

PALL CORPORATION
Pandemic Preparedness – A Global Webinar on Influenza and Infectious Diseases
– The Role of Breathing Filters in the Clinical Setting
Moderator: Joseph Cervia
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Joseph Cervia: Greetings and welcome to all to today's global Webinar on Pandemic Preparedness: Transmission of Influenza and Other Infectious Diseases; the Role of Breathing Filters in the Clinical Setting.

I'm Dr. Joe Cervia, an infectious diseases internist and paediatrician, Professor of Clinical Medicine and Paediatrics at the Albert Einstein College of Medicine in New York and the Global Medical Director for Pall Corporation.

Today's global webinar is sponsored by Pall Corporation; and, at this time, I'd like to take a moment to welcome our esteemed panelists; Dr. (Daniel Jernigan) who is Acting Associate Director of Science, the Division of Healthcare Quality Promotion at the National Center for Infectious Diseases, U.S. Centers for Disease Control and Prevention; Dr. Laura Hawryluck, Physician Leader, Ian Anderson Continuing Education Program, EOL Care on the Faculty of Medicine, the University of Toronto in Ontario, Canada; Dr. Klaus Züchner who is head of the Department of Anesthesia Technology, at the University Hospital of Goettingen in Germany and Professor. Andreas Widmer from the Division of Infectious Diseases, the University Hospital, Basel, Switzerland.

Influenza is obviously a topic on everyone's mind these days. According to the Centers for Disease Control and Prevention, 5% to 10% of U.S. residents

contract the flu each year. Of these, on average 200,000 are hospitalized and up to 36,000 die each year from flu complications.

But in contrast to such expected seasonal outbreaks, occasional viral reassortment may result in unexpected changes in the virus and with these changes, the possibility of a global pandemic.

Three such pandemics have occurred in the 20th Century. In the CDC's estimation, a pandemic of medium level severity could cause as many as 45 million cases, resulting in over 700,000 hospitalizations and 200,000 deaths in the United States alone.

As has been learned from other more limited outbreaks of serious respiratory and viral infections such as the outbreak of SARS that we'll hear about a little bit later, a flu pandemic would place great strain on human and technological healthcare resources.

The WHO has stated that despite advanced warning, the world is currently ill prepared to defend itself during a global influenza pandemic. It's clear that global, national and local health authorities and providers will need to educate themselves on the risks of pandemic influenza, and lead the way to ensure adequate resources are focused upon measures that will optimize preparedness for such an occurrence.

At this time, I would like to turn the program over to Dr. Dan Jernigan who will give us an overview of the health risk situation. Dan.

(Daniel Jernigan):

Thanks a lot. I wanted to spend a few moments just talking about Pandemic Influenza and infection control. There's quite a lot of information that's

available now and if there's any one thing to take home from all of this I think it's for folks to be directed to the Web site that contains the Pandemic Influenza plan and all of the guidance regarding infection control located at <http://www.hhs.gov> . Anyone can go to that site and get useful information on infection control for pandemic influenza. In addition, all of the national recommendations for infection control, including use of masks, gowns, gloves and other personal protective equipment can be found at <http://www.cdc.gov/ncidod/dhqp/>.

First of all, there are a number of reasons why new pathogens emerge, including 1) human exposure to new environments; that is, people going into places where they haven't been before, 2) changes in animal or vector exposures, that is people in Asia that live in crowded settings but still keep animals in close proximity. This allows them to have exposures to animals that previously did not occur in urban settings. 3) New procedures like intubation and CPAP, 4) there are new populations at risk; that is, more immunosuppressed people than ever and, 5) there are new social factors such as crowding, where many immunosuppressed individuals or elderly persons are gathered in one setting.

So, there are established past relationships between hosts and infectious agents that have been in place for thousands of years that are now changing and leading to factors that promote the emergence of new infectious diseases.

Let me briefly talk about three terms for influenza that are being used to describe the different characteristics of the infection. The terms can be somewhat confusing at times. The first is "seasonal influenza" and is a term that is most familiar and refers to the annual flu that occurs each year. The two Influenza A strains that cause annual disease are H3N2 and H1N1. The vaccine developed each year includes these two strains. The vaccines made

each year include human strains that are circulating in Asia. Infection control guidance is available for seasonal flu, and is available at <http://www.cdc.gov/ncidod/dhqp>.

A second term or way of thinking about flu is that of “Avian” Influenza. In many ways, this is the equivalent of the seasonal flu, but among animals. The influenza among birds, notably migratory waterfowl, is what we’ve been focused on most recently. There are numerous strains that occur among birds – the H9’s and H5’s, and others. H5N1 is the current strain that we are concerned about and is the one, which is circulating among migratory waterfowl. These birds are able to carry the virus from one part of the world to the other along the flight patterns of these migratory birds. H5N1 can be transmitted from the waterfowl to domestic poultry and can then cause incidental Avian Flu disease in humans. At this point in time, essentially all cases in humans come from exposures to birds and not from person-to-person transmissions.

The third term or concept for flu is that of “Pandemic” influenza. This occurs when one of the animal viruses, like the avian H5N1, is causing infection in a host animal (such as a human or pig) at the same time as a human strain of influenza is causing infection in the same host. These two different types of influenza can then share genetic information, known as “reassortment”, to generate a new strain of influenza which has components of both the human and the animal viruses. When this occurs it means that the new virus may be something which humans have not been previously exposed to and thus there is no innate or herd immunity in the human population.. Therefore, the virus can spread rapidly from person to person and cause disease which may be of a more severe nature than normal.

As was mentioned previously, there have been Pandemics in the past. The first that has been adequately recorded was H1N1 in 1918. H1N1 was replaced by H2N2 in 1957, and H3N2 replaced H2N2 in 1968. H1N1 reappeared again in the 1970s and is currently in circulation along with H3N2.

If you look at this map of avian influenza cases in humans and animals, you can see that there are more places where the virus has been identified in birds than places where it has been identified in people. To date, the total number of cases of Avian Flu is 148 and the deaths are at 79. Mortality is very high among cases of avian influenza probably because of the inability to recognize all cases of avian influenza which occur, meaning that there may be cases that are not detected that are of less severe nature; however, in those who are exposed and become ill, disease may be very severe.

We know that recognizing Avian Influenza is something which is vitally important to the control of Avian Influenza but also I think we're in an era now where we're able to find these viruses and find these infections more than we were in the past. And so the frequent information in news regarding all the different viral strains is a reflection of our ability to have better diagnostic and surveillance capability than we've ever had before.

There are clinical features of Avian Influenza which are similar to regular influenza or seasonal influenza. However the severity can be higher. There is persistent fever, lymphopenia (i.e., low white blood cell count), severe pneumonia or acute respiratory distress syndrome, and occasionally multi-system organ failure.

In almost all cases so far, there has been exposure to sick poultry, or to the environment, which has been contaminated by sick poultry. If clustering of

cases occurs, this can be an indication of person-to-person transmission; but, it can also be an indication of a point source for influenza transmission.

Some theoretical models have been developed to describe how Pandemic Influenza, if it were to occur, could be contained with antiviral agents. I put this slide up mainly to indicate that the work, which has been done by mathematical modelers, really indicates that an important factor in stopping a Pandemic is through use of community containment and control and through healthcare infection control. These non-pharmacologic activities are very important when there is no vaccine available. I'd like to focus on this for the next few minutes.

With regards to Pandemic Influenza, again I would point everyone to the www.hhs.gov site where the U.S. Pandemic Influenza plan is available which describes the recommended infection control practices.

The goals of infection control in a Pandemic, and in usual efforts to stop transmission of healthcare-associated infections, are to 1) define and identify cases, 2) to stop the spread of disease in: a facility, a population, or in a geographic region, 3) to ensure the safety for the healthcare workers – the personnel providing care, 4) to confirm the effectiveness of those practices, and to prevent inappropriate responses.

Well, how do infections such as influenza spread? I would like to go through a couple of different steps, or factors, in transmission. For each of these factors, there are windows of opportunity to stop transmission of influenza.

The *first* is that the infection must leave the original host. For influenza, we believe that transmission occurs primarily through large droplet nuclei. The means to prevent transmission of the large droplets from person-to-person is

to use “droplet precautions” which, among other practices, includes wearing a surgical mask when within three feet of an infected patient. (see http://www.cdc.gov/ncidod/dhqp/gl_isolation_droplet.html). Through coughing, an infected patient can contaminate the immediate area around them. Other individuals, touching these contaminated surfaces and items, can contract the infection. Thus, washing your hands with soap and water or using alcohol-based hand gel is an important practice to follow as well.

Let’s move on to the *second* point: “surviving transit”. Environmental factors can play a role in survival of the virus. These include humidity, temperature, and possibly ultraviolet light. Droplets containing the virus can allow the virus to persist in the environment for a short period of time.

The *third* point: “delivery to a susceptible host”. The window of opportunity here is in the prevention of hand-to-hand transmission through appropriate hand hygiene and in prevention of droplet transmission through following droplet precautions (i.e., placing patient in a separate room, HCWs wearing a surgical mask if within three feet of the patient, and placing a surgical mask on the patient during transport)(see http://www.cdc.gov/ncidod/dhqp/gl_isolation_droplet.html)

The fourth factor is: “reach a susceptible part of the host”. Here again, the use of appropriate personal protective equipment with droplet precautions and vigilance with hand hygiene will prevent transmission of infection to the susceptible host. Again, these recommendations are at the CDC website and at the HHS pandemic flu website.

With regard to the specifics of the infection control practices recommended for pandemic flu, there are three components described in the plan:

- standard precautions - which we recommend should be used all the time for Pandemic Influenza,
- droplet precautions - again should be used all the time

And for aerosol generating procedures, the use of

- airborne precautions.

For *standard precautions*, this means the use of certain personal protective equipment and activities as determined by the infectious risks facing the healthcare worker. (see http://www.cdc.gov/ncidod/dhqp/gl_isolation_standard.html) In general, Standard Precautions are designed to reduce the risk of transmission of pathogens from moist body substances and applies to all patients receiving care in hospitals, regardless of their diagnosis or presumed infection status. Standard Precautions apply to 1) blood; 2) all body fluids, secretions, and excretions except sweat, regardless of whether or not they contain visible blood; 3) nonintact skin; and 4) mucous membranes. Standard Precautions are designed to reduce the risk of transmission of microorganisms from both recognized and unrecognized sources of infection in hospitals. You apply the needed precautions if there is a risk from exposure to the body fluids listed above. In general this refers to the use of gloves, hand hygiene, the use of face shields, masks or gowns if splashes are anticipated, and then for any contact with blood, moist body substances except sweat, mucous membranes or non-intact skin.

An important thing to remember is that gloves are removed and discarded immediately after completion of a task and that hands are washed every time when gloves are removed.

Droplet precautions are recommended for those infections which are spread by large droplets -- like influenza -- and are generated by coughs and sneezes. For this, face shields or goggles and/or a surgical mask -- not an N95 mask -- are worn to prevent droplets from reaching the mucous membranes of the eyes, nose, and mouth when within one meter of the patient. (see http://www.cdc.gov/ncidod/dhqp/gl_isolation_droplet.html)

The patients should be separated by one to two meters or be grouped with other patients (i.e., cohorted) with the same infection colonization status. The patient should wear a surgical mask when outside of the patient room and when being transported in the facility. For droplet precautions, negative pressure rooms are not needed.

In this photo, you can see healthcare workers wearing personal protective equipment to provide airborne precautions in the laboratory. These special precautions are for high-risk procedures. These procedures include suctioning and intubation, and in the laboratory, these procedures include centrifugation and pipetting.

Airborne isolation is recommended for those aerosol-generating procedures and infections which are spread by particles less than five microns in size and which remain infectious while suspended in the air. For pandemic influenza we are currently recommending airborne isolation only for workers that are involved in the aerosol-generating procedures I mentioned above.

Airborne isolation includes the use of a negative pressure room, placing a surgical mask on the patient, an N95 mask for the personnel inside the negative pressure room and staff who are doing the procedure. Isolation room air should not be re-circulated in the building, and the air should be exhausted away from people, i.e., from off the roof. In conclusion, the components of

the infection control recommendations for pandemic influenza can be found at the HHS website <http://www.hhs.gov/pandemicflu/plan/> and at the CDC website <http://www.cdc.gov/ncidod/dhqp/guidelines.html>. And with that I'll hand the leadership of this back over to Dr. Cervia.

Joseph Cervia: Thanks, Dan. Our next speaker is Dr. Laura Hawryluck. Laura will share with us some of her experience in having addressed the epidemic of SARS -- lessons learned and potential implications for influenza pandemic. Laura.

Laura Hawryluck: Thank you. What I want to talk about is some of the experiences that we lived through in Toronto and SARS and explore what we've learned and talk a little bit about how we're applying that now as we develop our own pandemic plan for specifically critical care within the province of Ontario.

And at the end of it you can tell us what you think -- whether or not we're prepared here or what we need to do. We'll welcome any feedback. . So if we look at the current flu pandemic predictions that we're dealing with in Canada, we have been told to expect a 35% attack rate over a six-week period.

For us in Ontario this means hospital admissions to peak at 1800 per day. This would take 72% of the total hospital capacity. Now the demand for ICU will peak at 171% of currently existing bed capacity. And just for ventilators alone, we are expected to need 118% of the current capacity and this is only for patients with influenza. This does not include routine ICU admissions.

These numbers only take into account the physical capacity and not the human resource issues that we all will have to face and deal with as well. When we look at our experience in SARS, what became really evident to us after we were in it and did not have a plan is the importance of actually having a plan. And in that plan there is a number of different points that I want to talk about.

And you see them around this diagram that is currently in front of you. We'll go through them piece by piece. The first thing with any plan is you need to have leaders whom you identify to have key responsibility. They have to be able to work with others and coordinate efforts. And this is really breaking down a lot of the silos that we currently see in health care. We have to develop containment policies as we have heard, and we need to coordinate manpower and resource allocation. I am going to spend a lot more time on this issue.

We also heard about infection control. One of the other features is very important though is the sharing of data and research efforts. One of the things that has helped us extremely in terms of the SARS outbreak was the use of the internet and sharing our experiences with those other centers that were affected around the world. It helped us treat people. It helped us look at where we could concentrate efforts in terms of trying to clarify the unknown.

I'm going to speak about maintaining staff morale a little bit. That is an ongoing issue especially as talk about the new pandemic comes up. I will tell you how that is affecting us. The coordination with other institutions in your local area and coordination with government is extremely important –and needs to be developed before.

In the SARS outbreak we saw entire hospitals in Toronto and entire ICUs quarantined for 12 to 14 days. When we looked at what had happened, we had in fact lost 38% of our tertiary ICU beds and 33% of the community ICU beds at one point in time along this outbreak. Most of our intensive care units operate at 90 to 95% capacity on a daily basis so you can just imagine the impact. Our staffing was reduced because of illness, because of quarantine, and because of fear.

When we look at how we can better organize our resources - having learned from the SARS outbreak - it becomes really evident -- and I know that a lot of people around the world are talking about this -- is the need for the development of an effective triage system. This is to make sure that you have accurate up to date information available, that you have a committee that has command and control over their resources, that you have an effective communications network. This is extremely important.

During SARS we created our own sort of daily teleconferences to help share information because we couldn't tell the truth between what was in the media and what was actually happening. You need trained triage officers in this field who have the authority to enforce some very difficult decisions. And you see how hard this is in the next minute.

The challenges in dealing with a new infectious agent are the same that we saw in SARS and we will see again with the pandemic flu. We will not know what the pathogen is going to do. We don't know the course of illness. We are not going to be able to predict who will do well, who will not do well. We don't know the treatment. Is Tamiflu really going to be effective despite all the hype? Who knows?

The nature of the disease may change in mid-course. There could be secondary complications. How are we going to collect as we are trying to contain an illness and protect our own staff, especially with the sheer volume of patients that I've alluded to and we have been told to prepare for? The most challenging and the most chilling challenge I think is that even resources that we view currently as common have the potential to become very scarce. The primary goal of triage in a pandemic requires a major shift in medical thinking and in ethical modelling. So the goal moves to first-come first-serve and maybe some priority programs. And depending upon your work to do the

most for the most, which is a very utilitarian approach to medicine. This is because triage decisions will depend on the patient's probability of survival and on the availability of resources. We have never had these two so acutely linked in this kind of pandemic situation. .

Here is a model for this kind of triage that is used in ethics and has been created by Norman Daniels. It is supposed to be the strongest emerging ethical model for resource allocation when these resources are very scarce. And basically it is a set of criteria. So the questions are: is it based on something relevant? Is it made public? Is it enforced? And is there some way of appealing for the use of these resources in case somebody has made “not quite good decisions”, shall we say.

In essence, internally in ICU -- in the ICU world, accountability for reasonableness is very difficult to apply. So what we try to do in terms of pandemic is to work with existing knowledge by using the experiences that we have had before, i.e. the experiences of SARS, and the experience of previous pandemics - even though the intensive care world was not really fully developed at the time of the three other pandemics that we have experienced in the last 100 years or so.

However, that being said we do know things about ICU. We know things about people who survive and we can use that to create a scientific basis for our program. We can also try to make these publicly relevant or publicly available beforehand. We can devise the triage also to assist people who will have the very difficult job of enforcing these criteria. But where the problem will lie is the appeals process and how would you devise that in terms of this scheme?

So we can also learn from others. The military has used triage systems for many years in mass trauma situations. The sheer volume of people that they are designed to sort make them very useful in a pandemic, but (there) they have been devised for trauma. One of the things which is very interesting in these models is this notion of minimal qualification for survival to guide triage decisions.

The military basically colour-codes people. When we look at devising an Ontario pandemic plan, we have also colour-coded people to make the two systems match up. So the red people would be the highest priority for ICU care. We have some criteria there, but the plan is still in development. You can email me. I can't show it to you right now, but we can talk a little about what it looks like later, maybe in the discussion.

Yellow -- those are the people who might do well with ICU care, they might do well without. If we had the resources it would be nice but we don't have the resources to take them. People who are deemed blue -- in the United States this would be called black -- would be immediately palliated. And the green people are unlikely to meet ICU but do need to be reassessed in the future.

The biggest question from SARS is to anticipate your equipment needs -- to have some basic stock and a list of supplies so you can ensure that rapid increases and demands are met. And then you have to teach people how to use this equipment, because a lot of it is very foreign unless you're in that kind of situation. You can see the tape on the guy's gloves. You know, to tape gloves is not something that comes naturally. So there will be a lot of education, clear protocols, and a lot of training. And you have to repeat it over and over and over again.

You have to be prepared to survey your landscape. We don't have a clear beginning or clear ends. It's not like a bio-terrorist attack where we know when something happens. We don't know when this will end and this requires collaboration across a wide range of reasons. You have to balance quarantine and the maintenance of freedoms and that is very difficult to hit properly. If anything, I think, we erred to do more quarantine and most of us are prepared to accept that that's the risk you just have to face.

In terms of communication, you have to convey it locally, nationally, and internationally in these days of global travel. Websites, teleconferences are very useful. Media probably less so. There is a whole lot of spin that goes into this as we learned, and it's very difficult to tell the truth from fiction.

We have to make sure that this information gets to the front line workers. And frankly we fell down during SARS. The front line workers are usually the last to find out about things and that needs to change. Patients and their families of course are second on that list. And again we weren't all that great at communicating with them and that also needs to change.

If you can control the media a little bit that would be useful. I don't know honestly if you ever can because the fear and the spin that gets put on this was really quite incredible and I think will be even worse judging by what we're seeing already with flu.

Education -- we talked about re-educating and educating again and again and again. This is really important. We have people - it's almost like spying on your neighbour - to make that infection control measures are followed. It is something that we saw happen. It surprised us a bit but in the end it was probably necessary.

The creation of educational material and internet-based programs is also very useful as well as the creation of mobile education teams to go to hospitals, which are newly affected and share the information that has been gleaned from other hospitals and what they have learned by trial and error.

Team morale -- now this is a real tough one. I think you will have to tailor it to whatever suits them best. So regular support meetings maybe, debriefings, emergency crisis response teams, we had psychiatry come in and give counselling. I think the biggest thing that made a difference was saying: "Thank you!".

And also just trying to make their environment as good as possible. So for example the hospital would have those huge bins -- those garbage containers that we used to move garbage around. They sterilized them all and they put in ice and Coke and all kinds of other soft drinks. And that made a world of difference when you're working in N95 all day long. So on your way in and out you had at least something to make the world a little less dry.

Isolation, fear and anxiety are common. We were treated as pariahs by the rest of the community and by the general public. And that was very difficult. Still now, we see that a significant number of our staff is still wrestling with symptoms of post traumatic stress disorder and depression and are requiring ongoing support.

And we are not quite sure what will happen during the pandemic if or when it comes.

This is important: the sharing of information. I've alluded to this throughout. The collaboration of all levels of government. Now, in Canada this means cutting through a lot of red tape; a lot of sort of government slowdown and this kind of thing. But the bottom line is you don't have time to deal with all

their wonderful little procedures. You have to figure out a way of moving this forward.

And so right now with this pandemic plan, we are working with the government now to set up a command center that will be ready in case. And we are outlining what we need from governments.

The last point I want to make is: you have to lobby. You absolutely have to get out there and make sure that others understand your needs. And you need to get the commitments in advance to help you from all levels. From local to provincial governments or to federal government; whatever you are dealing with, they need to back you.

And that's it. You know what may work on your plans. Feel free to call me, or email me: and, I can share what we have. Thank you.

Joseph Cervia: Thank you, Laura. Next, Dr. Klaus Züchner will offer us the anesthesia perspective on the role of breathing system filters.

Klaus Züchner: I am talking about the role of breathing system filters in the clinical setting. The aim of what we need to do is to prevent patient-to-patient transmission, and of course - what we just learned about - patient to personal transmission.

What is the clinical setting we have to deal with? Firstly, we are talking about intubated patients, getting either general anesthesia or being ventilated with an anesthesia machine in the OR or a ventilated patient in the intensive care unit.

In the anesthesia setting, we normally have a re-breathing system; at least this is very common in Europe. In these systems the CO₂ absorber is producing water by a chemical reaction. Therefore the breathing system is on both sides,

on the patient side and on the ventilator side, challenged with water, which is a good substrate for growth of various species.

In the ICU we have two different settings. One, which is very popular in Europe, is to moisturize the inspired air of the patient with an HME, which keeps breathing tubes to the ventilator virtually dry. And secondly, what I think is more popular in the United States, is to have a humidification system for the inspired air with a heated humidifier, which can be of many different types and makes. Again, in this setting, we have a lot of water, condensed water involved. Some of those machines have heated breathing tubes, but we have water in the whole system.

Now, if we want to filter the air this means that we want to remove particles from the inspired and the expired gas. And we also want to prevent the passage of liquids, which may be contaminated with microorganisms from one patient to the other or to the personnel. We have to deal with those two aspects separately.

We make the assumption that microorganisms -- viruses, bacteria, fungi -- can be treated like particles. And we have to remove these particles by a filter. In order to give you an idea of how those filters work, I show you three different pictures of filter media.

In the next slide, you see a glass fiber filter (thanks to Dr. Tony Wilkes from Cardiff University). He has made these electron scanning microscopic filter pictures and provided me with this photograph.

Please note that the magnification is 100 micrometer as you can see on the right bottom side. We are talking about a three dimensional felt, which is resin bonded between glass fibers.

A different type of filter is shown on the following slide,. This is an electrostatic filter. Please note that this is the same magnification of 100 micrometers. Those are so-called electrostatic filters, which have a (unintelligible)-induced distribution of electric charges within the filter material, which normally is made of polypropylene.

The next slide again shows you a photograph of an electrostatically charged filter, in which the electrostatic distribution has been achieved by rubbing the filter media.

With those three different filters we want to understand how a particle can be filtered out if it is being used for airborne filtration. The first mechanism for the retention gas-borne or airborne particles is direct interception. The particle is just deposited onto the filter medium. The second mechanism is inertial impaction. This means that the particles, which have a mass, don't follow the gas stream and are also retained on the filter fibers Gravitational settling is a mechanism, which works for bigger particles.

Diffusional interception is difficult to understand for people who are not acquainted to it. It is based on Brownian movement.

The smaller a particle is, the higher its amplitude of oscillating. Therefore, smaller particles will be easily retained by filtration due to this diffusional movement. And the last mechanism I want to talk about is electrostatic attraction. This mechanism ensures that charged particles can be attracted by the filter fiber.

This picture gives you an idea of how this works. The red dot is a particle which hits the fiber due to interception or due to inertial impaction. The green

dot is a particle passing through the filter media. And the small yellow one is very small in size and mass, oscillating in Brownian movement

On the bottom of the graph you see if the fiber is charged, it can attract particles that are also charged. All those mechanisms combined make up for filtration efficiency. Filtration efficiency is high at large particle diameters. And it is also quite high at very low diameters or masses of particles.

Even with all filtration mechanisms combined there is a most penetrating particle size for a given filter medium. This particle size is at about 0.3 microns. This is one of the difficult to understand concepts of gas filtration, that efficiency will never be 100% and that there will be always a very small percentage of particles passing through the filter.

The most penetrating particle size, where the efficiency of such a three-dimensional filter felt is lower than at other particle sizes is in the range of 0.05 to 0.5 micrometers. Particles of this range pass the filter more easily. There is a standard for testing filtration efficiencies of breathing filters (ISO 23328). And Tony Wilkes–has used this method to do a comparative test with 104 breathing system filters.

And to cut this story short, glass fiber filters, perform best. Unfortunately, they tend to have only limited moisturizing properties, which is necessary at least for intensive care ventilation.

The next issue to address is a method to retain liquid from the breathing systems. As I mentioned before, there is water in the breathing systems due to the CO₂ absorption process, or due to the humidification process.

And again, Dr. Wilkes found in his experiments that glass fiber filter performed best to retain water. In this context we need to understand that in protection against liquid borne contamination we can't measure a percentage of particle removal efficiency

It is rather an all or nothing principle. If water breaches the filter medium, particles and microorganisms contained in the liquid will also pass. The key criterion for filters is therefore water retention.

In order to act as a barrier to liquid contamination, filters must withstand a certain water column pressure. This pressure should at least be in the magnitude of the pop-off pressure of the breathing system. Test methods, which help to define how can withstand a hydrostatic pressure have yet to be defined.

In anesthesia, glass fiber filters should be used at the y-piece -- between the end of the tracheal tube and the y-piece. Water produced in the CO2 absorber can be withheld and the filter is a clear barrier between the ventilation machine and the patient.

To position a glass fiber filter at the y-piece is the protection of choice in anesthesia.

In intensive care, we have to deal with a more complicated system. If you use heated humidifiers, the ventilator has to be protected against contamination. This enables it to be used for the next patient without sanitization at the inspiratory and expiratory port of the ventilator.

If you use an HME as the humidifying system, there are two possibilities. Either the HME is equipped with a good filter itself and gives a clear

separation between the breathing circuit and the patient. Or we have an HMEF with poor filtration efficiency, which means that we need to protect the ventilator. The best choice for the filter positioned at the expiratory port of the ventilator is again a glass fiber filter

In ICU ventilation we have HME filters. Those devices can be recommended for use at patient end if they have good humidification properties. If you use simple HME with good humidification properties, a filter has to be used at the ventilator's expiratory port. If heated humidifiers are used in this setting, separate filters are needed at the expiratory and inspiratory port. And that is what I have to say about filtration in the breathing system circuits. Thank you.

Joseph Cervia: Thank you, Klaus. And finally, Dr. Andy Widmer will familiarize us with some of his work on the use of filters in anesthesia breathing circuits.

(Andreas Widmer):

Hello to everybody. I actually did a study on ventilator breathing systems a clinical study that was required by our institution and was not supported by any pharmaceutical or medical company.

So the baseline was that those ventilators we purchased, were designed to become disinfected every month, which we considered as inappropriate if we used a filter.

However, looking at guidelines from the CDC, there is no recommendation for using a heated humidifier to prevent pneumonia. And the American Society for Anesthesiology claimed that there are insufficient clinical outcome data to support the routine use of bacterial filters for breathing circuits or anesthesia ventilators at this time.

So I will talk on the bacterial retention efficiency of the filters used in this clinical study.

Even we were exposed to the SARS epidemic when 20,000 people came to our city on April 1, 2003 at the high time of the SARS epidemic for an annual jewelery fair.

As I don't have data on the viral efficacy of those breathing filters I will talk about our study on bacterial efficiency.

. We have some evidence from Germany that filters actually may be associated with lower rates in ventilator-associated pneumonia.

In Circle 1A which is on the top of this slide, you see the overall effect. That continues to be more pronounced if regulation goes on for more than seven days which is Circle 1B on the bottom of the slide.

So we have some evidence that filters may prevent pneumonia. But at low exposure times - as the CDC guidelines show - we don't have strong evidence that we can prevent nosocomial pneumonia by routinely using filters.

Another string of evidence comes from exposure to blood shown in several studies. -Here is a picture of an endotracheal tube at the end of anesthesia. As you can see the tube is being contaminated with blood from the patient. So at least theoretically the ventilator and the breathing tube may be exposed directly with blood from the previous patient.

I have to reiterate that this is not a theoretical model there is enough data demonstrating that this really happens.

In Europe, we usually use one of those filters to prevent cross-transmission between patients as outlined on this slide.

On the question, which filter we are using: You need a highly effective filter which actually does not only filter bacteria, but also e.g. hepatitis C or HIV. And what matters more in Europe, especially in the UK, France and Switzerland the filter should be efficient against prion proteins. This is not an issue in the United States.

Our setting: an 850-bed hospital with about 26,000 surgical interventions per year. The goal of our study was to determine the rate of contaminated filters after anesthesia and to reduce the number of cycles for disinfection of the ventilators from once a month - which is the recommendation of the European Union - to once per year.

Our method was to test the filters on the outlet of the patient and on the ventilator side as internal controls. After surgery we removed those filters within a maximum of four hours (usually one hour) and transferred them to our laboratory.

The next slide shows you a scheme. On the right side you see the patient and on the left side, our anesthesiology equipment. We put 20 ml of phosphate buffered saline into both sides of the filter and centrifuged these 20 ml after incubation in the used filters for at least 5 minutes and then plated the centrifuge effluent.

We prepared 224 filters. Because we cultured both sides, we had 448 samples. The study was aimed at showing how to protect the machine. We

therefore did not collect information on type of surgery, duration of surgery and the incidence of nosocomial pneumonia.

We also did not assess for Hepatitis B, and C. – The prevalence of HIV in our surgical patients is below .5%. Hepatitis B is by far less than 1%. and for Hepatitis C, it's approximately 1%. So even if we had cultured thousands of filters with exposure the incidence of those cases would have been very low. Therefore this was not the goal of our study.

The results are: we had 12% contamination in the controls. That means on the ventilator side we mainly found coagulase negative staphylococci. and corynebacterium at very low rates, less than 10 (cfu) per 20 ml, which probably reflects contamination during processing, which was not done under sterile conditions. It was done in a laminar airflow hood. But we couldn't control highest level of sterility.

So my interpretation is that this reflects secondary contamination only. On the patient side we had positive cultures in 12.8% also. In 25% of those positive cultures we found the mixed flora, which we usually see, in broncho-alveolar lavage, typical bacteria like haemophilus or streptococci.

In 3% we also found *Klebsiella pneumoniae* and the rest was basically skin bacteria and upper respiratory tract non-pathogenic bacteria. However, we have some evidence that patients actually can contaminate the breathing system in the retrograde way.

My conclusion is that retrograde contamination with clinically significant pathogens occurs not very frequently; but we have now strong evidence that it may occur. None of the control filters showed growth of clinically significant pathogens. The use of filters in anesthesia breathing systems may be useful

not only for TB patients as recommended by the CDC, but also for other patients. For instance, patients with active pneumonia, cystic fibrosis or upper chronic pulmonary disease with pathogenic bacteria such as *Pseudomonas aeruginosa*.

I think one acceptable indication is also for those with suspected or confirmed influenza specifically Avian influenza. And that brings me to my conclusion. Thank you. Now swing back to our leader.

Joseph Cervia: Thanks (Andy). Just to sum up a couple of our key learning points before we move on to questions.

We've learned in today's conference that the re-assortment of animal and human influenza strains may result in virus to which humans have no past immunity, thus resulting in pandemic. Outbreaks of such viruses may arrive quickly and without much warning, taxing our material and human resources.

Advanced planning is going to be critical to the success of any institution in addressing such outbreaks and should include coordinated efforts to develop containment policies and to anticipate our manpower and resource allocations.

Finally, breathing circuits of intubated patients in ICUs and under anesthesia may be protected by filtration, reducing the risk of viral transmission from an infected patient to other patients and to healthcare personnel.

And at this time, I would like to open it up to questions. Our first question comes from New York and it's directed to Dr. (Jernigan). And the question is, "Why use a surgical mask rather than an N95 mask? And what is the difference between these two types of masks?"

(Daniel Jernigan): Thanks. That's an excellent question. I think the main difference of course is in the purpose of the mask. The surgical mask is really a barrier protection. And the N95 is really for filtering. It's a respirator.

And so the difference there is in what you're trying to prevent with regard to the influenza. The use of the surgical mask is really to prevent those large droplets from getting to the mucus membranes of the mouth. The N95 is really to prevent the smaller particles that are suspended in the air for those kinds of infections that are transmitted through airborne droplet nuclei, the very smaller nuclei.

And so the information that we have so far from seasonal influenza, the information so far from Avian influenza and also what we anticipate might occur during a pandemic would be that flu will be acting the way that we know it has acted for a while and that surgical masks are going to be of the most useful in terms of the barrier protection. But surgical masks are just one component of the overall approach to infection control that includes hand hygiene, use of gloves and other things that are indicated in the documents that I alluded to on our Web site.

Joseph Cervia: Thanks (Dan). The second question comes to us from a fan of Dr. Hawryluck's who asks, "In your article published in *Critical Care*, and that's the August 2005 issue, entitled SARS lessons and disaster management, you stated that ICU demand for ventilators will peak at 118% of capacity solely for patients with influenza. How is that figure calculated?"

Laura Hawryluck: That figure has been handed to us. I can't give you the actual formula. It has a whole sort of disaster management team developing mathematical models at the Ministry of Health Level here. And while I can find out, all we were told

is that this is what you've got to deal with. Plan for it. It was like a very sort of here you go kind of approach to it.

But the number's been consistent because we've questioned it but didn't believe it. And of course those two go back and they actually said no. This is what we want you to plan for. This is what we think is going to happen.

So the criteria, the fall out from this is that the criteria that you devise for any triaging of patients or any way that you're going to admit or discharge patients from your ICU has to take into account that the criteria are going to have to apply across the board.

Influenza patients and all other ICU patients are going to have to be treated the same way. And the chilling thing is when you have military people around the table they start talking to you about we will need you to revise these criteria. We want you to come up with something that's going to make you unhook somebody from a ventilator in six hours. Because that's the kind of turnover that you're going to need.

And, you know, I mean for the ICU we need much longer time than six hours to actually make a difference, unless somebody dies on us right?

Joseph Cervia: Exactly.

Laura Hawryluck: We've got a huge problem with this.

Joseph Cervia: Yes, thank you. The third question is for the entire panel. "As compared to past flu seasons, how is this flu season measuring up?"

(Dan), would you want to tackle that one?

(Daniel Jernigan): Yes. I think that just in terms of the onset of it and the magnitude of the problem, this is not one of those flu seasons that we would put as significantly different than any other. But certainly the feel though is that this is not one of those severe flu seasons like we've seen in some of the past few years.

Joseph Cervia: Would anyone else like to comment?

(Andreas Widmer): I think in Switzerland, the last flu season actually matches the incidence right now. So we - I can just confirm that the statement by (Dan) that this season doesn't appear to be particularly different from other seasons.

Joseph Cervia: Thanks.

(Andreas Widmer): However more people are vaccinated in our country than any year before.

Joseph Cervia: Yes, perhaps that's the silver lining isn't it, that concern about the nature of influenza has perhaps renewed interest in immunization.

Okay, the next question is for Dr. Hawryluck. "One Toronto hospital used 18,000 N95 masks and 14,000 pairs of gloves daily during the SARS outbreak. How can such equipment volumes be used as a reasonable baseline for calculating future demand for other healthcare facilities?"

Laura Hawryluck: With difficulty. I think we have to remember in SARS is that we were also in a panic situation. I mean there were a lot of unknowns. There was a lot of waste of materials that we could have been more careful in how we used, and what we did with our resources.

So I think you can look at it, but you also have to look at some of the problems that arose. And I don't know that we actually have that data. So it's hard to give you absolute numbers of what you're going to need. That's why having supplier access is going to be really important.

Joseph Cervia: Okay and I have one final question also for Laura or anyone else who would like to comment as well. "Who will mostly likely play the role of triage officers during a pandemic?"

Laura Hawryluck: I've told them it cannot be me. That's my comment. I mean I think we're talking about training triage officers once we have the criteria and plan that's hard set for them to use. Now of course, hard set is a relative term. We're going to have to adapt as more information becomes available and we see what happens with our resources. But I think it's going to have to be a very special person indeed who is going to be willing to take on that role.

They're talking about recruiting intensivists. So far no one's exactly signing up here.

Joseph Cervia: That's understandable. Well with that, I would like to say thank you to our wonderful panelists for today's Webinar as well as all of our participants and wish you a good day. Thank you.

Operator: This concludes today's conference call. You may now disconnect.

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