The Hospital as an Ecosystem

Foundations of Environmental Infection Prevention



CLPC Fall 2026 Seminar

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Understanding environmental reservoirs, transmission pathways, and prevention opportunities.

Disclosure

- No relevant financial relationships or commercial interests to disclose.
- Educational content should be interpreted alongside applicable regulations, facility policy, manufacturer instructions for use, and current public-health guidance.
- The presentation uses published outbreak investigations as teaching cases; case-specific findings should not be generalized beyond their evidence.

MAIN TAKEAWAY

Establish scientific independence and appropriate scope.

LAB LENS

Presenter disclosure; CDC/FDA guidance where applicable.

SOURCE Presenter disclosure; CDC/FDA guidance where applicable.

Learning Objectives

01 Describe how the healthcare-built environment can serve as reservoirs and pathways for pathogen transmission.

02 Identify key environmental factors that increase healthcare-associated infection risk and fundamental mitigation strategies.

03 Explain the clinical microbiology laboratory's role in recognizing, investigating, and preventing environmentally associated infections and outbreaks.

SOURCE Seminar learning objectives.

Foundational Infection Prevention Concept: The Chain of Infection



The Hospital as an Ecosystem

Interconnected Environments. Shared Microbes. Vulnerable Patients.



PATHOGENS MOVE. OUR ACTIONS MATTER.

The Environment We Don’t See

- A patient room includes the visible patient, bed, staff, monitor, sink and supplies.
- Water, drains, HVAC, surfaces, reusable equipment, people and construction interfaces form the less visible care environment.
- Environmental reservoirs become clinically important when a plausible pathway connects them to a susceptible host.



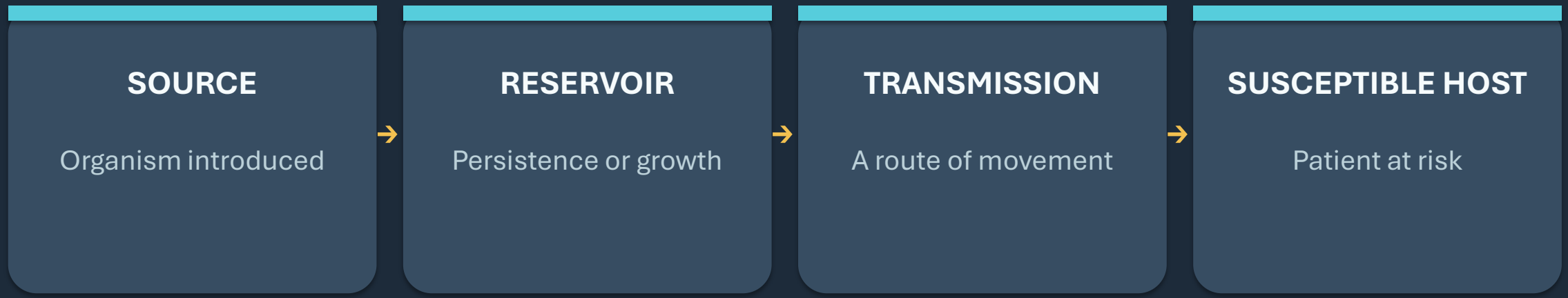
MAIN TAKEAWAY

The room is only the visible layer of a much larger patient-care system.

SOURCE CDC Environmental Infection Control guidance.

A Framework for Environmental Transmission

FROM RESERVOIR TO EXPOSURE



Follow the chain of infection to identify ways to break the chain

SOURCE CDC/HICPAC environmental-control principles.

One Building Change Can Alter the Ecosystem

Environmental changes can connect infrastructure, reservoirs and patient exposure.

A CHANGE IN THE BUILDING

Construction, plumbing or ventilation work alters the environment.

A POSSIBLE EXPOSURE PATHWAY

Water, air, dust, surfaces or shared equipment can move organisms.

A PREVENTION OPPORTUNITY

Assess risk before work starts and verify that controls are maintained.



Conceptual hospital cutaway; connections are illustrative, not a facility-specific engineering plan.

TAKEAWAY **An environmental change can become an infection-prevention issue before a case occurs.**

Evidence: CDC/HICPAC Environmental Infection Control; ICRA concepts.

Environmental Presence Does Not Equal Transmission

WHAT TO KNOW

- Microorganisms are expected in water, air, dust and on surfaces.
- A reservoir matters when organisms can persist and reach a susceptible host.
- An environmental isolate alone cannot establish patient infection or source, but it does create a risk.

INTERPRETATION

Consider organism ecology, the exposure pathway and patient vulnerability before concluding an environment caused disease.

Finding a microbe is not the same as demonstrating transmission.

SOURCE CDC Environmental Sampling guidance.

How Environmental Conditions Shape Microbial Risk

WATER & MOISTURE

Stagnation, temperature and biofilm help explain why wet systems need controls.

AIR & DUST

Disturbance and airflow can carry environmental particles into care spaces.

EQUIPMENT DESIGN

Channels, internal water and difficult-to-clean components create opportunities for persistence.

CONTACT NETWORKS

People, shared objects and high-touch surfaces can connect reservoirs and patients.

Habitat generates a hypothesis when evaluating the risk.

SOURCE CDC/HICPAC Environmental Infection Control.

People and Infrastructure Connect the Ecosystem

PEOPLE & WORKFLOWS

Hands, movement and routine care can transfer organisms between settings, rooms, and patients.

PLUMBING & VENTILATION

Water distribution and airflow determine where organisms may move.

EQUIPMENT & SURFACES

Shared objects connect patients, staff and multiple care areas.

CONSTRUCTION & CHANGE

Maintenance, renovation and leaks can create new exposure pathways.

Infection prevention depends on how these systems interact—not one surface or risk factor.

SOURCE CDC/HICPAC Environmental Infection Control; CDC Core Practices.

Water Systems: An Invisible Hospital Network

A single facility contains many points of use—and different water-quality requirements.

ONE SOURCE, MANY USES

Water reaches sinks, showers, ice makers, selected devices and reprocessing areas.

CONDITIONS THAT MATTER

Stagnation, temperature, chemical residuals and biofilm can increase microbial risk.

MANAGEMENT AND CONTROL

Map the system, maintain control measures and respond when conditions change.



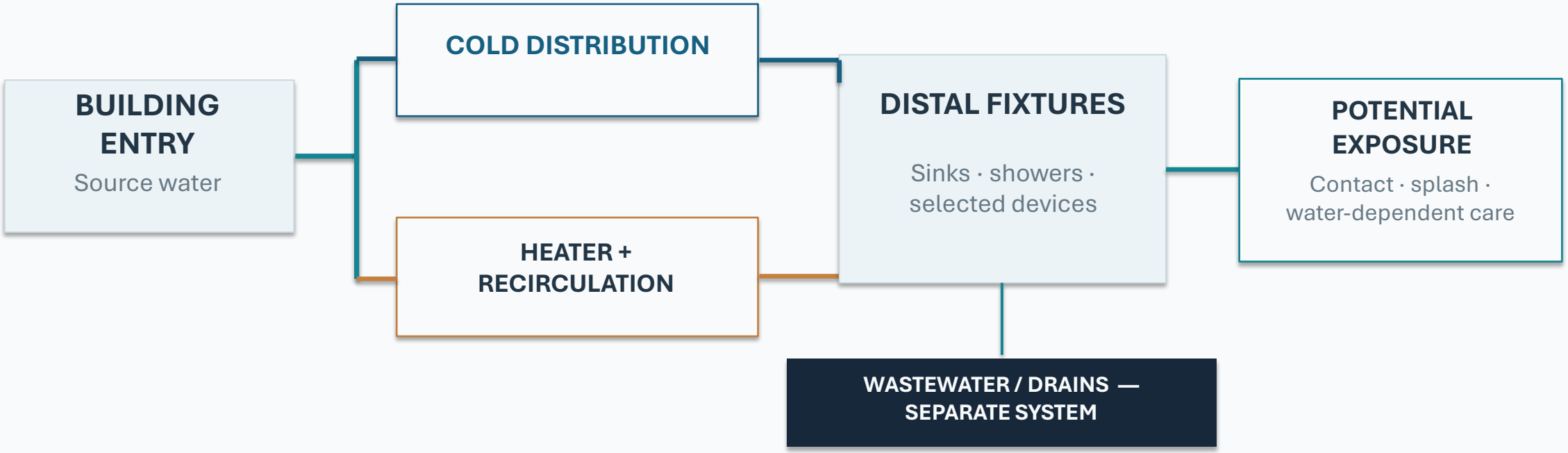
Conceptual overview. Specialized clinical systems require treatment appropriate to their use.

TAKEAWAY **Potable water is not sterile and is not interchangeable with every-day clinical-use water.**

Evidence: CDC healthcare water-management and environmental-control guidance.

Follow the Water: Building Systems and Exposure

Conceptual schematic: cold and hot water branches serve fixtures; wastewater is separate.



What changes microbial risk?

Water age
Stagnation or low flow

Temperature
Conditions favorable to growth

Disinfectant
Residual decay in distribution

Biofilm
Persistent attached organisms

KEY DISTINCTION Water systems create possible exposures; finding organisms does not establish transmission.

CDC water-management principles. This is not a facility-specific plumbing drawing.

WICRA: Prioritizing Water-Related Infection Risk

Risk depends on the source, route, host, exposure and existing controls.

01

Water source

What system or fixture is involved?

02

Transmission route

How could organisms reach a person?

03

Host susceptibility

Who might be exposed?

04

Patient exposure

How often and by what route?

05

Program preparedness

What controls already exist?

Risk assessment informs priority, controls, monitoring and reassessment.

REMEMBER A WICRA is part of ongoing water management; it is not limited to construction or outages.

CDC Water Infection Control Risk Assessment tool; relative scores are not infection probabilities.

When Should Water Risk Be Reassessed?

The water management program is ongoing. Reassess water-related exposure risk at baseline and when conditions change.

01 Routine baseline review

Review vulnerable areas, fixtures, devices and known exposure routes as part of the water management program.

02 Changes to the water system

Plumbing repairs, shutdowns, pressure loss, stagnation, renovations or reopening unused spaces.

03 Changes in patients or use

New high-risk patient populations, added procedures, new devices or different water-use activities.

04 A potential water-related concern

Unexpected clinical clusters, water-quality deviations, sink splashing or device-associated concerns.

WMP = ongoing system control | WICRA = prioritizing water exposure risk

SOURCE CDC healthcare water-management guidance (2026); CDC WICRA tool.

WICRA: Five Questions That Lead to Controls

A WICRA combines the water source, exposure pathway, susceptible host and preparedness—not just a culture result.

01 Water source

Which water, fixture, device or system is involved?

02 Transmission route

Could exposure occur by contact, splash, aerosol or ingestion?

03 Susceptibility

Who could be exposed, and how vulnerable are they?

04 Patient exposure

How often, how directly and during which activity?

05 Preparedness

Which controls exist, and are they reliable?

Turn the assessment into action: Reduce splash • Relocate supplies • Restrict unsafe use • Monitor and reassess

SOURCE CDC Water Infection Control Risk Assessment (WICRA) for Healthcare Settings.

WICRA in Practice: Same Unit, Different Priorities

CDC Burn ICU example | Scores compare where to focus controls—not the probability of infection.

PATIENT-ROOM SINK | Oncology Unit

Supplies on sink counter

36

Indirect contact: sink water may splash onto patient-care supplies.

$$4 \times 3 \times 3 = 36$$

Highest susceptibility • High exposure • Poor preparedness

CDC example actions: splash guards, sink-hygiene improvement, flushing.

SOILED-UTILITY HOPPER | Inpatient Rehab

Hopper in soiled utility

8

Indirect contact: exposure pathway is more separated from patients.

$$4 \times 2 \times 1 = 8$$

Highest susceptibility • Moderate exposure • Good preparedness

CDC example actions: automatic door closure and proper soiled-equipment storage.

PREVENTION TAKEAWAY

The same susceptible patients face different exposure conditions; controls should target the higher-risk pathway.

Source: CDC Water Infection Control Risk Assessment (WICRA) for Healthcare Settings, hypothetical Burn ICU example.

Water Ecosystem: Organisms to Recognize

LEGIONELLA SPP.

Building plumbing and showers; inhalation of contaminated water aerosols is a key route.

PSEUDOMONAS AERUGINOSA

Sinks, drains and wet biofilm; splash or contact can connect the reservoir to care.

NONTUBERCULOUS MYCOBACTERIA

Premise plumbing, water and ice; exposure or specimen contamination may occur.

OTHER WATER-ASSOCIATED GNB

Stenotrophomonas, Burkholderia and Ralstonia; opportunists in wet systems.

Water-associated organisms are clues—not proof that water caused infection.

SOURCE CDC Healthcare Water Toolkit (2026); CDC Environmental Control: Water.

Inside the Patient-Room Sink

- Separate the potable-water side from the wastewater side.
- Faucet and supply lines deliver water; the basin receives water and contamination.
- The drain, tailpiece and P-trap can support persistent biofilm communities.
- Splash, drain design, water impact point and nearby supplies can influence exposure pathways.



MAIN TAKEAWAY

The drain is a habitat—not merely a dirty surface.

SOURCE CDC water/environmental-control guidance; sink outbreak literature.

Why Biofilm Makes Wet Areas Hard to Control

WHAT TO KNOW

- Microbes can attach to wet surfaces and form protected communities called biofilms.
- Biofilm can persist inside sinks, drains, tubing and some water-containing devices.
- Cleaning the visible surface may not remove organisms deeper in the system.

PREVENTION IMPLICATION

Persistent biofilm requires attention to system design, flow, cleaning, maintenance and water use—not just wiping a visible surface.

Biofilm helps explain persistence; it does not prove the source of an infection.

SOURCE CDC Environmental Infection Control: Water.

Biofilm in Healthcare Water Systems

Why wet surfaces can support persistent microbial communities



The microbiology

01 Attachment

Organisms adhere to internal pipe or device surfaces.

02 Matrix formation

A microbial community becomes embedded in protective material.

03 Persistence and dispersal

Biofilm can survive environmental stress and release organisms. This can lead to sharing of genetic resistance between bacteria.

KEY DISTINCTION Environmental recovery suggests a possible reservoir; it does not independently prove patient transmission.

CDC/HICPAC environmental infection control; image is a conceptual cutaway, not an outbreak photograph.

From the Drain to the Patient: What Must Happen?

A drain reservoir matters when a credible exposure pathway reaches a susceptible host.

THE RESERVOIR

Microbes may persist in drain and wastewater biofilm.

MOVEMENT OR TRANSFER

Splash, contaminated hands, equipment or nearby supplies may provide a route.

PATIENT EXPOSURE + EVIDENCE

Exposure is possible; proving transmission requires clinical and environmental evidence.



Conceptual sink/drain cutaway; arrows represent possible routes, not a proven outbreak pathway.

TAKEAWAY **Plausibility is not proof: an environmental positive does not establish the source.**

Evidence: CDC Environmental Sampling; published hospital sink investigations.

WHEN THE ECOSYSTEM BREAKS: VIM-CRPA and the ICU Sink

OUTBREAK INVESTIGATION / EVIDENCE CHAIN

01 Tennessee investigation: eight VIM-producing carbapenem-resistant Pseudomonas aeruginosa cases were associated with a single ICU room over approximately two years.

02 Bathroom and handwashing sink drains yielded VIM-CRPA.

03 Available patient and environmental isolates were ST253, carried blaVIM-1, and were closely related by whole-genome sequencing.

04 Published evidence aligned patient location, drain recovery, ST253 / blaVIM-1 WGS relatedness and response to intervention.

Source attribution became credible because multiple independent lines of evidence converged.

SOURCE Stjärne Aspelund et al., Clinical Infectious Diseases / PMC10173543.

Reducing the Risk From Sinks and Drains

01

SEPARATE

Keep clean supplies and patient-care items away from sink splash zones.

02

LIMIT SPLASH

Use sink design and practices that reduce water impact and dispersion.

03

MAINTAIN

Address drainage defects, stagnation and inappropriate waste disposal.

04

REASSESS

Review exposures and strengthen controls when concerning cases occur.

Environmental controls interrupt pathways; routine blind swabbing does not.

SOURCE CDC 2026 healthcare water guidance; sink-associated outbreaks.

When a Building Water System Has a Problem

WHAT TO KNOW

- Outages, leaks, pressure changes or repairs can alter water conditions.
- Facilities and infection prevention assess risk and set temporary controls.
- Affected areas follow approved restrictions, cleaning and water-use plans.

SHARED RESPONSIBILITY

Report unsafe water conditions, follow approved precautions and communicate when an activity is affected.

Water safety requires coordinated action—not improvisation at a sink.

SOURCE CDC Water Management Program resources.

Water Quality, Instrument Integrity and Infection Risk

Water chemistry can affect the reliability of cleaning and subsequent reprocessing.

MINERALS AND HARDNESS

Scale, spotting or residual deposits may make soil removal more difficult.

CHLORIDES AND INCOMPATIBLE pH

Corrosion, pitting and surface damage may impair instruments and cleaning.

MICROBIAL QUALITY AND PROCESS CONTROL

Rinse-water quality, device instructions and validated methods all matter.



Illustrative clinical imagery; surface damage can complicate cleaning but does not prove an infection.

TAKEAWAY **Cleaning comes before sterilization. Inspect recurring deposits and damaged devices.**

Evidence: Follow manufacturer IFUs and applicable healthcare reprocessing-water standards.

Dialysis: When Water Becomes Part of Therapy

WHAT TO KNOW

- Treated water helps prepare dialysate used in hemodialysis.
- Dialysate and blood travel on opposite sides of a semipermeable membrane.
- The water system, machines and drainage require defined infection prevention controls.

WHY CONTROLS MATTER

Treatment, distribution, monitoring and maintenance protect water and dialysate quality. Contamination can create serious patient risk.

Water quality is a patient safety issue even without direct blood contact.

SOURCE CDC Water Use in Dialysis; CDC Dialysis Wall Boxes and Drains.

Dialysis Water: Monitoring Two Different Hazards

BACTERIAL COUNTS

CFU/mL estimates recoverable bacteria under a defined method and sample plan.

BACTERIAL ENDOTOXIN

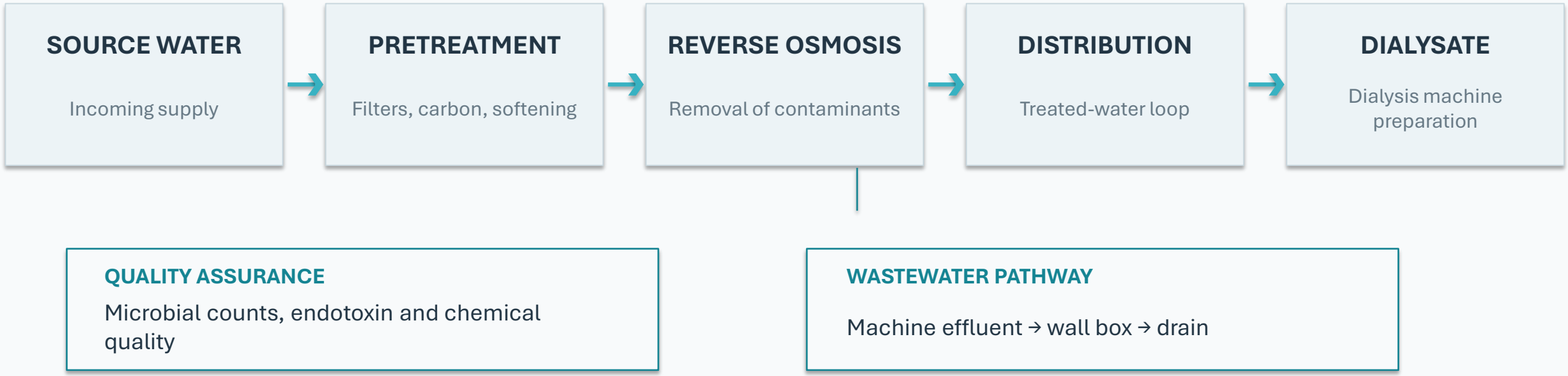
EU/mL measures endotoxin activity; it cannot replace microbiologic counts.

Defined sample points, test methods and action limits support water-system control.

SOURCE CDC Water Use in Dialysis; AAMI/ISO referenced guidance.

Dialysis: Water Treatment and Exposure

A distinct high-volume water system with specific microbial and chemical quality requirements



ECOSYSTEM LESSON Clean-water, dialysate, blood and wastewater circuits are distinct—even when located near one another.

CDC Dialysis Safety: Water Use and Wall Boxes/Drains; product water and dialysate are not blood.

Air Is an Environmental Pathway

- Air moves through supply, filtration, patient-care spaces and return/exhaust systems.
- Pressure relationships influence the direction of airflow.
- Doors, penetrations, barriers and temporary construction conditions can alter intended airflow.
- Airborne environmental risk is therefore an engineering and infection-prevention problem.



MAIN TAKEAWAY

Airflow is an invisible infrastructure component.

SOURCE CDC Environmental Infection Control: Air.

Air and Construction: Organisms to Recognize

ASPERGILLUS SPP.

Airborne conidia from dust and disturbed materials can threaten highly susceptible patients.

MUCORALES

Rhizopus and related molds may be carried in dust; exposure depends on environment and host.

OTHER OPPORTUNISTIC MOLDS

Fusarium and Scedosporium can cause serious disease in susceptible patients.

IMPORTANT DISTINCTION

TB, measles and varicella are airborne from people—not typical construction reservoirs.

Construction controls focus on dust containment, airflow and protecting high-risk hosts.

SOURCE CDC/HICPAC Environmental Infection Control: Air and Construction.

Construction: Dust, Airflow and Patient Exposure

Work outside the patient room can alter exposure inside patient-care areas.

DUST AND SPORE RELEASE

Construction can disturb dust containing Aspergillus and other molds.

HOW EXPOSURE CAN OCCUR

Airflow, barriers, pressure relationships and traffic shape possible spread.

WHAT CONTROLS THE RISK

ICRA guides containment, air management, monitoring and corrective action.



Illustrative containment setup; pressure and airflow direction must be verified in practice.

TAKEAWAY **Control dust at the worksite before it can reach susceptible patients.**

Evidence: CDC Environmental Infection Control: Air; construction ICRA guidance.

ICRA: Assess Risks Before Construction Begins

WHAT TO KNOW

- ICRA identifies hazards and vulnerable patients before building work begins.
- Controls may include dust barriers, air-pressure management and safe traffic routes.
- Facilities, infection prevention and project teams monitor controls and correct failures.

IF A CONTROL FAILS

An unsealed barrier, uncontrolled dust or water intrusion needs prompt reporting, assessment and correction.

ICRA connects construction decisions to patient protection.

SOURCE CDC Environmental Infection Control: Construction / Air.

ICRA: Construction Risk Assessment and Controls

Plan the work, protect susceptible patients, then monitor the controls.

01 PLAN

Define the work, location and susceptible populations.

02 CONTAIN

Barriers, sealed penetrations, appropriate airflow and routes.

03 MONITOR

Check barrier integrity and required pressure relationships.

04 CLEAR

Clean, verify controls and approve reoccupancy.

RISK CONTROL Not every project requires the same barrier or air-control measures; controls are risk-specific.

CDC healthcare environmental construction guidance; this is a conceptual summary, not an ICRA permit.

WHEN THE ECOSYSTEM BREAKS: Construction-Associated Aspergillosis

OUTBREAK INVESTIGATION / EVIDENCE CHAIN

01 A published outbreak involved six cases of nosocomial invasive aspergillosis in a hematology unit during major hospital construction.

02 The vulnerable patient population and concurrent construction activity prompted a multidisciplinary response.

03 Interventions included unit relocation, impermeable barriers, face masking and antifungal prophylaxis for additional high-risk patients.

04 The case illustrates the importance of coordinated environmental and clinical controls during construction.

Environmental controls matter because they interrupt a demonstrable pathway.

SOURCE Chang CC et al. J Hosp Infect. 2008;69(1):33-38. doi:10.1016/j.jhin.2008.02.010.

Construction Can Affect Care and Diagnostic Results

PATIENT EXPOSURE

Dust and airborne spores can reach vulnerable patients when barriers or ventilation fail.

SPECIMEN CONTAMINATION

Published events show construction dust can also contaminate specimens or culture materials, producing misleading results.

Environmental disturbances can cause real exposure and false outbreak signals.

SOURCE CDC Environmental Infection Control: Air, construction examples.

Reusable Equipment: Organisms to Recognize

HEATER-COOLERS

Mycobacterium chimaera: water biofilm and possible airborne dispersal during surgery.

MOIST ENDOSCOPE CHANNELS

Pseudomonas aeruginosa and other Gram-negative rods when cleaning or drying fails.

DUODENOSCOPES

CRE such as Klebsiella pneumoniae and E. coli have been linked to transmission.

SHARED NONCRITICAL DEVICES

MRSA, VRE and C. auris may transfer through contaminated touch surfaces.

Device design and reprocessing determine the pathway—not the organism alone.

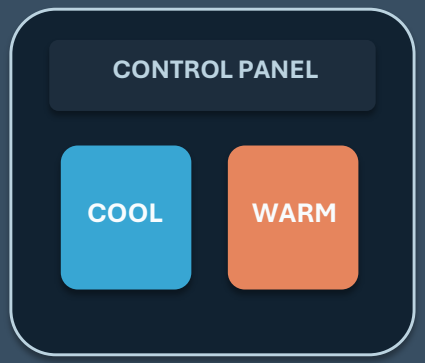
SOURCE FDA Duodenoscope Safety; FDA Heater-Coolers; CDC Disinfection Guidance.

What Is a Heater-Cooler Device?

A temperature-control system used during cardiothoracic surgery

It circulates warmed or cooled water to external heat exchangers or warming/cooling blankets.

1 HEATER-COOLER UNIT



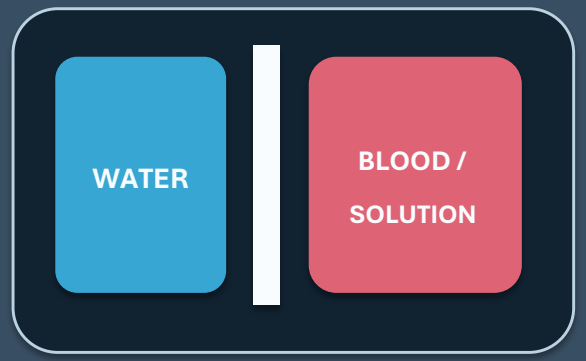
Water tanks + pumps

Adjust temperature as needed

water

return

2 HEAT EXCHANGER



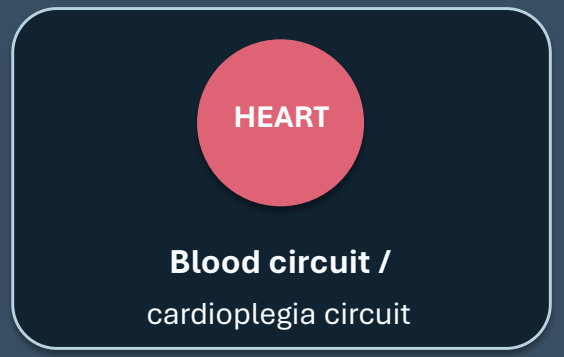
Solid separating wall

Heat moves across the barrier

blood

return

3 PATIENT CIRCUIT



Helps maintain the desired

patient temperature

KEY DISTINCTION **Device water transfers heat, but does not contact the patient's blood or body fluids.**

Next: how contaminated water inside the unit can become an airborne environmental hazard.

SOURCE FDA: What Is a Heater-Cooler Device? / Recommendations for Water-Based Heater-Coolers

Heater-Coolers: Water, Biofilm and Air

A device can create an indirect environmental pathway during cardiac surgery.

WHY THE DEVICE IS USED

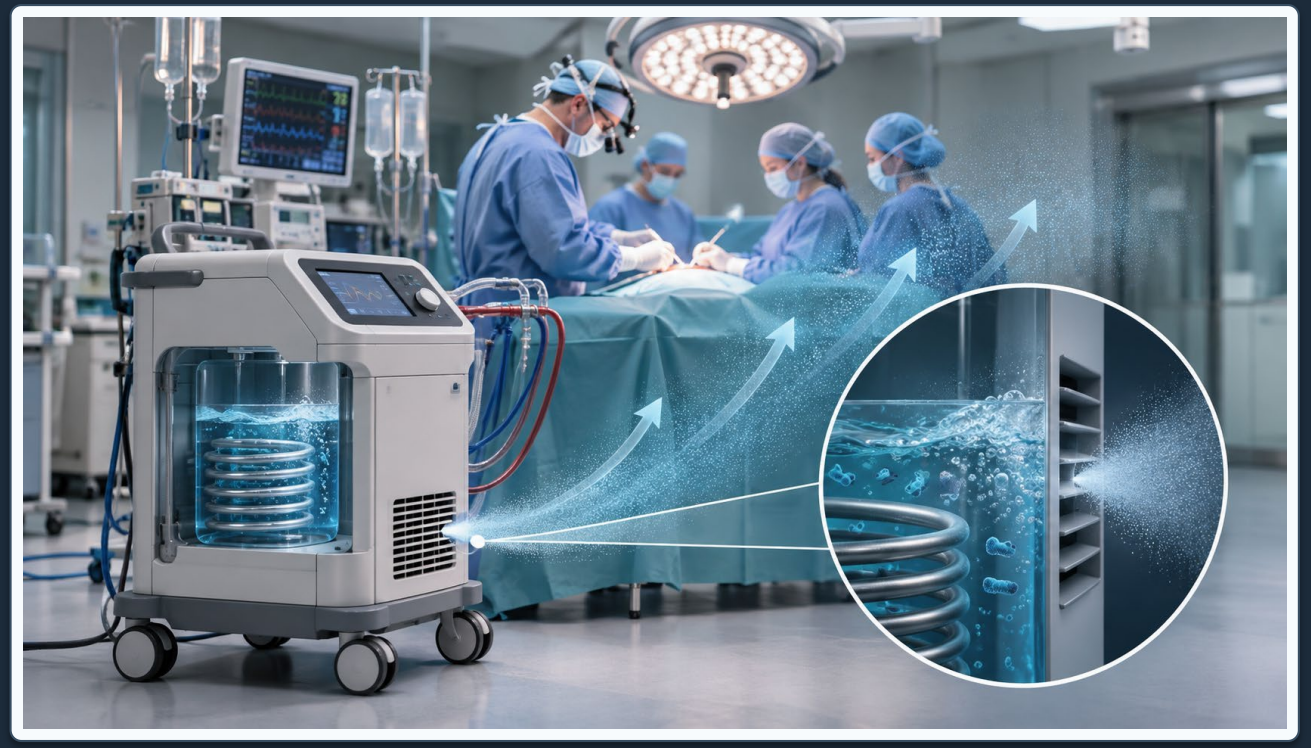
It circulates temperature-controlled water in a separate device circuit.

WHERE ORGANISMS PERSIST

Internal water systems can support biofilm, including nontuberculous mycobacteria.

WHY THE OPERATING ROOM MATTERS

Certain contaminated devices may release aerosols into the surgical environment.



Conceptual rendering. Device designs and aerosol pathways vary; water does not contact blood directly.

TAKEAWAY **An indirect airborne route can matter even when device water never touches the patient.**

Evidence: FDA heater-cooler device safety communications; CDC M. chimaera investigations.

Heater-Coolers: How Environmental Exposure Can Occur

The device water circuit is separate from the patient blood circuit.

01

WATER CIRCUIT

Reservoir and tubing

→

02

CONTAMINATION

Biofilm may contain NTM

→

03

DEVICE EXHAUST

Organisms may disperse

→

04

OPERATIVE SPACE

Possible indirect exposure

CRITICAL DISTINCTION The water does not need to touch blood or tissue for an indirect environmental pathway to matter.

EVIDENCE For M. chimaera, the concern involved contaminated device water and potential airborne dispersion.

FDA heater-cooler communications; pathway illustrated conceptually.

WHEN THE ECOSYSTEM BREAKS: Mycobacterium chimaera

OUTBREAK INVESTIGATION / EVIDENCE CHAIN

01 Contaminated heater-cooler device → NTM biofilm → aerosolization → open surgical field → implanted/prosthetic material → delayed clinical disease.

02 Latency can be months to years, making exposure recognition difficult.

03 An unusual NTM isolate may therefore point to a remote environmental exposure rather than a recent healthcare event.

04 This case links microbiology, device engineering, biofilm ecology and epidemiology.

An organism recovered today may reveal an environmental exposure years earlier.

SOURCE CDC/FDA heater-cooler resources; M. chimaera literature.

M. chimaera: When Device-Related Disease Appears Years Later

WHAT TO KNOW

- Contaminated heater-coolers can expose an operative field indirectly.
- Disease may become apparent months or years after cardiac surgery.
- Linking an illness to exposure may require clinical, device and microbiologic evidence.

INVESTIGATION CHALLENGE

Long latency can obscure the source. Clinical teams, infection prevention and device experts reconstruct the exposure history.

The time between exposure and illness can make the source hard to recognize.

SOURCE FDA heater-cooler safety communications; CDC M. chimaera reports.

Case Study: Mycobacterium chimaera

Delayed recognition can obscure the original environmental exposure.



CARDIAC SURGERY

Exposure to heater-cooler-associated aerosols.

DELAY

Clinical disease may emerge months or years later.

CASE RECOGNITION

Unusual NTM infection leads to further review.

INVESTIGATION

Device, patient and epidemiologic evidence evaluated.

Evidence-based attribution requires clinical, environmental and epidemiologic findings to converge.

TEACHING POINT A diagnosis today can point to exposure months or years earlier; time and place are essential.

CDC/FDA heater-cooler-associated NTM investigations; case sequence is a teaching synthesis.

Reusable Equipment: How Transmission Can Travel

COMPLEX DESIGN

Channels, seams and connectors can be difficult to clean and disinfect.

WATER RESERVOIRS

Wet internal components may support persistent biofilm.

MOVEMENT BETWEEN AREAS

Mobile and shared devices can connect separate rooms and patients.

REPROCESSING CONTROL

Follow validated cleaning, disinfection, storage and equipment instructions.

The equipment pathway is controlled by design, ownership and reliable reprocessing.

SOURCE CDC/HICPAC environmental-control guidance; device manufacturer IFUs.

A Patient Room Is a Network of Touchpoints

WHAT TO KNOW

- Hands, equipment and high-touch objects connect people and care spaces.
- Environmental surfaces generally contribute through contact pathways.
- The risk depends on transfer, contact frequency and host susceptibility.

TOUCHPOINT EXAMPLE

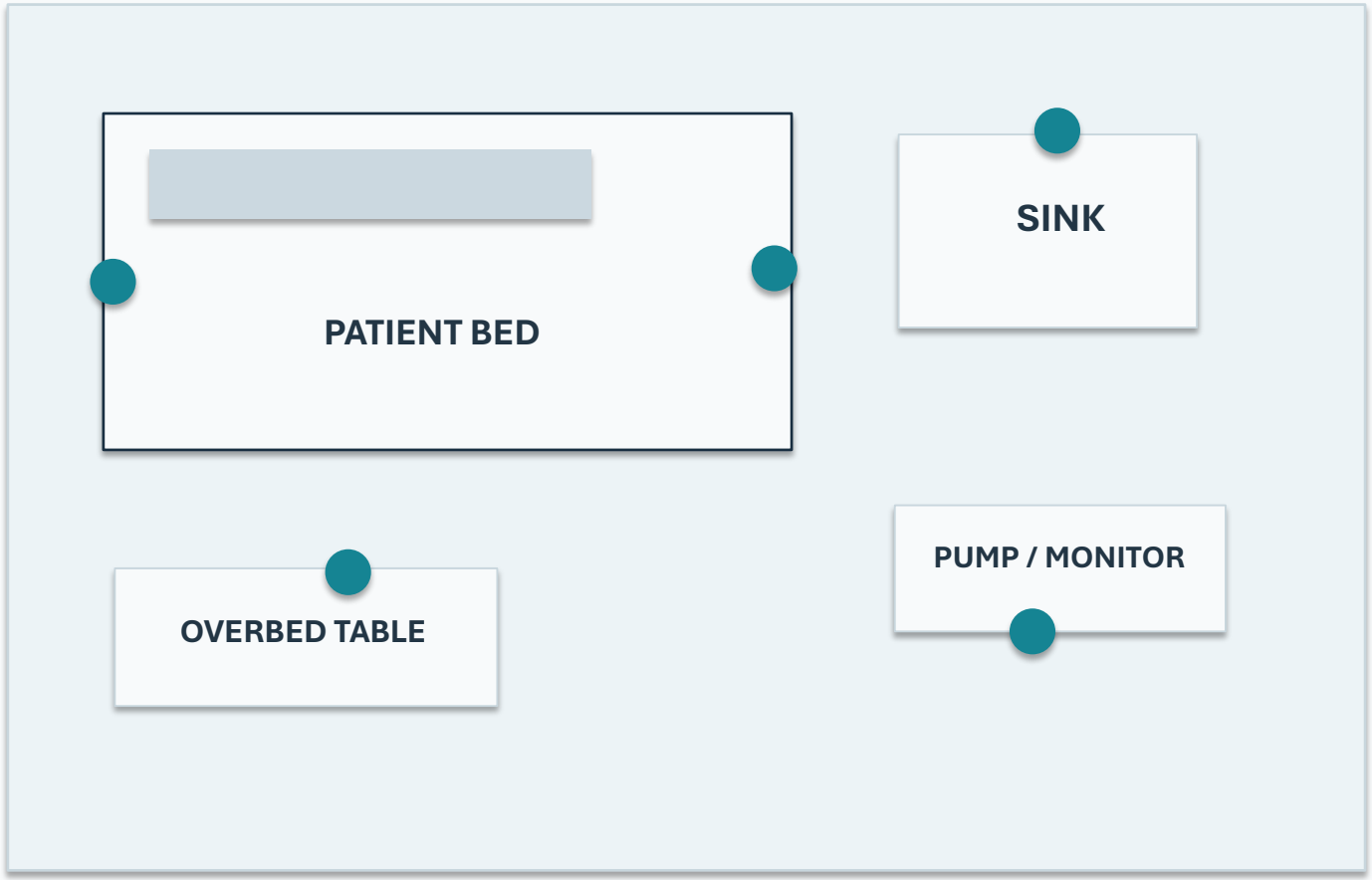
Bed rails, workstations, monitors, carts and shared devices are touched by many people throughout care.

Cleaning and hand hygiene interrupt the network of contacts.

SOURCE CDC Environmental Cleaning and Core Practices.

The Patient Room: High-Touch Contact Network

Surfaces, hands, people and shared equipment create pathways between tasks.



Priority contact points

01 Bed rails
Frequently touched during patient care

02 Call button / controls
Shared use by staff and patients

03 Overbed table
Contact with hands and supplies

04 Sink vicinity
Splash and contaminated items matter

05 Shared devices
Touchpoints move between tasks

PRACTICAL CONTROL Cleaning plus hand hygiene, contact time, ownership and monitoring are all part of the system.

CDC Environmental Cleaning guidance; room diagram is conceptual and not to scale.

Surface Ecosystem: Organisms to Recognize

C. DIFFICILE

Spores persist on surfaces; use the approved cleaning and sporicidal approach as indicated.

CANDIDA AURIS

Can persist on high-touch surfaces; requires products effective against C. auris.

MRSA & VRE

Bed rails, shared objects and hands can support indirect contact transmission.

ACINETOBACTER BAUMANNII

Can persist on equipment and nearby surfaces, especially in outbreak settings.

Match cleaning methods and contact time to the organism and surface.

SOURCE CDC Environmental Cleaning; CDC C. auris Infection Control.

Why the Organism Can Change the Cleaning Approach

C. DIFFICILE

Spores can survive routine conditions; an appropriate sporicidal process may be required.

C. AURIS

Can persist on surfaces; use effective EPA-registered products per policy.

OTHER MDROs

Shared surfaces and devices can sustain transmission if cleaning & disinfection is unreliable.

CONTROL PRINCIPLE

Choose an approved product and process matched to the organism and surface.

The correct disinfectant, technique and contact time all matter.

SOURCE CDC C. difficile; CDC C. auris Infection Control.

Environmental Cleaning: More Than a Product

WHAT TO KNOW

- Which high-touch surfaces and devices are included?
- Does the product suit the organism, surface and equipment?
- Is the correct technique and wet/contact time followed?
- When should cleaning occur and who is responsible?
- How are missed steps, audits and corrective actions addressed?

OWNER + PROCESS

Define responsibility, frequency, verification and equipment-safe products; follow manufacturer IFUs.

Reliable cleaning is a process—not simply a bottle of disinfectant.

SOURCE CDC Environmental Cleaning; manufacturer IFUs.

Recognizing an Environmental Problem Takes a Team

01

A SIGNAL

Cases, unusual organisms or environmental failures raise concern.

02

A HYPOTHESIS

Epidemiology asks what locations and exposures patients share.

03

AN ASSESSMENT

Facilities, IP and laboratory teams evaluate a plausible reservoir.

04

A RESPONSE

Controls are strengthened, documented and assessed over time.

The laboratory provides evidence; prevention depends on the whole system.

SOURCE CDC/HICPAC environmental investigation guidance.

Laboratory Results Can Reveal Environmental Signals

A clinical result is one clue—not an environmental source conclusion.

UNUSUAL ORGANISM	Unexpected recovery of a water-, device- or dust-associated species.
TIME / PLACE PATTERN	Related findings cluster by unit, timeperiod or procedure.
RESISTANCE SIGNAL	Repeated uncommon phenotypes or mechanisms warrant review.
CLINICAL DISCORDANCE	Positive findings inconsistent with the clinical presentation.

ROLE OF THE LAB Provide accurate results, preserve relevant information and communicate concerns to the investigation team.

CDC environmental infection control and investigation principles.

Clues That May Suggest an Environmental Problem

UNUSUAL PATTERNS

Are related infections appearing in one location or timeperiod?

BUILDING EVENTS

Was there a water outage, renovation, leak or ventilation problem?

SHARED EXPOSURE

Could patients have encountered the same fixture, device or care area?

MICROBIOLOGIC CLUES

Do organism identification or isolate comparisons support the hypothesis?

Patterns inform the investigation; no single clue establishes the source without proper evidence.

SOURCE CDC environmental investigation principles; healthcare water guidance.

Environmental Sampling: A Question Before a Culture

WHAT TO KNOW

- Environmental sampling is different from routine patient diagnostic testing.
- Random swabs may detect organisms without establishing a clinical link.
- Targeted sampling can help when there is a clear epidemiologic question.

BEFORE SAMPLING

Define the hypothesis, specimen, laboratory method and how either a positive or negative result will change the decision.

An environmental culture is only useful when it informs an action.

SOURCE CDC Environmental Sampling guidance.

Environmental Sampling: Three Questions Before a Culture

Collecting a specimen makes sense only when the answer can guide a decision.

01

WHY?

What epidemiologic or control question are we answering?

02

WHERE?

Which reservoir or exposure pathway does the hypothesis identify?

03

WHAT NEXT?

What action follows a positive or negative result?

POSITIVE DOES NOT PROVE SOURCE • NEGATIVE DOES NOT PROVE ABSENCE

LAB COLLABORATION Plan sampling and interpretation with clinical microbiology and infection prevention—not just through the lab.

CDC Environmental Sampling guidance; routine required monitoring is a separate activity.

Why One Environmental Culture Can Mislead

POSITIVE DOES NOT PROVE SOURCE

It tells you an organism was recovered from that specimen at that time.

NEGATIVE DOES NOT PROVE ABSENCE

Sampling location, timing and recovery method affect what can be detected.

Interpret results with specimen method, clinical data and epidemiology.

SOURCE CDC Environmental Sampling guidance.

Contamination or Infection? Check the Whole Pathway

PATIENT CONTEXT

Do symptoms and clinical findings support the microbiology result?

COLLECTION PROCESS

Could water, ice, shared equipment or handling introduce contamination?

QUALITY CONTROLS

Were specimen handling, transport and analytical methods appropriate?

EVIDENCE REVIEW

Combine clinical, environmental and testing findings before concluding.

A contaminated specimen can mimic an outbreak: follow the exposure pathway.

SOURCE CDC Environmental Infection Control; reported pseudo-outbreak cases.

WHEN THE LAB RESULT MISLEADS: Legionella Pseudo-Outbreak

OUTBREAK INVESTIGATION / EVIDENCE CHAIN

01	Four patients had Legionella recovered from bronchoscopy specimens during a 2008 investigation.
02	The patients ultimately did not have Legionnaires' disease.
03	Nonsterile ice used to cool saline-filled syringes for bronchoalveolar lavage was identified as a likely contamination pathway.
04	The potable water supplying the ice machines was heavily colonized with Legionella.
05	The case demonstrates that microbiologic recovery and even relatedness must be interpreted within clinical and epidemiologic context.

Even a convincing microbiologic finding can mislead when the clinical pathway is wrong.

SOURCE CDC MMWR: Pseudo-Outbreak of Legionnaires Disease, Arizona, 2008.

How Evidence Supports Environmental Source Attribution

01

PATIENT PATTERN

Are affected patients linked by time, location or shared exposure?

02

PLAUSIBLE RESERVOIR

Could water, air, surfaces or equipment account for exposure?

03

MICROBIOLOGY

Do clinical and targeted environmental findings support the link?

04

CONTROL RESPONSE

Does transmission decrease when plausible pathways are interrupted?

Source attribution requires evidence from more than one direction.

SOURCE CDC Environmental Sampling; published outbreak investigations.

Five Principles of Environmental Infection Prevention

01	**SEE THE SYSTEM**	Water, air, surfaces, equipment, people and infrastructure are connected.
02	**IDENTIFY HAZARDS**	Look for conditions that promote persistence or spread.
03	**TRACE THE PATHWAY**	Ask who could be exposed and how.
04	**INTERRUPT EXPOSURE**	Use appropriate engineering, cleaning and workflow controls.
05	**CONNECT EVIDENCE**	Combine clinical, microbiologic and environmental information.

Prevent transmission by controlling pathways—not sterilizing every environment.

SOURCE Seminar synthesis: CDC/HICPAC environmental infection control.

Closing: See the Ecosystem. Interrupt the Pathway.

WHAT TO KNOW

- The built environment is a network of reservoirs and possible exposure routes.
- Risk assessment and reliable controls reduce opportunities for transmission.
- Clinical and laboratory findings help identify threats and guide interventions.

FINAL MESSAGE

Water, air, surfaces, equipment, people and infrastructure require coordinated prevention—not isolated fixes.

The hospital is an ecosystem. Effective prevention protects the connections.

SOURCE Seminar synthesis.

The Environment Is Part of Patient Safety

Recognize reservoirs. Understand pathways. Interrupt transmission.



THOUGHTFUL PREVENTION INTERRUPTS RISK

- **Monitoring**
- **Containment**
- **Cleaning**
- **Maintenance**
- **Collaboration** (Multidisciplinary)
- **Laboratory Awareness**

Small Environmental Failures... → **...Can Lead to Transmission** → **Thoughtful Prevention Interrupts Risk** → **Patient Safety & Infection Prevention**

The Hospital as an Ecosystem

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References — Dialysis, Construction & Air

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References — Case Investigations and Laboratory Support

CDC AR Laboratory Network Testing

cdc.gov/antimicrobial-resistance-laboratory-networks/php/about/testing-s...

CDC C. auris Identification

cdc.gov/candida-auris/hcp/laboratories/identification-of-c-auris.html

CDC Legionella Methods and Specimen Collection

cdc.gov/investigate-legionella/php/public-health-strategy/legionella-tes...

CDC NTM Clinical Overview

cdc.gov/nontuberculous-mycobacteria/hcp/clinical-overview/

CDC Environmental Air / Construction Laboratory Examples

cdc.gov/infection-control/hcp/environmental-control/air.html

CDC Dialysis Water Monitoring

cdc.gov/dialysis-safety/hcp/recommendations-resources/water-use-in-dialy...

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Published VIM-CRPA Sink Outbreak

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Full source URLs and additional case references are provided in the speaker notes.