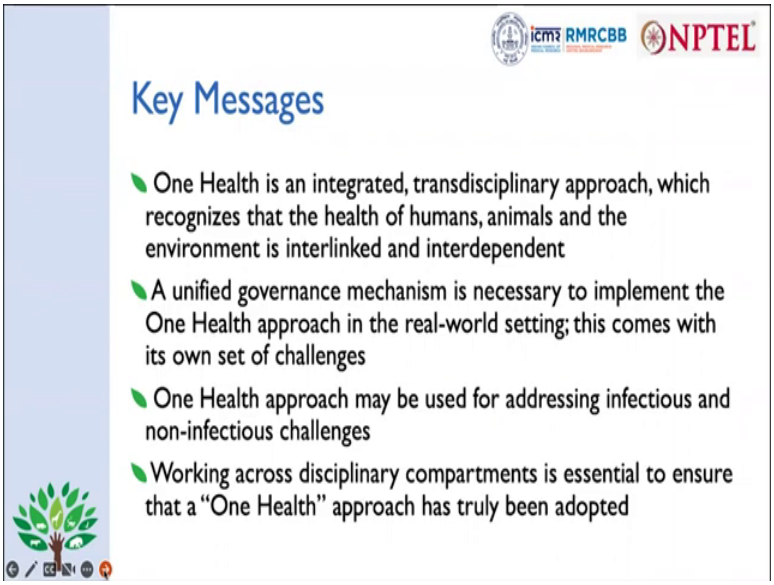

So, as we draw to the close of this session, I want to leave you with these key messages. You have to remember that one health is an integrated transdisciplinary approach which recognizes that the health of humans, animals and the environment is interlinked and interdependent. A unified governance mechanism is necessary to implement the one health approach in the real-world setting and this comes with it is own set of challenges.

The one health approach may be used for addressing infectious as well as non-infectious and non-communicable disease challenges. And working across disciplinary compartments is essential to ensure that a truly one health approach has been adopted.

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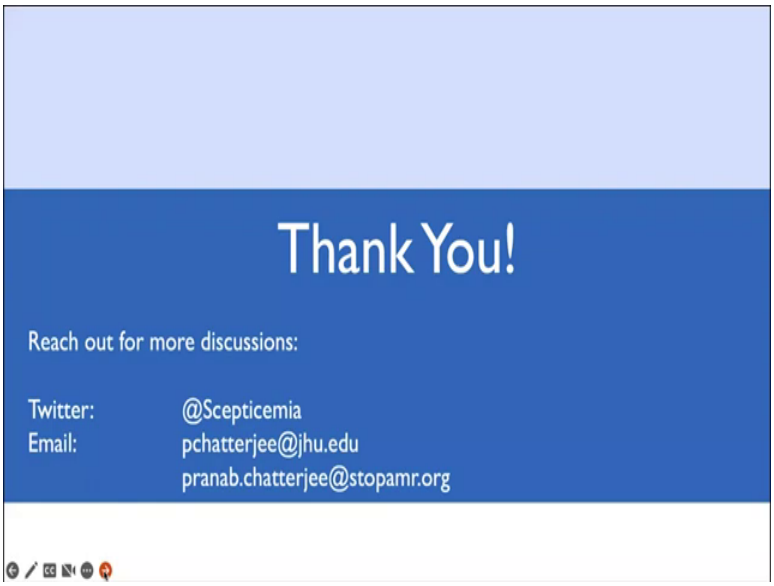

I hope you had as much fun going through this session as I had in presenting it. I am always interested in talking about one health and discussing one health and related ideas. Please feel free to connect with me on twitter. My handle is Scepticemia. It is right there on the slide. I know it is very weird to spell. Alternatively, if you prefer email, you can write to me either at pchatterjee@jhu.edu or pranab.chatterjee@stopamr.org.

I would be happy to chat about one health infectious diseases or AMR. I would also like to offer my best wishes as you embark on this learning experience in this course on one health. Thank you for your patient listening.