

Inaugural address of the Norman L. Ford Science Literacy Lecture Series
"Infectious Diseases of the 21st Century: A New World Order"
Presented by Dr. Michael Osterholm
Pellegrene Auditorium
Saint John's University
September 29th, 2015

Richard Ice:

Good evening and welcome to the Dr. Norman L. Ford Science Literacy Lectures Series. I'm Richard Ice. I am the interim provost of College of Saint Benedict and St. John's University. Let me give you a little background on the creation of this lecture series. A couple years ago, a St. John's alumnus from the 1970's, who wishes to remain anonymous, came to us with the desire to endow a lecture series. He majored in the natural sciences as an undergraduate. His goal for the lecture series is to engage our students, our members of our academic community, and the wider public in cutting-edge science topics igniting their curiosity and developing their overall science literacy. We are deeply grateful to him for this generous gift and creative concept. He was unable to join us this evening, but has conveyed to us that he is thrilled with the selection of Dr. Michael Osterholm as the lecture series inaugural speaker, having admired Dr. Osterholm many years. At the donors request, the lecture series is named in honor of one of one of his favorite and most inspiring professors; Professor Emeritus Dr. Norman L. Ford. We are very fortunate to have Dr. Ford in the audience tonight for this inaugural lecture series, along with his family and friends. Would you wave your hand here norm? [Applause]. Dr. Ford taught biology at the College of Saint Benedict and Saint John's University for 31 years, from 1967 until his retirement in 1998. He was a specialist in ornithology and was widely published in his field. As important as his considerable, professional accomplishments are, it was Dr. Ford the consummate teacher who is warmly remembered and admired by the hundreds of students he taught during his years here. This skill was formally recognized in 1998 when St. John's presented Dr. Ford with the Robert L. Spaeth Teacher of Distinction Award. The citation that accompanied that presentation really says it says it best. He said "its 7:45 AM on a Wednesday morning and Norm Ford and his class have already been at work (Did you hear that students? They had already been at work and its 7:45) Uh... he came early to gather with his students in a field and listen to the morning silence. The silence and the bird songs that punctuated it. He came early to help students tune their ears, train their eyes to notice things, the color of a feather, the tone of a mating call, which the rest of us might pass by, leaving them unnoticed and unknown." For more than 30 years, Norm called his students to a more perceptive understanding of their world because of his fine crafted presentations, an emphasis on critical thought. Many students consider Dr. Norm Ford to be the finest professor at their undergraduate careers. On a personal note, 26 years ago, Dr. Ford welcomed me as young first year professor on this campus and I classify him as one of my mentors and I thank you Norm for that. In many ways this lecture series, in Dr. Ford's honor, is a continuation of Norm's mission, as our speakers call us to a more perceptive understanding of our world. And now I'd like to welcome to the stage Dr. Barbara May, Associate Professor of Biology, to introduce our guest speaker tonight.

[Applause].

Barbara May:

Thank you. It is an honor and a pleasure to introduce Dr. Michael Osterholm as our an inaugural speaker for the Norm Ford Science Literacy Lecture. A graduate of Luther College in Decorah, Iowa. Dr. Osterholm continued his graduate work at the University of Minnesota with the Masters in Science, a PhD, and a Master's in Public Health. His list of accomplishments are vast and I'm sure I could spend a long time talking about all these and I'm just going to mention a few. He's authored over 300 papers, uh

21 book chapters, and has written a book entitled *Living Terrors: What America Needs to Know to Survive the Coming Bioterrorist Catastrophe*. I read it a while ago and have um thought about Oster--Osterholm and he has been a hero of mine as a microbiologist for a long time. In all of his work, Dr. Osterholm is known as an advocate for the development of National Emergency Preparedness for Rising Pandemics and Biological Weapon Attacks. Uh His list of service is long, he served for 24 years in various roles at the Minnesota Department of Health. The last 15, as the State Epidemiologist and Chief of the Acute Disease Epidemiology section. While at the Department of Health in Minnesota, Osterholm and his team were leaders in the area of Infectious Disease Epidemiology. He led numerous investigations of outbreaks of international importance including food borne diseases, the association of tampons and toxic shock syndrome, the transmission of hepatitis B in healthcare settings, and the human immuno--immunodeficiency virus infection in healthcare workers. His role changed slightly in the early 2000's when he became the Director of the Center for Infectious Disease Research and Policy at the University of Minnesota. From 2001 to 2005, he also served as a Special Adviser to the U.S. Department of Health and Human Services under secretary Tommy G. Thompson. He advised the National Government on issues related to bioterrorism and public health preparedness. His--had additional leadership in advisory roles with other agencies including the Center for Disease Control and Prevention, the National Science Advisory Board on Biosecurity, and the World Economic Forum Working Group on Pandemics. Currently, he's a Regents professor at the University of Minnesota. He's also the McKnight Presidential Endowed Chair in Public Health and he remains the Director of the Center of Infectious Disease Research and Policy. He's also a distinguished teaching professor in the Division of En--Environmental Health Sciences which is part of the School of Public Health, a Professor in the Techno-- Technological Leadership Institute in the College of Science and Engineering, and an Adjunct Professor in the Medical School. He he has reached a vast audience. Finally, he does have ties to the College of Saint Benedict and St. John's University as his daughter, Dr. Erin Osterholm who is fortunate to be with us today, um is a Bennie graduate. [Applause]. So it-- I'll like-- I would like to give us-- like us all to give Dr. Osterholm home a warm CSBSJU welcome as he presents his talk entitled *Infectious Diseases of the 21st Century: A New World Order*. Thanks.

[Applause].

Dr. Michael Osterholm:

Thank you and good evening uh, President Hemesath, other distinguished guests in the room, professors, students, and most of all, Norman, Billy, and your family. Um I've had the good fortune to give lectures in many locations, under many circumstances, and I can't think of any that honor me more than to be here tonight with you, Norm, and to celebrate this inaugural address. Norm and I go back a long long time. I never will forget the first time you called me and asked me to come lecture here in my busy schedule and I realized why you are, who you are because no one could say no. [Laughter]. But more importantly, as was described earlier, Norm is the consummate professor. You invented the term "pay it forward" long before anybody else ever thought it up. Your legacy is in this room tonight and it'll be here forever, long after you and I are gone. In addition to the fact that he's not just a great professor, Norm defines for me, in a new way, the word; class. I once was told that class can be defined by someone who, because of their accomplishments, could go to the head of the line, but they never fail to always go to the end of the line. Norm, you are class, and for me to be here tonight is just such an honor. Thank you. It means more to me than I can ever say. On top of that—[Applause]. As someone once famous said "at least you do for my brother you do for me". Erin, my daughter, not only was a Bennie, but she actually was Norm's graduate assistant TA in his last year of teaching. Norm wrote a letter of support for her application to medical school that today as a father still makes me cry. Norm, thank you. It is an honor to be here with you tonight. With that, let me begin and I will have a slide here

shortly. To share with you, at the outset, the reason why you're here and I don't mean for this talk. Why you're here at this campus or should be at this campus. It's because it's all about a liberal arts education. Tonight, I'm going to talk about why connecting the dots in a modern world becomes more and more important every day. I've been in this business for 40 years and I can say with all honesty more has happened in the last 5 to 7 years and happen in the previous 33 to 35 years. The calculus of change in this world is working against us to be successful against many many issues. Not just world politics or world economics, but also public health and infectious diseases and tonight that's my job is to share with you that and why I am looking to you, many of the students in this room, for the solutions. Somebody in this room tonight could very well be the person that provides the answers that some of us old-timers haven't quite figured out how to do yet. Last count I had about 55,000 slides in my repertoire of slides, electronic slides. And... I have to tell you if I had a slide fire tonight the one slide I'd save is this one. This one tells me and tells you about the world that we live in today, probably better than the other slide. While it's a bit old because it was published in little over past 2000, if you look you can see first... last hundred and fifty years, it literally took us over a year to circumnavigate the globe. Around the world with fast sailing vessels and by the 1950's with the advent of jet engines we could do that a little over a day. Well I can tell you that that flat part of the line is actually maybe the most dynamic part of the line tonight and I'll show you why and what that's about. I think about that last Tuesday afternoon I was in a meeting in Seoul, Korea at 1 o'clock in the afternoon and I was actually on a conference call back here in Minneapolis at 5 o'clock that afternoon. Think about how fast we now travel and traverse the world. If you look at world population, think about this. From 1850 when we were talking about 600,000 people in the world and now we're talking about--600 million excuse me, now we're talking about 7.6 billion. And as some of you may know, the U.N. just revised its estimates of the world population increase to now 10.2 billion people by 2050. We don't even need to wait that long, a lot of every people has ever lived as on the face of the earth right now and guess where they're being born? They're being born largely in the mega cities of the developing world where if Charles Dickens were alive today couldn't adequately describe the lack of sanitation and the living conditions that these people have to experience. If you want to make infectious disease cauldrons, you would invent the developing worlds of the modern world and you'd create the cities that are in those developing countries. That's a big change. Now if you look at world population in terms of life expectancy, we have really had remarkable changes. Make no mistake about that. In 1900, in Minnesota, the average life expectancy was 48 years. It took us over eighty thousand generations to get to that point and since that time, literally, in places like the United States, for every 3 days we've lived in the last 110 years, we've gained one day of life expectancy, that's amazing. Now the rest of the world hasn't come along. Now why is that? It has very little to do with modern medicine. Modern medicines done very little for that. It's about a guy named Tesla, who all of you now think of the electric car. Mr. Tesla actually gave us the alternating current. He invented, in a sense, modern electricity. With modern electricity, we could make water pumps and create safe water supplies. With water supplies, in pump water, we could create sewer systems. With electricity, we can refrigerate food. With electricity, we could make vaccines. That's where all that changes come from... and unfortunately some of us are very concerned, we're about ready to tip that. That those numbers are not going to continue to increase and you'll see why in a minute. So don't think that what we've experienced over the last 110 years necessarily dictates where we're going, and I'll explain why tonight. And I'll let you be the judge. If you look at world population, this is from a slide from our World Economic Forum in Davos in February. Where in fact, if you look at world population increase the O.E.C.D.: the Organization Economic Cooperation Development which is the United States, the EU, Australia ,etc... the quote/unquote developed countries. You can see world population increase is really quite minimal. But if you look at the BRIC countries: Brazil, Russia, India, China, and South Africa, as well as all the others. Look where the growth is at. That's where the infrastructure is the least. That's where we have major challenges and I'll share that with you tonight

why the diseases that occur there are going to be very important to you, here. Because you don't have to be there to get those diseases anymore. And from an infectious disease standpoint, if you get nothing else out of this lecture just know oceans, mountain ranges, canyons, and political boundaries are irrelevant to microbes today and that's one-- a very important point. This is the world we live in today. Where the peri-urban kind of slum is right there with the modern world. Just in recent weeks, I've been involved with several cases of high-level IT experts from India on consultation basis here in the United States who only found out after 4-6 weeks of coughing at their workplace that they had multi drug-resistant T.B. and everyone had been exposed to it. It's not just the slums themselves, it's the spillover that's occurring in the world. In 1968, when the world decided that they would eradicate smallpox from the world... of horrible disease. They were able to do it for two reasons; one is the disease itself that was only infection in humans, we had a vaccine that would work. But the second and most incredibly important thing is the USSR and the United States of America decided we will do it... and when those two countries decided anything in the 60's or the 70's, it happened because every domino behind it was a country and when-- as soon as one of the two superpowers pushed a button, everybody fell in line. Today, nobody's in charge. We don't have a world leader. We don't have one. So we can't do the same things we once did. How do you explain to people in Pakistan trying to eliminate polio that it's good to go to work every day when 87 people have been assassinated in the last 2 years just trying to deliver polio vaccine to the population? That would never have happened 30 years ago or 20 years ago or for that matter, even 10 years ago. It is a new world order. Today we have failed States, something we wouldn't have ever thought of before. 34 countries in this world today are considered in failed state status. With the Ebola crisis we had in West Africa, I ended up doing a number of briefings on the hill, in Washington, for Congress. Guess who wanted to hear about this? Not the public health committees or the health committees, it was the intelligence committees and the military committees because they worried that should Ebola move eastward across sub--across... the central part of Africa, it would end up in the countries where Boko Haram and Isis is alive and well. Who would be in charge then? Who would deal with that issue? How would that further basically undermine the status of the governments there? So today, trying to deliver these services are very difficult. How many of you are aware of the fact that, as bad as the crisis is in Syria right now... we have good data to show that many more people have died from infectious diseases than have died from the war itself? Think about that. Lack of basic Public Health vaccines, safe water and food, injury related infections, you never hear about that part but that's part of the real world. The World Economic Forum, which is the International Forum for Economic Issues, and as mentioned in the introduction I shared the pandemic preparedness Committee for that group, but this report came out from another section of the World Economic Forum this past year... and it's a pretty important report. It interviewed and followed up on it from the best minds in the planning and preparedness world and I don't have a pointer here but if you look at the legend you can see on the bottom the likelihood goes from lowest: left to right, the impact goes from lowest: bottom to top. The two red dots on the top are spread of infectious diseases and water crisis's. That's their words, not us as public health people, that is the world's experts in preparedness said that's we have to be concerned about, not all the other issues have come up. Last February, James Clapper, the Director of National Intelligence for the United States government, issued his annual report, a report unlike he had ever issued before. And I say that because it was a whole section on the issue of *Infectious Diseases Continues to Threaten Human Security Worldwide* and they highlighted this that this had the ability to undermine whatever government's we had out there and could create, literally, a colossal, global calamity. Jim Kim, President of the World Bank, gave a very important talk in January of this year. In which, the headline says it all *the World is Dangerously Unprepared for Future Pandemics*. I've spent my whole life trying to get ready for outbreaks or large, global pandemics and I can tell you we've never been less prepared... and I'll give you the reasons why tonight and what we have to do to turn that around. Why the -- yeah -- those students in this room, I'm counting on you to help us get out of this

mess and frankly you don't have a choice because you don't have a get out of jail card. We've got to figure out how to deal with this. Bill Gates, someone would say, knows a lot about a lot of things. I personally appreciate what he did at Microsoft, but I can tell you the Bill and Melinda Gates Foundation has been the bedrock of Public Health support and preparedness for the last decade. But, for Bill Gates, I don't know what we'd be doing right now for support for Public Health around the world, amazing. He wrote in the New England Journal of Medicine, this past March, that in fact, the thing that had the greatest likelihood of disrupting the entire world order as we knew it was an infectious disease pandemic, not new martyr killer war. Think of that, a pandemic, and he went through all the reasons why. I think he's right. Now I'd like to share with you why some of this is the case. And what I'm going to do here... if I can successful here... old men need the glasses... See if our guy appears... I'm trying to get down here... Well I may not be able to do this. What I needed to try to do here was get the pointer to take me down to the bottom there. Is our baby guy still here? Okay, he's not. Well I'm going to have to try to get us back in here then. What? This isn't working. What? Thank you. [Laughter]. This will give you a sense. This was data from basically uh... 2014, but these are air flights every day that are occurring around the world. This is actually one 24-hour period. Every one of those is an airplane full of people and an underbody that may be full of mosquitoes or any number of different things. Now watch what happens globally as you follow a time. They just keep coming and coming and coming and coming and coming. You want to know if we're mixing up germs around the world? Either in people or animals or in cargo holds. It is now around the world. That's the modern world we live in today. Remember a hundred years ago this didn't exist, for all of time. So this gives you a sense, basically, of what we're talking about today, just with airplane travel. Who said you can't teach an old dog new tricks? This is a slide taken from yesterday, every hour on the hour, all the major shipping vessels in the world report their location, the weather conditions, we follow this every hour, and you can see 62,000 different ships up here, all big cargo ships. This is the warehouse of the world, any of you are business majors in here, do not ever suggest the word; warehouse. That's enough to make you go to confession daily. Because it's a just-in-time delivery world. Things that we need right now are on a ship somewhere sailing from China to the United States, that we hope they get here in time for tomorrow's need. All these ships run [inaudible] or Liberian or Panamanian flagship, nobody's really in charge. Anything it would disrupt this, would be amazing. We just did a study several years ago in which we surveyed a group of Pharm D's, doctorates and pharmacy, they spanned all the areas of Medicine, we said "What are those life-saving drugs you have to have every day or people die? Not not cancer drugs, not a lot of those lifestyle drugs. What do you need that's on the crash cart in the emergency room?" We found 31 different drugs that we absolutely have to have every day or people die right now now, not tomorrow, not next week, now. Of those 31 drugs, all of them were generic. All them were made offshore. All of them are just in time delivering, there's no stockpiles anywhere. That's how vulnerable the world is right now. So that's what we have to deal with in terms of understanding the global context of infectious disease in the modern world. If you look at travelers, right now uh, tourism is obviously a booming business. Over 1.1 billion people tra—crossed the international border last year just for purposes of tourism. Next time you take that trip to the Caribbean, bottle this talk later, and I want to ask you about your mosquito exposure and what that means to you, or what it might mean to you. I don't want to dismiss a number of important things like antibiotic resistance and the availability of antibiotics. Just think of this, every time a child is born, we assume it takes from about 20 years to hit a next generation level. It takes an E.coli 20 minutes. And now we're watching rape as a weapon of war in Africa, be used repeatedly and beginning to continue to alter the HIV related transmission issues. These are not done. The issues of even what to do in terms of disease like polio, we're trying to eradicate it from the world, we keep finding hotspots where the virus finds those hotspots before we do. In the Ukraine, right now, we're very concerned about a major polio outbreak in the Ukraine because less than 25 percent of the population is vaccinated for polio given all that's going on there and we now just have cases introduced. Look at the

issues of something like measles, a disease that we don't even really worry about in this country because we've done such a good job of vaccinating our kids. Yet, in the Congo, we're talking about an outbreak there. Just in the last several weeks, has killed 400 individuals. Remember those people travel to somewhere and maybe not to the United States, but they travel to somewhere with somebody who is going to travel the United States comes. And I can guarantee you, if we don't keep our immunization rates up we're going to find more and more of these illness problems, like this. Then we even have the issue with the refugees and what's happening with worldwide migration. Right now, what's happening in the Middle East and Syria is a travesty of humankind. But one of the issues I mentioned before, the number of deaths from infectious diseases as opposed to even just those related to war. The risk of infection continues to increase and we even see the fear that goes with that. Which in some cases, is totally unjustified. The--yes they're at risk for themselves but not to others and already our dear colleagues in Norway, who are well known for being some of the most altruistic and socially conscious people in the world, are seeing big increases in public fear about taking refugees in. What is that going to mean? Today, we also worry about the issue of another disease called monkey pox. Monkey pox is a virus very similar to that which calls smallpox, but in this case transmitted from some human primates to humans, not from human to human. We never used to see monkey pox problems in Africa. Why? Because everybody was getting vaccinated or they'd had smallpox and either one protected you against monkey pox, but we have been vaccinating for 30-some years in Africa. We've now created a whole cohort of people who have been born who have no immunity to either smallpox or monkey pox. Now, monkey pox isn't at all like his sister smallpox. Instead of killing 35 percent of the people who get it only kills 20 percent... still pretty good. We're worried today, we have no plan in place whatsoever for what to do about monkey pox. We never thought we'd have to be vaccinating again. We never thought about that. We thought "we're done." Then that brings me to smallpox and I just want to mention this, this is an issue that has been front and center for me. Probably the most poignant moment in my public health career that I will still never forget and it haunts me to this day. I had the good fortune of serving as a personal adviser to His Majesty King Hussein of Jordan for a number of years on the issues of bioterrorism before he died. In January of 1999, I was still at the State Health Department, I got a call from the Jordanian embassy saying "his Majesty wanted to see me right away. (which usually meant sometime in the next few weeks we'd set something up) No. Right away." To make a long story short, I was on a plane to London, where he was at his estate Ascot outside of London, within four hours and the same clothes I went to work in. I landed at Heathrow early that next morning, overnight flight. I was picked up by the security detail, taken to the main house (usually if I would come I would stay at one of the outhouse areas, beautiful Lodge areas, sleep for the day etc.) I went right into his house (I hadn't showered since I went to work, I'm still in the same clothes). He comes down in his robe along with the head of GID, the Jordanian CIA, and pumped me for four and a half hours about smallpox. I knew he knew something. Everyone knew King Hussein was at the centerpiece of every major intelligence information, good guys or bad guys. Ten weeks later, he wrote a very famous letter that dismissed his brother as the region or heir apparent and appointed his son Prince Abdalla to be the new King, which unfortunately, came true just four weeks later when he died suddenly. And-- but what was more telling, was most the letter was about a man saying that the thing he worried the most was not about war, he worried about terrorism because of what that would do to ripple effect through the population. The thing he worried about most, was smallpox and he wrote it all in this letter. To this day, the intelligence communities don't know what he knew. But I had no doubt at that time that smallpox was not just securely in two labs at the Centers for Disease Control and Prevention and at the Russian research station at Novaya, Siberia. I just still don't believe it's true. But we don't even need to worry about that anymore because here's a disease, while even though it was only here in part of the 20th century and only part of the world, it killed 200 million people. But smallpox is something you can't ever forget. Day 3 and a young child, day 5, days 9, day 13 and knowing that up to 30 percent of these people will die. A

large number will be left blind and other health problems, not a good disease. There's a young girl from Pakistan who had hemorrhagic smallpox which is very common in pregnant women uh and select individuals where you can see the bleeding in her eyes and mouth. These people typically die within about 24 hours, almost 100 percent case fatality rate, not a good disease. Well why do I tell you this? Because you know what? Even if somebody doesn't have it out there, even if a terrorist is not going to use it. Back in the 1980's, we had made a decision in this country "we maybe we should destroy the smallpox virus as we had left". But there was a big debate, well we should keep them because we may need to do research on them. No, we should destroy them, but everybody agreed we'd publish the sequences. So back then, before we could sequence agents like we can today, major projects were undertaken to sequence orthodox viruses i.e. smallpox. Well this is like sequencing the Grand Canyon. These are huge huge viruses and nobody ever thought second of it, of publishing all the data. So you can go, right now online, and find the entire genetic sequence for several small pox strains. Well you know what? Technology changed. Just like back in 1980, I still got in a hard line phone, asked an operator to connect me to a certain long-distance number and that was it. Today, my iPhone does FaceTime with me when I'm in Korea with my grandkids... very different. Well guess what happened? We now got good at taking these genetic sequences and making real bugs. In 1990—or in 2001, research group at Stony Brook in New York, reconstructed a polio virus de novo from just taking the published sequences, buying amino acids, now putting them together like tinker toys, and they made a virus that was lethal. Well we never thought we could make smallpox virus because it was a 1,600 story genetic building. Which is too big, nobody could make a 1,600 story genetically, just as this article says we can today. I have no doubt it's going to be just a matter of time before somebody makes smallpox virus. I don't even know think it's necessary for nefarious purposes, but if it gets out, we're screwed. That's part of the modern world we live in that I would never have imagined myself 15 or 20 years ago. Influenza remains, also a lion king of infectious diseases. Again, for those and and Norm this is your bird centric world. Where in fact [laughter]. influenza viruses took up residence the wild aquatic birds many millions of years ago. Many millions years before chickens even showed up. They virtually live in the gut of the bird. They don't have very good receptor sites for getting into lungs, whether bird lungs or even human lungs, particularly. But guess what? Over time, those viruses do fly out of there and they do get into poultry and they can cause severe disease. They still have a hard time getting to people but they can because again, the receptor sites, the lock and key, just doesn't work very well. But pig has become the universal recipient and donor. Pig lung cells actually have receptor sites for bird viruses and human flu viruses. And when the viruses get together in the same pig cell just by accident they're the most promiscuous virus you could ever imagine. They swap out gene material left and right and they create new strains that are now human adapted but have a lot of the bird characteristics. That's when we get pandemics. That's when suddenly influenza wipes through like it did in 1918, killing 50 million people in this world. Well we did worry in 2004, when H5N1, a type of influenza virus showed up a lot in birds and Asia, caused us some real concerns. Well it kind of-- you can see from the data on the left there we had cases in humans but we never saw sustained human to human transmission and I don't think anybody haven't heard about this in the media. Look what's happened in Egypt over the last year, it's exploded and we can't explain why. It could be more exposure but as the virus changed and what we're worried about is over time this virus is like it's like a drip phenomenon boop, boop, boop, and pretty soon, there's enough water in that barrel to put out a fire or to drown someone. And what we're worried about is we are seeing these changes now with H5N1 after having everybody get upset in 2004 and then by 2013 they said "oh don't bother me with that again". Is Egypt a harbinger of things to come? Well I don't know, but this is the one that even scares me more. H7N9, another type of flu virus out of birds that we had never even thought of as being a potential risk factor for humans, and it turned out that in 2013, suddenly started seeing these cases. By the way, a third of the people who get this died. And it was not very good person-to-person transmission, was coming out of somewhere though and we turned out that with high path flu

viruses, like H5N1, they do kill domestic poultry. Where there's smoke, there's fire. You know you got a problem if your birds start dying. These birds were all fine. We went in and sampled these birds and guess what? They were loaded with H7N9 and they weren't sick at all, not even a slight fever. We did the studies as part of our Center at Minnesota in which we actually took the viruses from China and put them into quail, chickens, turkeys, etc. And guess what we found? Instead of mostly pooping it out the south end, which is what birds do with flu viruses. They were blowing it out the north end and they weren't getting sick and initially the Chinese went in and tried to basically take out these flocks but there was such an uprising by the population of killing healthy birds, that they stopped doing it. Right now, there's no control rods in the reaction in China. What's this going to do over time? I don't know. The case fatality rate remains at 30-some percent. Is this going to be the next flu virus? I don't know. It could be. It's primarily located in eastern China. Get a sense of this, the average time period from a chicken being hatched until that chicken breast is on your plate is about 35 days, 35 days. It's the fastest anything we have in the food supply for converting energy to protein. In the peri-urban region of Shanghai alone, just one town, one city in China, 100 million chickens are born every month, just to feed Shanghai for that month. Every one of those is a virus vessel. Every one of those is another test tube. That's just one city in China. The WHO put out a rather strong statement in February this year, basically saying "warning signals from the volatile world of influenza virus is the current global influenza situation characterized by a number of trends that must be closely monitored these include an increase on and on and on..." The summary statement here "the diversity and geographic distribution influenza virus is currently circulating in wild and domestic birds run precedent since the advent of modern tools for virus detection characterization. The world needs to be concerned." Well we've been following it since 1940's, with virus detection, but even if you go back to chicken flock health studies dating back into the turn of the century, nobody's ever seen this before. Something is happening in nature and it's-- I don't know what's going to keep these viruses from spilling out and causing a pandemic. Look no further than what happened right here, don't go very far from here. This past summer, we in the U.S. were kind of smug about our quote-unquote poultry production capability and our biosecurity to keep viruses out. And I say this with kindness because I--it's not that anybody isn't doing anything wrong if we didn't know better. But it's kind of like the people that buy a submarine put a screen door on it and never taken it underwater for 10 years and tell everybody how well the screen door works and the first time they take it under, didn't work so well. Well suddenly, with the high path virus, we had 223 different outbreaks of H5N2, in poultry, in Minnesota, Iowa, and to a couple of adjoining states and small numbers. Almost 50 million birds died or were put down. This is unprecedented. This is incredible. We've never had that happen before. We had one small outbreak of a high path flu virus in American poultry back in 1983 and six farms in Pennsylvania, all next to each other, and we put it down. We don't know if this is going to come back or not. It could. Again, we're in total uncharted territories. What was really interesting is we had this mindset, this is this closed mindset that we own today. This is where our liberal arts students challenge us on everything. We thought "well this has to be kind of a farm gets infected I feel like a concentric circle exposure like a bomb, so you know you're this far out this far out" Well we now know that's not the case. We actually did virus sampling outside of these barns and we look at the spread. And guess what? It was a wind rose, meaning it was a long plume. You could have been one mile on either side of that farm but if you weren't in the wind plume, you were fine. But, if you were 20 miles downwind you might have got hit. Totally rewriting the world of flu viruses. So suddenly, what do we do to create poultry production in this country? We concentrated them in places like Kandiyohi County because the ease of production, delivering, supplies, harvesting. You know where we put our pig operations? In the same counties. Talk about a mixing vessel, and remember pigs don't get sick with this virus, so we don't really know what's happened with virus infection in pigs. Again, if I had told you this story last winter, any of you would have looked at me and said "you know what's he been drinking?" and now it's right before us. Back in the old days, you'd have to worry about vectors i.e. mosquitoes or

anything else surviving an airplane flight, so you actually didn't always know you were going to survive. [laughter]. You know DDT between the DDT and the smoke you could cover everything. [laughter]. That's-- times have changed. Today, *Aedes albopictus*, which is the worst of the worst of the worst of the worst mosquitoes. And I say that because they're mosquitoes-- basically are a nuisance until they can carry a disease and only a very limited number mosquito species carry diseases. The ones that carry diseases are the ones that, to get infected themselves, so when that guy takes a blood meal there-- woman actually, only female mosquitoes feed, that's a whole other story. Basically, what's happening, is they take blood up into their proboscis. They then take the virus from or whatever else is in that blood and if they are susceptible to that virus or that parasite they then become infected and it goes basically into their salivary glands. So the next thing, they take a blood meal, they don't die from the infection. When they inject that saliva down that proboscis to keep the blood flowing and anticoagulant, that's how you get your mosquito bite, you're reacting to that material but that's where the virus or the parasite is. That causes you to get infected. Well thank God most mosquitoes don't carry any diseases at all. *Aedes albopictus* is the universal donor. It can get infected by darn near everything. Look what happened. The green areas of the world where *aedes albopictus* was historically found, through the 1980's. And then we had a major run on used tires for large vehicles because of the world economics around tire and rubber production. And suddenly, we started shipping tires from Asia, Southeast Asia in particular, that inside of were all these *aedes albopictus* eggs and they landed in ports all around the world and look what happened overnight. *Aedes albopictus* spread around the world including right here in Minnesota and it does fine thank you. So we've suddenly created-- we put this huge howitzer right in the public square and just said-- dared anybody, just you know put a bullet in, go ahead. So we already had the underpinnings of a potential for a problem before any viruses or bacteria or parasite first showed up. *Aedes aegypti*, again another famous mosquito, the reason why it took so long to finish the Panama Canal because in fact it kept causing to all the people to die from yellow fever, work there. This slide is one we're actually working on right now, but in the 1930's, this is where *aedes--aedes aegypti* was found in the Americas. By the 1970's, when I got an infectious disease and everybody said "why are you getting into horse and buggy making?" You know, it's old, it's done, it's over with. They had every reason to say that, not only was it only in lesser areas of the Americas but in much lower numbers. This is 2000 and we're now in the process of making the 2015 slide and I can tell you it is spread even much more through the Americas and the numbers of populations have gone dramatically higher. 1930, 2015, you tell me, which will be better prepared to deal with mosquitoes with? So again, this isn't just trying to tell you that things are worse because I want you to be worse. We have the data to show we are living in a very different world order today. This slide, which was meant not to be read because it's meant to scramble your brain to think about something, and that is; chikungunya. And you say "what the heck is that?" It's a mosquito-borne virus that basically, like another disease called dengue fever, causes people to really get kind of sick, but not that many people die. Fortunately, probably 1, 2, or 3 percent at most. But we're now realizing that 40 to 50 percent of people that get chikungunya, actually end up having some very serious neurologic and muscular skeletal issues for months and months and months. Up to 40 percent or more. Well guess what? In December of 2013, somebody brought chikungunya infected mosquitoes to St. Martin in the Caribbean. Since then, all these millions of cases have occurred. We now know it's millions and millions and this is what's happened. It has spread not only through the entire Caribbean, it's into all the Americas, and even in the United States we now have indigenous transmission in Florida including pretty widespread transmission in Dade County and the keys. 38 states have reported people with chikungunya. Most of them traveling to the Caribbean for vacation. So when you think about your vacation spot this winter, I always thought the cold of St. Cloud and St. John's was not so bad. [laughter]. This is-- this river, this hadn't existed in the end of 2013 early in 2014 and look where it's at today. Millions of cases have occurred. Other new scans, you can see here, this is from our CIDRAP website where we have in very active new site. Bajo today just

announced 12,000 new chikungunya cases and in studies being done looking at actual cases versus reported. We think the underreporting is about somewhere in the neighborhood of 50 to 80 fold of the actual cases. So when we report a million cases, you can read and assume that's 50 to 80 million of these cases. That's pretty significant. This is a paper that I published in Lancet uh Major Medical Journal a few years ago, 2011. It's the worst paper I've ever published in my life for a heartache. We had been very involved the 2009 influenza pandemic at our group. And we took onto a study to look at just how well the flu vaccines work after that and we thought it would take us a couple of months and how prepared we'll be for the future. Well the more we peeled back the onion, the more we peeled back the onion, and the more we found wasn't the case. In this paper, we found that we had been grossly overselling how well flu vaccines work in the public and that at best 59 percent was the average, particularly for younger people, and that we had a real absence of data for older people and yet we've been pushing this. Last year, this was really brought home. Where in fact, originally it was 23 percent. In the end, and the bottom slide you can see here, overall flu vaccine was just 19 percent effective. No evidence of protection of those over 65 and yet I bet most of you didn't know that. Now we hope we're going to do better this year because we've actually put two strain changes in but it's still not going to be optimal. Well what's going on here? We need flu vaccines seasonally, but more importantly eat them for pandemics. We looked at the issue of the pandemic in 2009 that we had which was a quite mild one by all standards and if you look here what you see that blue line actually is the number of percent of visits for influenza like illness on this right bar. Basically, really detailing the second wave of the 2009 pandemic which really peaked in mid to late October. Vaccine didn't arrive until October. Most of didn't get here until November, December and if you look at the numbers we're still talking about 16-80 million doses. But most of these doses went in kids, which was a two dose regimen. So there you have to cut it in half of people that really had vaccinated. The whole world experienced this. Most world had no vaccine at all. Even the new modern cell culture vaccines used in the old technology of the 1940's, which is what the current flu vaccine is, didn't get out any sooner than the egg-based cultures. We got problems. We went back and looked at '68 and '57, the two previous pandemics. Each time the vaccine arrived too little, too late. Well we then did this quite exhaustive study starting in 2009 called the *CIDRAP Comprehensive Influenza Vaccine Initiative Study: The Compelling Need for Game-Changing Influenza Vaccines* and, you may not be able to see all this, but each of these chapters reflects a very different part of the flu vaccine world. We went through over 15,000 papers. We even had the old department of war studies brought out of the archives to look at the original flu vaccine licensure studies of the 1940's and to understand what they did. We interviewed over 120 world experts in all aspects of vaccine, some of them many times. Finance, business if you look in chapters... down here at 12, 10, 11, 12 we looked at the entire business model. And guess what? We've been telling people for so long this vaccine is so good... the vaccine industry said "well why are we going to invest any money in a new vaccine? You've been telling me it's really good." We were shooting ourselves in the foot. Paper after paper has come out recently showing new potential vaccines that are very different than the ones we have today. Very different but could work very differently and much more protective. Idea of a universal flu vaccine, which I'm not sure it can ever be universal, but when you sure get one that could work a lot longer, a lot better. What's the problem? This is a figure from our report. This thing called the valley of death. What happens when you start working in discovery in phase 1, phase 2, phase 3, we invest all this money in this, when I say all its you know 20 million 50 million here but not big money relative to what vaccines are going to take, and then we suddenly get it and it stalls out when it gets to phase 3 which is actually putting it into people and doing a big study. We estimate today it'll probably cost us a billion dollars to bring one flu vaccine through and nobody in the private sector has an appetite for that. They'd have to charge \$120 a dose for flu vaccine, even think about recouping any other investment. How is that going to compete against the ones we have now? Because public health has not been clear and compelling its message we knew-- need new and better flu vaccines and they should be

government supported. In other words, we're not going to get them. So we can sit here and argue about this but one day we're going to wake up with a flu pandemic on our hands and saying "why in the hell didn't we do better?" Even recently, BARDA, the organization and U.S. government is supposed to be funding these kinds of things, basically said "we can't fund what's out there right now." and they blamed it basically on the inadequacy of the vaccines candidates which really was-- the truth of this matter was you can't go in and buy a new Lexus for 10 cents and they just didn't have the resources to do what it's going to take. So meanwhile you and I are all sitting here. My kids, my grandkids are sitting potentially on top of a future flu pandemic with the vaccine that's grossly inadequate and a vaccine it'll be way too little, too late and we know it now. We don't have to wait for the hurricane to hit shore to know what's going to happen. It's all about public policy and leadership. We waste a billion dollars every day in our government. Wouldn't it be great if we had something that actually protected us and worked? Ebola, let me just briefly say this is another example the same thing. I mean all of you are probably Ebola'd out by now but the bottom line is this outbreak started in Africa... in the Western countries of Africa a little over two years ago and basically rewrote the history of Ebola. We've had more cases, 20-some thousand cases, 11,000 deaths, more than all the cases combined in the previous 40 years, 2,400 cases, about 600 deaths. Well, what happened? This is a piece that I wrote in the Washington Post a year ago, last July, not not last July but the month before anybody even cared about Ebola in this country when the first American physicians came home with Ebola from Africa. And it was my attempt to get the world to wake up and said in this article I said "you know what? Wake up guys this has the risk of destabilize the entire Western African area." and people yawned. But the one thing I made clear was there was no evidence this virus had changed, Africa had changed. Africa is no longer a continent of rural villages. Kinshasa Zaya-- Kinshasa Congo today, a country in a city with 11 million people living in one concentrated area, 4 million living in the worst slums you could imagine. May well be Kenya. I've been in Kabara, the slum of Nairobi where it took me days to get the odor out of my nose. A million people living in the most squalor conditions. This is going to happen again. If this virus gets into those settings from rural Africa, there's nothing's going to stop it again. We're going to have a Deja vu all over again and we've had great success in West Africa at a great cost but it's not over. We are cau--cautiously optimistic, we've done a successful job of getting the cases to stay low. We keep-- one week we report Ebola free, Sierra Leone has some cases the next week. This recent article from this week here. Now we have some cases in Guinea. Brand-new surprises, we had no idea when you recover from the Ebola virus infection you may have the virus and your seminal fluid for six months or more. So if you go back home and start having sex again, you're going to more Ebola cases. We never knew that. We didn't know that it's in your eyeballs. Seen your ocular fluid. If you have anybody look at your eyes because a serious eye problems if we see a lot of with Ebola. Doctors and nurses are at risk by touching your eyes, even though you've been recovered for months. So we're rewriting the book but there's optimism. But what did we really learn? Well we learned at one time, basically, we could respond but it took us months and months to do. We now know is that we really haven't learned the lessons because nothing is in place after Ebola. WHO hasn't changed. There's nothing in the works right now to really change WHO at all. We did find a vaccine was effective using this unique ring vaccination approach where we vaccinated around cases and looked at whether or not people got infected or not. This is a vaccine, it needs to be kept at minus 60 degrees in Africa, that's not easy to do. It's a vaccine that we don't really understand how reactionary it is in terms of people who have HIV infection. We need more vaccines. Our group at CIDRAP, the Center for Infectious Disease Research and Policy, along with the Wellcome Trust, the largest foundation in the world supporting infectious diseases (slightly larger than the Gates). Jeremy Farah, the Director that I chair this group of 28 international experts that have been staying on top of this vaccine. Because guess what? It's the yawn factor again. Once it went away, everybody's walking away. At least three companies have put over 250 million dollars into research for Ebola vaccines, they're all going to lose it. The same thing happened with SARS in 2004. Are they ever going to come back to the table again? Not

likely. We've shot ourselves in the foot and we may not in the end get even a licensed Ebola vaccine out of this situation. We hope you'll get at least one, but we don't know what's going to happen. We've got to change that. Again, thinking for the future, I don't want to see Kinshasa go up in Ebola flames one day. A vaccine would sure help. Which gives me to my last topic here just talking about the issue of another mediate and urgent health crisis. SARS came upon us back in 2003-4. It was a severe acute respiratory distress syndrome disease. It started in the Guangdong Province of China. We realized this virus called the corona virus was actually in badger dogs and civet cats in the market, both rodents, not dogs and cats actually. They were a food supply. Once we recognized they were the source, they were exterminated from the food source, food chain, all the human cases. New ones from that source stopped. We basically shut the faucet off but we had to just lap up then the human to human transmission. This is what happened. We took this around the world was a physician in the red box up there from the Guangdong province stayed in room 911 at the Metropolitan in Hong Kong. All those people in that yellow box stayed at the Metropolitan too. None of them had face-to-face contact with him, was either in the elevator or living on the same floor and then it spread around the world. 9,000 cases, thousands of deaths, literally shut down Toronto General Hospital, it was a disaster. One of things we learned is some people don't spread the virus at all but a couple of people become super spreaders where they shut it very effectively. Well then along comes... this situation. A pathologist in Saudi Arabia two years ago recognized a very serious illness, looked like SARS, did the testing on it, turned out to be a new corona virus we now call MERS: Middle Eastern Respiratory Syndrome virus. Same kind of family of viruses, corona virus. Well since that time, we have seen this epidemic activity going on in Saudi Arabia. Initially, it's seasoned around the early spring when camels were birthing their camels, young camels there. But more recently it's been constant and the red boxes actually reflect an outbreak in South Korea. It's all about the camels. We now realize that dromedary camels in the Middle East are likely source. And that, in fact, what we see happening here is these animals were previously infected with corona viruses but not what was called MERS. Something happened about three years ago. Genetically, those virus changed and suddenly started transmitting to people causing severe illness. If you look at the whole schematic of how it happens, we believe bats are the ultimate source of this but it got into the camels then got into the people and either spread in the community--we're more likely a spread in the hospital setting. Where a super spreader might come in and actually be located. Well dromedary camels are kind of important. Liberal arts educated people should know that. There are... approximately 12 million dromedary camels in the world. Of those, only 1.5 billion live on the Arabian peninsula. 10.5 million live in East Africa, North Africa. The country with the largest population of dromedary camels in the world is Somalia. Well it turns out, so far that virus hasn't crossed the Red Sea, but it's just a matter of time. And what this has been doing to the Arabian Peninsula, particularly KSA: the Kingdom of Saudi Arabia, will dwarf be dwarfed by whatever might happen in Africa because there's no resources to respond in Africa. This is just a function of time. But more specifically, we've had these continued outbreaks and hospitals in KSA. Three outbreaks going on right now, a large one in Riyadh. The Saudis have responded very poorly. They have not followed the direction that Public Health Officials either from the WHO or elsewhere have given them. I have been in the Middle East. I've worked up outbreaks and Abu Dhabi in the United Arab Emirates. They're doing more about it but it's very frustrating. So this source continues and one of the issues about this is the camels. It turns out that camels in the Middle East are more sacred than the service dogs could ever be in our country. Why? Because for 4000 years that's how they survive, with their camels. Camel milk in the desert. The camel meat that they did sacrifice from some camels. The beasts of burden, even the shade protection in the desert. So if you go and tell one of them their camels killing people, you might as well say something about my sister. [laughter]. Because that's how its interpreted and we're having major social cultural challenges there. If you look at this issue, we keep having these outbreaks and hospitals, the virus is coming from the camels. It's not stopping. It's in people and then these super spreaders come along. We have new

clusters of cases as the Hajj disk was completed yesterday. We run bated breath with an incubation period of 7 to 10 days to see if any of these people take it back to the countries they came from. Over two million people arrived in Saudi Arabia from around the world. If you look here again, more problems with the Hajj. We don't know what's going to happen here but we're very concerned. Recently, the data shows that this virus may be changing and becoming even more amenable to human to human transmission. We think that's surely what happened in part in South Korea. What happened though is a reflection of this, people who become infected in the Arabian Peninsula and then fly elsewhere. Either knowing they're infected in seeking medical care elsewhere or not knowing like two physicians who were treating patients in Saudi Arabia when they came back to the U.S., had no idea they were infected, and in both instances neither hospital did any kind of major infection control for the first 24 hours. The only thing was, thank God they were not super spreaders. To give you an idea what a super spreader can do. One of the outbreaks, I worked up at a hospital in Abu Dhabi was one where in fact, 7 different patients came into that hospital over a period of a year with MERS, didn't transmit to anybody. They felt very comfortable what they were doing. The 8th patient came in, transmitted to 28 health care workers, 2 of them died. Again, the super spreader versus the none super spreader. Well to give you an idea why that's important, this was a paper published in the MMWR, the CDC weekly publication, after the 2 cases in the U.S., detailing the fact that every month about 70,000 people fly directly from the Arabian Peninsula to the North America, either Canada to the United States and others take indirect flights through Amsterdam or London. Every month these people are dropping in on us. Every month there's a risk there, but I even worried even more today. 75 percent of all the health care in Saudi Arabia is provided by Indian or Filipino health care workers and every day there's a 747 that leaves Riyadh to Manila or Mumbai. One day they're going to take back one of these infected health care workers and there. So what happens when this occurs? This. This is an outbreak that I've been very involved with in South Korea at Samsung Medical Center. One of the most modern 2,300 bed hospitals in the world, not some developing world hospital. They would rival whatever we see at the Mayo Clinic. Somebody came in with MERS, ended up having an outbreak where they found infection control lapses, this person had been in the Middle East. No one recognized him with having MERS, but the infection control lapses they saw were no different we see in every hospital around the country. Do you have any idea what happened here? Patient 1 came into Korea from the Arabian Peninsula, infected patient 14, who infected 80 people in the emergency room of the Samsung medical center and has spread from there. They shut down this modern, 2300 bed hospital, for seven weeks. This new season could be St. Mary's, University of Minnesota hospitals, or Mount Sinai. You see a Medical Center, could be any of them. We're not ready at all. Here the President replaced the Health Minister, just give you an idea the impact that this has in a country. South Korean hospitals in the center of this, I've actually been, that's where I was last week was at Samsung Medical Center again, and again I can tell you over and over again my worst nightmares it's just as it could happen in St. Cloud or Minneapolis or St.-- Rochester. It's just a matter of bad luck of getting the wrong patient to fly in and present with respiratory illness and we're not ready. What do we need? We need a vaccine for camels. We've been working hard to get that. Guess what? Nobody wants to fund it. Pennywise and pound-foolish. Could this happen anywhere? Absolutely it could. That's the modern world of infectious diseases. Mark my word, it's going to. So let me just conclude by saying, one of our very famous American authors Lewis Carroll said it so well once "if you don't know where you're going any road will get you there" I feel desperately that's what we're at today. I challenge the students in this room... to challenge us who are in positions of supposed authority and responsibility. What in the hell are we actually doing? How are we going to make this world so that when you grow up in 2050, you're not dying more frequently from antibiotic infections than you are from cancer and right now we have no roadmap. My most famous philosopher of all time however, Mr. Ebenezer Scrooge once said "are these the shadows of things will be the shadows of things that may be only" and I can tell you I need no... convincing of why I do my job today. I think I'd do

it if I didn't get paid. It's not about anymore honors or publications. It's because of that lady sitting right here in this room and my three grandchildren and my other son, that's why I do it and for all of you and all of us in this room. We're older ought to be asking ourselves the same question "what legacy are we leaving our kids?" I can't think of a worse one right now than the infectious disease legacy. And if Norm Ford taught us anything, he taught us about the issue of being educated and acting on that education and that's why I'm so honored to be here in front of you tonight, Norm. Trying to do my best. Thank you very much. [Applause]. I think they like you Norm. [Laughter].

Barbara May:

At this point we'll take a few questions if there are any. If you can't speak as loud as I am, I do have a microphone. That I can pass around.

Dr. Michael Osterholm:

And I'm the other Mike. [laughter]. Yes?

Audience Member:

[Inaudible].

Dr. Michael Osterholm:

Yes... well let's put it this-- thank you. If all of you didn't hear it, it's about the viruses that are coming out of the permafrost. Well first of all, what they're coming out of is bodies that were basically long-term secured bodies in the permafrost and yes we are concerned about that. We we can't say that it's a big issue. Um surely smallpox, other viruses could be there that could still be alive. Flu viruses. We have had some experience with basically looking at bodies out of permafrost for flu viruses and we couldn't ever find whole viruses but it's a problem. But what you probably didn't hear this week, in terms of infectious diseases, is one that has me just as long with the number of my colleagues chilled and that is Mars. We have no idea-- we now have confirmed that there's water on Mars and we have no clue what an extraterrestrial microbe might look like or what it might do in a different world order. And originally one of my mentors, Josh Lederberg Nobel Prize laureate, got involved with the whole issue of biosecurity infectious diseases because of the original space flights. I can't tell you that it's going to be a problem. I would not want to find that there's a microbe on Mars we bring back that under the conditions of the Earth's atmosphere and the kinds of conditions here could spread and be a real problem. And so one of the things I know NASA, and there's a group of us that have been communicating about this, is very concerned if we do take any missions to Mars now that we know that there's likely water there. Which likely means there are microbes there. That in fact, what does that mean? So again another twist in the modern world of infectious diseases. Yes sir?

Audience Member:

[Inaudible].

Dr. Michael Osterholm:

Yes well let me just say, right at the outset, you're one of the solutions. I can tell that because you're asking the right question. And we need a we need a global plan. One of the things we've been working on is trying to get a global plan that says "this is as important as buying bullets and guns" because if you stop these problems look at all the things else you stopped. The best estimate right now in Ebola in West Africa puts it somewhere in the neighborhood of probably a 100 billion dollars in cost. Do you know how many healthcare systems we could have funded in West Africa for dimes in the dollar with that? That would have helped us stop this much earlier. At the same time, by the way, save people from

measles. Save them from T.B. Save them from a number of other infections. So one of things we have to get our head around is what is the cost of investment and what's the cost of not investing. So your question is right on the mark. You know, we shouldn't be just talking about sealing our borders from infectious diseases. Go to the disease and put it out where it's at. Figure out what we need to do with these kinds of issues. What are we going to do about mosquitoes? Don't tell me we can't do anything. I won't accept that. So I think there's a number of us trying to move and we're we're trying to move the philanthropic community. Where the largest transfer of wealth is going to occur in the next few years, to understand why this is a good investment in their world. Why it's a good investment in governments and not get bogged down into the politics of foreign aid but get bogged down in "how are we going to do all this issue to save all of us, not just somebody in a foreign country?" So thank you for that question. Very good. Yes?

Audience Member:
[Inaudible].

Dr. Michael Osterholm:

Um... I think, by far, the biggest impact climate change is going to have, this is going to change the vector control borne disease picture a lot. Because temperatures are going to warm up we're going to see mosquitoes and other ticks surviving in areas they haven't survived... before. In addition to that though, part of that it's not just surviving but there's basically a situation where every winter mosquitoes go into a condition called diapause. Diapause is a sunlight length related change where right around Labor Day to middle September, mosquitoes in Minnesota stop taking blood meals. Why? Because, genetically, they've been programmed if they take them later than that they may have an early frost like we just had up in northern Minnesota and they're dead meat because that blood will swell up, freeze, and they'll explode and die. That's why it could be 55 degrees in January and mosquitoes could actually be out but they won't take a blood meal. Well we've already seen an Alaska data to support that diapause has been extended almost two more weeks in some areas now. Where genetically those that would have in the past die, are actually making it. And so, with mosquitoes, in a summertime basis we look at a concept called amplification. So if you have 2 mosquitoes, basically infected, then it gets to 4, then it gets to 8, then it gets to 16, and it gets to 32, then it basically 64, and by the late summer is when you get most transmission of these diseases because you have so many infected. If we add on 1 or more 2 cycles at the end of the season, we could be in big trouble. We know that right here with encephalitis in Minnesota. So I think that that's going to be the highest impact issue. The 2nd thing is going to be water and sanitation. Water is going to change completely. You know I was recently in Hyderabad, India, where I stood from where I stood 15 years before in a well. At that time the water was basically coming from 110 feet down. They were now at 700 feet down, they ran out of water. Climate change is going to finally change the distribution of precipitation and it's going to... open up all these errors we've made and how we've allocated water. We've mined groundwater as if it somehow its limitless. We now realize that there will be big changes where in fact rainfall falls or then how fast it does fall. We're going to see more flooding. So all of those, with sanitation, are going to be huge and they're also going to affect the food supply. Right now, I worry desperately, where we have really good growing conditions for produce in California, they can't do it anymore. They're running out of capability to do it. We're going to ship those offshore to countries where the hygienic san--sanitation conditions are much less satisfactory but that's isn't going to be the same produce you're going to be eating. I can tell you we've seen more and more produce outbreaks. So I think there's a number of things, but I clearly think that the vector control issues are going to be the huge ones. Make no mistake climate change is real. It's real. And every day we postpone doing something we're doing it, not at our expense, you and me, we're going to be gone, but

our kids and grandkids are going to suffer miserably. And if we don't care about anything else, just keep thinking about your kids and grandkids. You know, ask yourself "what does it mean to their world"

Barbara May:
One more question.

Dr. Michael Osterholm:
Yes?

Audience Member:
[Inaudible].

Dr. Michael Osterholm:
[Laughter]. You know I get that question a lot. And actually I do pretty well. But I... um you know I think I actually have a I have a belief that we can make a difference. I wouldn't be doing this. I mean we wouldn't be fighting on the Ebola vaccine front right now. We wouldn't be doing a lot of these things. So it's just a matter of organizing society to understand this. And I hate to learn from lessons like Ebola or MERS to help advance it, but that's what you have to do. And so you know, I have a fundamental belief in the future. Maybe I'm naive but I have to because I have three grandkids that I can't accept the fact that the world's going to be such a not much better place. So that's how. I do sleep at night. I'm careful what I eat, you know. I do things like that, you know. But beyond that, I um...I just I don't we don't we don't have a choice. We don't have a choice. We have to we have to do this. Thank you all very much. Norm, again, thank you. It's my honor. Thank you.

[Applause].