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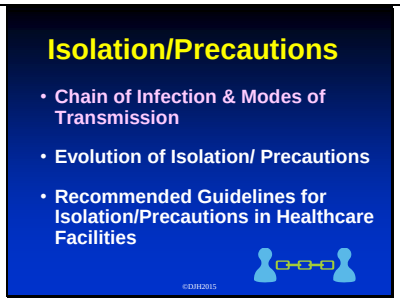
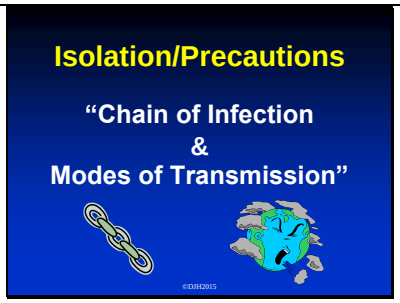
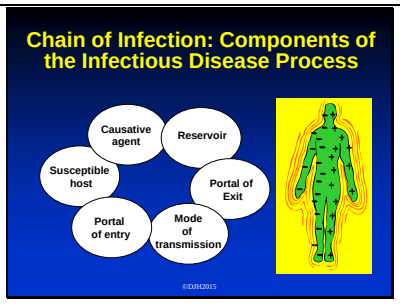
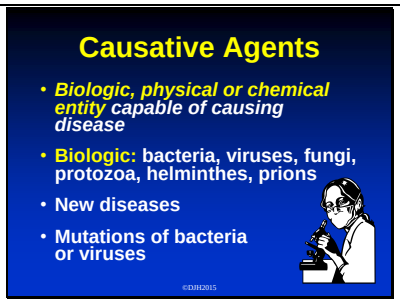
| Slide 1 |  | Welcome to Isolations/Precautions, which is divided into three lectures. The first lecture covers the chain of infection and modes of transmission. The second lecture covers the historical evolution of isolation/precautions systems in healthcare facilities. The third lecture outlines the most current recommendations from the Centers for Disease Control & Prevention (CDC) for isolation/precautions in healthcare facilities. |
| Slide 2 |  | This is the first lecture entitled "Chain of Infection and Modes of Transmission". |
| Slide 3 |  | The infectious disease process, also known as the chain of infection, consists of six components: the causative agent, the reservoir, the portal of exit, the mode of transmission, the portal of entry, and the susceptible host. |
| Slide 4 |  | The first link in this chain of infection is the "causative agent". This is defined as a biologic, physical or chemical entity capable of causing disease. Examples of biologic agents include, but are not limited to, the following: bacteria, viruses, fungi, protozoa, helminthes and prions. Additional causative agents include the emergence of new diseases, such as SARS, as well as mutations of bacteria or viruses, such as avian influenza H5N1. |
| Slide 5 |  | The definition of a "reservoir" is a place in which an infectious agent can survive but may or may not multiply. Hepatitis B virus may survive for a certain amount of time on the surface of a hemodialysis machine, but it does not multiply. Pseudomonas in a reservoir such as a nebulizer on a ventilator, can not only survive, but it may multiply as well in that solution. Human reservoirs include patients, healthcare personnel, household members and other visitors. Such source individuals may have active infections, may be in the asymptomatic and/or incubation period of an infectious disease, or may be transiently or chronically colonized with pathogenic organisms, particularly in the respiratory and gastrointestinal tracts. The three most common reservoirs associated with hospital-acquired infectious agents include patients, healthcare personnel and the healthcare equipment/environment. |

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| Slide 6 | **Portal of Exit** EXIT<br>• *Path by which infectious agent leaves the reservoir*<br>• Respiratory, genitourinary, GI, skin/mucous membrane, mother to fetus, & blood<br>• Reservoir may be a solution, product- *portal of exit changes*<br>©DJH2015 | The definition of a "portal of exit" is the path by which an infectious agent leaves the reservoir. Portals of exit associated with human and animal reservoirs are the following: the respiratory tract, genitourinary tract, gastrointestinal tract, the skin/mucous membranes, transplacental from mother to infant, and via blood. In a healthcare facility, if the reservoir is a solution, such as an intravenous bag of fluids, then the portal of exit may change, depending upon how that agent leaves that reservoir and ends up in the susceptible host. |
| Slide 7 | **Modes of Transmission**<br>*Definition:*<br>The mechanism of transfer of an infectious *agent* from a *reservoir* to a *susceptible host*<br>http://3.bp.blogspot.com/_Ko_hB2n1k8M/TMT2Lve2YiI/AAAAAAAAA1U/2dc-Nw_za-E/s1600/cough.gif<br>©DJH2015 | The formal definition of "modes of transmission" relates to the mechanism of transfer of an infectious agent from a reservoir to a susceptible host. We will go into much more detail on the modes of transmission in a few more slides. |
| Slide 8 | **Portal of Entry** Enter<br>• *Path by which an infectious agent enters the susceptible host*<br>• Hospitalized patients have MANY portals of entry & numerous opportunities for entry<br>• *Examples:* intravenous lines, surgical, medical procedures, ventilators, etc.<br>©DJH2015 | The "portal of entry" is defined as the path by which an infectious agent enters the susceptible host. Portals of entry associated with human hosts are numerous, and similar to the portals of exit. Remember that in healthcare facilities, patients have many portals of entry and numerous opportunities for the entry of infectious agents. The ways that diseases or organisms may enter hospitalized patients or patients in other healthcare facilities include through intravenous lines, during surgery or medical procedures, or through ventilators, etc. |
| Slide 9 | **The Skin as Portal of Entry**<br>• Emergency lines<br>• Intravenous, arterial lines<br>• Dialysis fistulas<br>• Pressure ulcers<br>• Burns<br>• Newborns<br>http://www.nigms.nih.gov/education/PublishingImages/300skin.jpg<br>©DJH2015 | The skin is the first line of defense against infection. The skin is also a significant and often violated portal of entry for hospital-acquired infections. Ways that the skin can be compromised include through lines placed during emergency situations; through intravenous and arterial lines; from dialysis fistulas; from a pressure or decubitus ulcer; from burns or other large areas of interrupted skin and in newborns, who have an immature first line of defense. |
| Slide 10 | **Susceptible Host**<br>• *Person/animal lacking effective resistance to particular pathogenic agent*<br>• Host characteristics influencing susceptibility: age, underlying disease, immunization status, diagnostic or therapeutic procedures, medications, pregnancy, trauma, & nutritional status<br>©DJH2015 | Infection is the result of a complex interrelationship between a potential host and an infectious agent. Most of the factors that influence infection and the occurrence and severity of disease are related to the host. The definition of a "susceptible host" is a person or animal lacking effective resistance to a particular agent. There are numerous characteristics of a host that influence susceptibility to and severity of disease. These include but are not limited to the following: age, underlying disease, immunization status, diagnostic or therapeutic procedures, medications, pregnancy, trauma, and nutritional status. |

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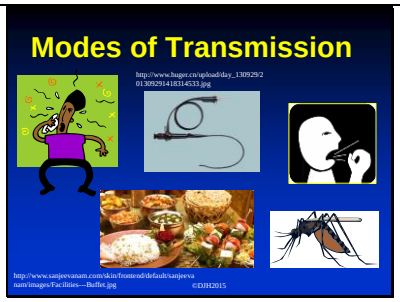
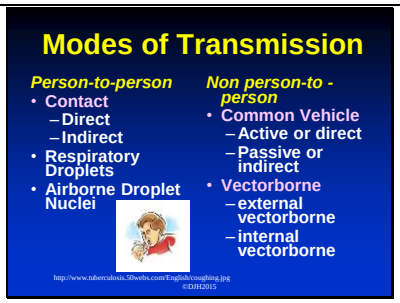
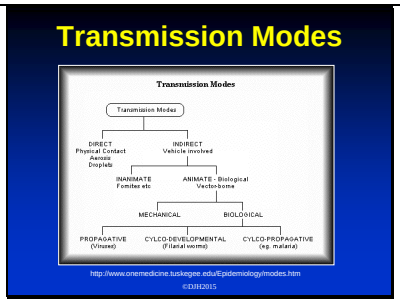
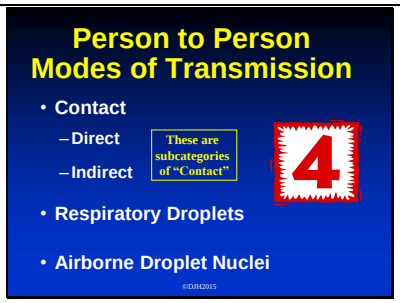
| Slide 11 |  | We will now discuss the modes of transmission in more detail. |
| Slide 12 |  | This slide outlines the modes of transmission. There are two major categories: person to person and non person to person. Within person to person there are contact transmission which has two subcategories, direct and indirect; person to person by respiratory droplets; and person to person by airborne droplet nuclei. In non person to person, we have common vehicle, with two subcategories: active or direct, and passive or indirect. That has to do with whether the organism replicates in the common vehicle or not. That determines whether it is active or passive. Then we have vector borne: external vector borne and internal vector borne and we'll give some examples of that. So that is the broad overview of the modes of transmission. |
| Slide 13 |  | This slide shows a similar categorization system for modes of transmission, differing only in the subcategories of indirect. You will not be responsible for knowing this particular diagram; it is presented to give you an additional point of view of this concept of transmission modes. |
| Slide 14 |  | Let's look at these categories more specifically, starting with person to person. There are four (4) types of person to person transmission. For the purposes of this class, direct and indirect are definitely subcategories of contact. Then we have respiratory droplets and finally, airborne droplet nuclei, (which are the smallest particles). The best example I can give of a disease transmitted by airborne droplet nuclei is tuberculosis. |

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| Slide 15 | **Direct Contact**<br>• Occurs when microorganisms spread directly from person-to-person<br>• Actual physical contact between source & person<br>• *Example:* herpetic whitlow transfer from patient to HCW, skin-to-skin contact of scabies<br>*(Subcategory of Contact)*<br>  <br>www.google.com<br>©DJH2015 | Direct contact transmission occurs when microorganisms are transferred from one infected person to another person without a contaminated intermediate object or person. There is actual physical contact between the source and the person. Let's give some examples. Let's say that a dentist is taking care of a patient who has herpes simplex virus circulating in his/her mouth, (which many people who have HSV-1 will have even before an eruption). So the virus is circulating in their mouth and the dentist gets a cut in his glove or doesn't wear gloves when in someone's mouth and gets herpes simplex on their finger. This is very painful and is called herpetic whitlow. That is direct transfer or direct contact from person to person. Another example would be a physical therapist taking care of a person with scabies and they are doing a massage in an area where the person has scabies and that physical therapist contracts scabies. That is an example of direct contact. In this second case, there is direct ungloved contact with the patient's skin. |
| Slide 16 | **Direct Contact**<br>  <br>http://www.fotosearch.com/LIF140/lnu217010/<br>• More efficient than indirect<br>• Occurs less frequently than indirect in healthcare settings<br>• Occurs more frequently between patients & HCWs than between patients<br>• Disease more likely to develop following direct contact transmission (DCT) when pathogen is ↑ virulent, has ↓ infectious dose, or pt. Immune suppressed<br>©DJH2015 | Obviously, by its name, direct contact is more efficient than indirect and it occurs less frequently than indirect, thankfully. If it didn't, we would have a real problem justifying any kind of infection control practices. It does occur more frequently between a patient and a healthcare worker than between patients, because most patients don't have direct contact which each other, except by the airborne route. In terms of disease, direct contact transmission (DCT) is more likely to develop following a direct contact when the patient is highly viremic, highly virulent, and has an organism that is very infectious or if that particular infection requires a very small infectious dose. The one that comes to mind is tularemia which requires only about 10-100 organisms to cause infection. If the patient is immune suppressed, it would make the infection potential easier. So that is direct contact. |
| Slide 17 | **Indirect Contact**<br>  <br>• Transfer of infectious agent thru contaminated intermediate object or person *(HCW hands, instrument, toys, devices)*<br>• Intermediate object passively involved<br>• *HCW's hands often cited as an important contributor*<br>• *Examples*: contaminated endoscope; thermometer *(Subcategory of Contact)*<br>©DJH2015 | Indirect transmission involves the transfer of an infectious agent through a contaminated intermediate object or person. Remember, it can be an object or person that is the intermediate agent transferring this organism, disease or infection. So the intermediate object is really passively involved. You'll read that in many outbreaks in a hospital from organisms or infections, hands of healthcare workers are the indirect contact mechanism. HCW's can take care of a patient, not wash their hands, and go to the next patient. The healthcare worker is not the source, the patient with the organism is the source, but the hands are the indirect mechanism by which the organism or infection reaches the next patient. In addition to hands, another example could be through an instrument. If someone has an endoscopic procedure and the scope is not cleaned correctly, and the next patient has an endoscopy with the same scope, an infection can occur. It wasn't the person who transmitted it, it was an intermediate object, the scope. A third example of indirect transmission could be through a shared patient care device (e.g., thermometer, glucose monitoring device). Thermometers are notorious for transmission of vancomycin resistant *Enterococci* (VRE). In fact, one of the first outbreaks that was written up on VRE had to do with electronic rectal thermometer transmission. Afterwards, guidelines came out |

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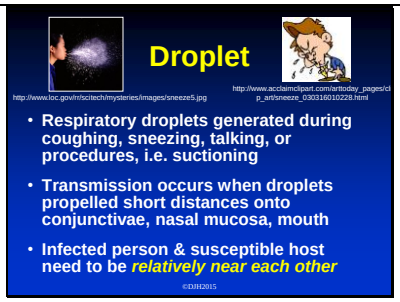
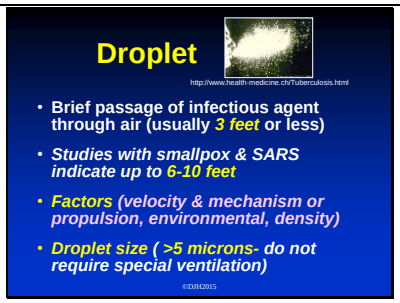
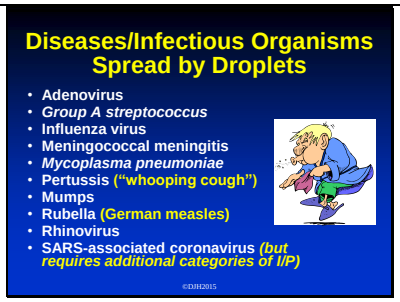
| | | that said if a patient has VRE, you don't use an electronic rectal thermometer because it is too easy to transmit that. Additional examples include shared toys among pediatric patients contaminated with respiratory syncytial virus (RSV) or *Pseudomonas aeruginosa.* |
| Slide 18 |  | Droplet transmission results when people generate larger scale organisms than airborne droplet nuclei and that can occur when you talk loudly, when you sing, when you sneeze, when you cough, when you suction someone, or during cardiopulmonary resuscitation. This happens when these larger droplets are propelled short distances, and can land in the conjunctivae, the nose, or mucous membranes. In this situation, people have to be relatively close to each other. Droplets travel, but they can't go too far because they are fairly heavy. |
| Slide 19 |  | The general guidelines state that 3 feet or less is the distance that a droplet can travel. However, when you look at case examples, particularly smallpox and SARS, the distance can be up to 6-10 feet. There are factors that can change the rate that droplets travel. Those factors are: the velocity of the organism, if there wind in the room, is it being propelled by a strong cough so that is goes farther, what the environmental conditions are (e.g., humidity), and how dense either the atmosphere is or the room ventilation. When SARS first appeared they really didn't know how it was transmitted and the recommendations were for people to be put in Strict isolation which included gown, gloves, and masks. When they looked at healthcare worker transmission, they found that in procedures where secretions were brought up, like suctioning or bronchoscopy, healthcare workers in those situations had a greater chance of becoming infected. (*Sometimes you have to see how a disease progresses before you can say exactly what type of precautions are needed.)* In general, a droplet is greater than 5 microns in size and Droplet Precautions do not require special air handling, like with airborne droplet nuclei. Droplets of about 5 microns in size can generally travel about 3 feet, but that can change depending upon the conditions we just discussed. |
| Slide 20 |  | This information o this slide is very important to know. All of the diseases or conditions listed on this slide are spread by droplets. Pertussis is also referred to as "whooping cough" and rubella is also known at "German Measles." Rhinovirus is the virus that causes the common cold. If you are in a hospital and have one of these diseases or conditions, you will be placed on Droplet Precautions. |

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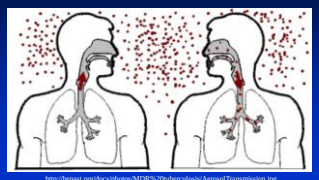
| Slide 21 | **Airborne Spread**<br>• **Dissemination of airborne droplet nuclei** (*small particle residue*) **of evaporated droplets containing infectious microorganisms** (*that remain suspended in air for long periods*) **or dust particles containing infectious agent**<br>• **Organisms may be of several types contained within droplet nuclei or *dust particles*** (e.g., *Aspergillus*, tuberculosis)<br>©DJH2015 | Airborne transmission occurs by dissemination of either airborne droplet nuclei or small particles in the respirable size range containing infectious agents that remain in the air over time and distance (e.g., spore of *Aspergillus* spp. and Mycobacterium tuberculosis). These are so light that they can be suspended in the air; they can be resuspended if they are on the floor and there is a gust of wind or a change in ventilation. Generally, the terms for diseases spread by the airborne route are “droplet nuclei” or “dust particles”. |
| Slide 22 | **Diagram of Airborne Droplet Nuclei Transmission**<br>  <br>http://bepast.org/docs/photos/MDR%20tuberculosis/AerosolTransmission.jpg<br>©DJH2015 | On this slide is a diagram illustrating aerosol transmission of tuberculosis. Tuberculosis is spread by droplet nuclei which are expelled when a person with infectious TB coughs, sneezes, speaks, or sings. They also may be produced by aerosol treatments, sputum induction, aerosolization during bronchoscopy, and through manipulation of lesions or processing of tissue or secretions in the hospital or laboratory. Droplet nuclei, containing two to three *M. tuberculosis* organisms, are so small that air currents normally present in any indoor space can keep them airborne for long periods of time. Droplet nuclei are small enough to reach the alveoli within the lungs, where the organisms replicate (American Thoracic Society, 2000). |
| Slide 23 | **Airborne Spread**<br>  <br>http://www.cdc.gov/niosh/npptl/topics/respirators/factsheets/respsars.html<br>• **Suspended in air for extended periods; thus may be spread through ventilation systems *(e.g., tuberculosis)***<br>• **Can be spread in same room or over longer distance from source patient when air supply shared**<br>• **Thus, need special ventilation, air handling & N-95 respirators to prevent airborne transmission**<br>©DJH2015 | Microorganisms carried in this manner may be dispersed over long distances by air currents and may be inhaled by susceptible individuals who have not had face-to-face contact with (or been in the same room with) the infectious individual. Preventing the spread of pathogens transmitted by the airborne route requires the use of special air handling and ventilation systems to contain and then safely remove the infectious agent. Because of this, what is required to be worn by HCWs is respiratory protection (e.g., an N95 respirator), and special air handling or ventilation for the isolation room. This room is referred to as an Airborne Infection Isolation Room or AIIR. Thus, the N-95 respirator and the AIIR are the personal protective equipment requirements and engineering controls, respectively, that we need in an Airborne Precautions situation. |
| Slide 24 | **Diseases Spread by Airborne Route**<br>  <br>• **Measles**<br>• **Varicella**<br>• **Tuberculosis**<br>• ***Smallpox****<br>• ***SARS*, VHF* reported, ?***<br>*= diseases/conditions require additional categories of I/P besides airborne<br>©DJH2015 | Diseases that are known to be spread by the airborne route are: measles, varicella (chickenpox), or tuberculosis. Published data suggest the possibility that the smallpox (or variola) virus may be transmitted over long distances through the air under unusual circumstances and AIIRs are recommended for this agent as well. However, it is important to point out that droplet and contact routes are the most frequent routes of transmission for smallpox. For SARS, although transmitted primarily by contact or droplet routes, airborne transmission over a limited distance (within a room) has been suggested but not proven. This is true of other infectious agents such as influenza virus and noroviruses. Viral hemorrhagic fevers (Lassa Fever and Ebola virus) can potentially be spread by the airborne route. We don’t know the natural reservoir of Ebola and until we do, we take special precautions with that condition. With Lassa Fever, there have been case histories where people who were very viremic and had lung involvement, possibly |

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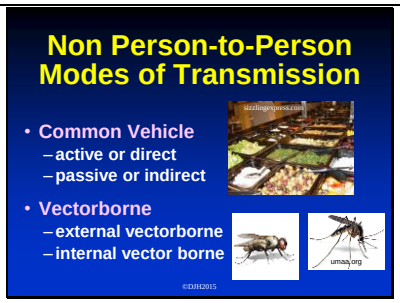
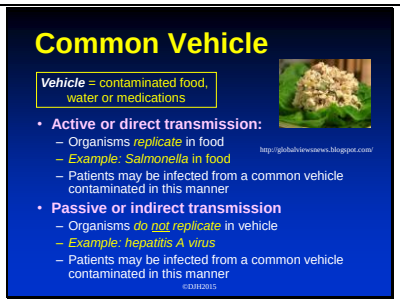
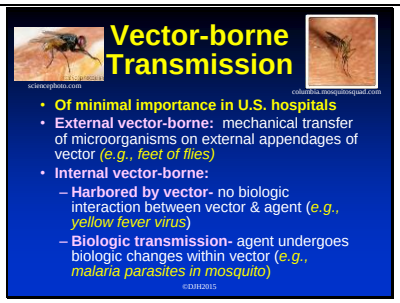
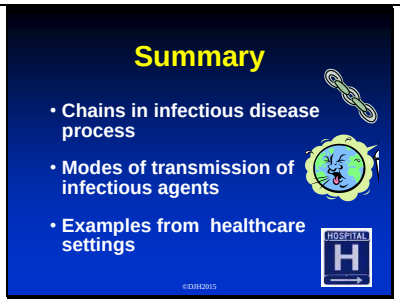
| | | transmitted VHF to healthcare workers by the airborne route. That is why we still question whether that could be happening and err on the side of caution. Until we know for sure that that is not the case and until we find out the natural reservoirs for some of these diseases in the VHF group, Airborne Precautions in addition to Contact and Standard, are recommended. |
| Slide 25 |  | With non-person to person modes of transmission, we can have transmission that occurs by a common vehicle such as food or a solution. A contaminated IV solution that comes out from a manufacturing plant or a pharmacy in a hospital is one example. Common vehicle transmission can be active or direct versus passive or indirect, depending upon whether there is replication in the common vehicle. Vector borne transmission can be external or internal. |
| Slide 26 |  | With common vehicle transmission, the vehicle can be food, medication, or water. Salmonella organisms can replicate in food, so if a common vehicle transmission occurred with Salmonella, it would be considered active or direct. If a food was contaminated with hepatitis A and infected others, hepatitis A does not replicate in food. Thus, this would be an example of passive or indirect common vehicle transmission. Patients can be infected from a common vehicle contaminated by either active or passive modes. |
| Slide 27 |  | In U.S. hospitals, vector borne transmission is really rare. This is not so in developing or undeveloped countries, so in these areas there has to be insect control. An example of external vector-borne transmission would be the mechanical transfer of microorganisms on the appendages of the vector (e.g., feet of flies). There are two types of internal vector borne transmission. The first is where there is no biologic interaction between the vector and agent, such as the case of yellow fever, where the agent is harbored by the vector. The second type of internal vector borne transmission is where there is biologic transmission and the agent undergoes biologic changes within the vector. An example of this is malaria. |
| Slide 28 |  | In summary, we have covered the chains in the infectious disease process, and modes of transmission of infectious agents. This has been conducted with a focus on and examples from healthcare settings.<br><br>This concludes the first of 3 lectures about Isolation/precautions. |