

Heating Ventilation and Air Conditioning

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Question #1

Which of the following statements about Air pressurization is FALSE?

- A. Positive air pressure keeps microbial contamination out of the room
- B. Negative air pressure keeps microbes from leaving the room.
- C. Positive air pressure is used in operating rooms and bronchoscopy rooms.
- D. Negative air pressure is used in rooms to isolate patients with infections that can be transmitted via airborne route.

Answer/Rationale #1

Answer is C

- A. Positive air pressure keeps microbial contamination out of the room
- B. Negative air pressure keeps microbes from leaving the room.
- C. Positive air pressure is used in operating rooms and **bronchoscopy rooms**.
- D. Negative air pressure is used in rooms to isolate patients with infections that can be transmitted via airborne route.

Rationale:

Bronchoscopy rooms should have negative air pressure. Bronchoscopies can produce droplets and aerosols. The negative air pressure will prevent aerosols produced from spreading outside of the room.

Question #2

Which of the following minimum efficiency reporting values (MERV) is sufficient to meet minimum operating room (OR) standards for air filtration?

- A. MERV 10
- B. MERV 12
- C. MERV 14
- D. MERV 16

Answer/Rationale #2

C. MERV 14

Rationale:

Heating, ventilation, and air condition (HVAC) systems include filtration systems to remove particulate matter, including airborne microbes. The American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) created a numerical system to rate filtration based on the particle size that the filter could remove. This system runs on a scale of 1 to 16, with 1 being a filtration system that removes only larger particulate matter and 16 being a filtration system that removes greater than 95% of particulate matter. The minimum standard for air filtration in an OR is 90%, which equates to a MERV of 14.

Question #3

Which of the following would be an acceptable route for diffusion of air in an operating room (OR)?

- A. Laminar airflow with a supply over the surgical table and an exhaust in the floor at the center of the room.
- B. Laminar airflow with a supply over the surgical table and an exhaust near the floor at the periphery of the room.
- C. Noninductional unidirectional infusion of air with a supply over the surgical table and an exhaust in the floor at the center of the room.
- D. Noninductional unidirectional infusion of air with a supply over the surgical table and an exhaust near the floor at the periphery of the room.

Answer/Rationale #3

D. Noninductional unidirectional infusion of air with the supply over the surgical table and an exhaust near the floor at the periphery of the room

Rationale:

Airflow in a healthcare facility should move from a clean area to one that is considered to be less clean. In the OR, the air supply should be from the ceiling near the center of the room, and the air exhaust should be near the floor on the periphery of the room. Laminar airflow is not appropriate for an OR setting as there is evidence that his high rate of airflow may induce hypothermia in the patient. A lower rate of air supply flow termed noninductional unidirectional infusion is used in the OR.

Question #4

You have been asked to advise the design team of a new healthcare facility on the planning for an airborne infection isolation room (AIIR). Which of the following are correct recommendations for this type of room in a new facility?

- 1) The AIIR must have an audible alarm to indicate when negative airflow is not being maintained
- 2) If the AIIR is a permanent dedicated negative airflow room, the the air should exhaust to the outside
- 3) The AIIR must have at least 12 air exchanges per hour
- 4) The AIIR is required to have an anteroom

- A. 1, 2
- B. 2,3
- C. 1,2,3
- D. 1,2,3,4

Answer/Rationale #4

B: 2,3

Rationale:

Airborne infection isolation rooms (AIIR) should be maintained under negative air pressure to ensure that airborne infectious organisms are under negative air pressure to ensure that airborne infectious organisms are not ventilated into the facilities corridor. These rooms must have at least 12 air changes per hour and newly constructed AIIR's must have a visible means of monitoring air flow. Anterooms are not required but there must be an area outside the room that allows for hand washing and for storage and disposal of PPE. If an AIIR is a dedicated negative airflow room then it should be designed to allow for air to exhaust directly outside the facility.

Question #5

In a construction zone in a healthcare facility that is occupied, airflow should be:

- A. Negative in the construction zone
- B. Positive in the construction zone
- C. Neutral in the construction zone
- D. Negative outside the construction zone

Answer/Rationale #5

A. Negative in the construction zone

Rationale:

Because of the potential in a construction area to generate dust that may contain harmful pathogens such as *Aspergillus*, it is critical that airflow in a construction zone that is in an occupied facility is negative. This will pull air into the construction zone whenever someone enters it rather than allowing air to escape from the construction zone into areas where patients and healthcare workers might be exposed.

Question #6

Which of the following statements are TRUE?

- A. Daily verification that airborne infection isolation room (AIIR) remain in negative pressure when not in use
- B. Ultraviolet germicidal irradiation (UVGI) can be used instead of HEPA filtration
- C. HEPA filtration has an efficiency of 99.97% in removing particles 0.3 micron or more in size
- D. The minimum air changes per hour (ACH) for a patient room is 3.

Answer/Rationale #6

C. HEPA filtration has an efficiency of 99.97% in removing particles 0.3 micron or more in size

Rationale:

- A. Daily verification that All room has negative pressure when in use and monthly when not in use.
- B. The optimal relationship between ventilation and UVGI is unknown. Because the clinical effectiveness of UVGI systems may vary, it is not recommended as a substitute for HEPA filtration
- C. True:
- D. According to the CDC, the minimum air changes per hour (ACH) for a patient room is 6. This may be reduced to 4 when supplemental heating or cooling syste

Water systems issues and prevention of waterborne infectious disease in healthcare facilities

Jeff Rogers, MPH

Question #1

In what cells within infected hosts and in what organisms is *Legionella pneumophila* capable of replicating?

- A. Alveolar macrophages
- B. Monocytes
- C. Alveolar epithelial cells
- D. Amoebae
- E. All of the above

Answer/Rationale #1

E. All of the above

Legionella pneumophila, the most common species of *Legionella* bacteria that produce a Legionellosis, is a facultative intracellular parasite and survives well in various freshwater protozoa, including their cysts (yes, inside protozoa). The bacteria is acquired by inhaling contaminated water droplets/aerosols. Once in the alveoli of the lungs they promote their uptake by alveolar macrophages.

Once ingested by the macrophages, the bacteria survive by producing various effector proteins (yes, inside macrophages). These effectors prevent the phagosome-lysosome fusion and create an environment where the bacteria can hide out and multiply. The host cell eventually dies releasing the bacterial cells to infect other tissues.

This bacteria is hearty as it can produce biofilms or live comfortably inside of protozoa which provide ample amounts of security from circulating immune cells or biocides in the water supply. These adaptations provide the bacteria with many resources to survive and thrive.



Question #2

What are the two most common serotypes of *Legionella pneumophila* isolates?

- A. Serotype 2 and Serotype 3
- B. Serotype 1 and Serotype 2
- C. Serotype 1 and Serotype 6
- D. Serotype 3 and Serotype 4

Answer/Rationale #2

Answer is C: Serotype 1 and Serotype 6

While true, it may be due to the way in which Legionellosis are typically diagnosed, with the urine antigen test, which has its limitations. While it is easy to use in determining a diagnosis, this test is limited only to *L. pneumophila* serotype 1. This may or may not be inflating or biasing *L. pneumophila* serotype 1 as the most isolated species and serotype. Culture is still the preferred method as it can determine species and serotype, but requires more effort to acquire a clinical specimen.



Urine Antigen Test (UAT)

Question #3

What are the most common waterborne pathogens in healthcare facilities? List all that apply.

- A. *Pseudomonas aeruginosa*
- B. *Legionella pneumophila*
- C. *Staphylococcus aureus*
- D. Non-tuberculous or Environmental *Mycobacteria* spp.
- E. *Streptococcus pyogenes*
- F. *Vibrio cholerae*
- G. *Cryptosporidium parvum*

Answer/Rationale #3

A, B & D. *Pseudomonas aeruginosa*, *Legionella pneumophila* & non-Tuberculous or Environmental *Mycobacteria* spp.

Both *Staphylococcus aureus* and *Streptococcus pyogenes* are not commonly isolated from aquatic environments. While *Vibrio cholerae* and *Cryptosporidium parvum* are aquatic pathogens, they are not commonly isolated from healthcare facilities due to properly executed facility water management programs.

*Note: Sinks and sink drains are common places for aquatic organisms such as these to setup reservoirs as there is a constant supply of resources that flow freely downstream to them



Question #4

What are the most common health risk factors for disease onset of Legionellosis?

- A. Immunocompromised
- B. History of smoking/vaping
- C. Age (≥ 50)
- D. Chronic disease (e.g. diabetes, obesity, COPD, etc.)
- E. A, B, D
- F. A, C, E
- G. All of the above

Answer/Rationale #4

- A. Immunocompromised
- B. History of smoking/vaping
- C. Age (≥ 50)
- D. Chronic disease (e.g. diabetes, obesity, COPD, etc.)

All of the above. Each of these risk factors have a common denominator - diminished host immune response.

<https://www.cdc.gov/legionella/downloads/fs-legionnaires.pdf>

Question #5

What are some effective water management and infection control mechanisms to mitigate disease from waterborne pathogens in healthcare facilities? Choose all that apply.

- A. Maintain water temperatures (both hot and cold water) outside the ideal range for pathogen growth
- B. Prevent water stagnation by maintaining regular flow of water throughout the facility
- C. Ensure adequate disinfection of water supply (copper-silver ion, chlorine-based)
- D. Maintain devices to prevent sediment, scale, corrosion and biofilm
- E. Ensure appropriate PPE and cleaning/disinfection practices are taking place paying attention to splash zones near sinks, sink drains, toilet areas, high-touch surfaces or shared equipment

Answer/Rationale #5

Each of these are actions that when combined provide the most ideal scenario for preventing exposure of waterborne pathogens in healthcare facilities

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Construction and Renovation

Linda Rider, RN/CIC

Question #1

A hospital is beginning a major construction project. The IP has been asked to join the planning team to assist with the development of the Infection Control Risk Assessment (ICRA) for the project. What is the purpose of the ICRA?

- a. Develop and oversee the construction project schedule
- b. Minimize infectious hazards for patients and healthcare personnel
- c. Provide direction for level three and four projects only
- d. Coordinate systems start-ups

Answer/Rationale #1

Answer = B - minimize infectious hazards for patients and healthcare personnel

Rationale: An ICRA must guide a strategic, proactive design to mitigate environmental sources of microbes, prevent infectious hazards through architectural design (e.g. hand washing and hand hygiene stations; isolation rooms; materials selection for surfaces and furnishings), and provide control measures that mitigate potential contamination during actual construction or renovation (e.g. dust barriers, pressure differentials, protection of air handlers).

Question #2

Which of the following statements best describes human factors?

- A. Ability to identify the many and various factors that impact upon a complex situation or event
- B. Prevention of errors and adverse effects to patients associated with healthcare utilization
- C. Environmental, organizational, and job elements and human and individual characteristics that influence behavior at work in a way that can affect health and safety
- D. The attitudes, beliefs, perceptions, and values that employees share in relation to safety

Answer/Rationale #2

Answer = C Environmental, organizational, and job elements and human and individual characteristics that influence behavior at work in a way that can affect health and safety

Rationale: Human factors examine the relationship between people, the tools and equipment they use in the workplace, and the systems with which they interact. The goal of human factors is to minimize errors by focusing on improving efficiency, productivity, and job satisfaction. The application of human factors knowledge in healthcare can help design processes to improve patient safety.

Question #3

Your organization is planning a major renovation project. You (the IP) have been asked to complete the Infection Control Assessment (ICRA) by the project manager. You explain that:

- A . It is his job to complete the ICRA
- B. The construction company will complete the ICRA
- C. An ICRA is not needed for the project
- D. The ICRA must be conducted by a committee with expertise in a variety of areas

Answer/Rationale #3

Answer: D The ICRA must be completed by a committee with expertise in a variety of areas

Rationale: The ICRA shall be conducted by a committee with expertise in infection control, direct patient care, risk management, facility design, construction, ventilation, safety and epidemiology. The committee shall provide documentation of the risk assessment together with updated mitigation planning throughout the project.

Question #4

An infection preventionist should be involved in which of the following phases of construction and renovation?

1. The design phase
 2. The construction phase
 3. The clean-up phase
 4. The return to use phase
-
- a. 1
 - b. 1,2
 - c. 1,2,3
 - d. 1,2,3,4

Answer/Rationale #4

Answer = D - 1,2,3,4

Rationale: It is critical that an Infection Preventionist is involved in all aspects of construction. Involvement during the design phase will ensure proper selection of materials, placement of products, and oversight of air and water quality. Involvement during the construction phase will ensure that design plans are being implemented properly and that the patient care environment is being protected from construction materials and dust. Involvement during the clean up phase will ensure that any existing dust and debris are properly removed. Involvement during the return to use phase will ensure that the area is functional and is being utilized in the manner in which it was intended.

Question #5

Poor planning during a construction project can lead to an increase risk of infection related to :

1. Construction delays
 2. Compromised air quality
 3. Contaminated water
 4. Increase in construction-related traffic
-
- a. 1,3
 - b. 2,4
 - c. 2,3
 - d. 1,4

Answer/Rationale #5

Answer: C - 2,3

Rationale: Insufficient planning can lead to compromised air quality and potential for continued environmental contamination from fungi (e.g. *Aspergillus* spp.) or water contaminated with water-associated microorganisms (e.g. *Legionella* spp.) during construction or renovation.