Infection Prevention and the Health Care Built Environment: Why Every Aspect Matters

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Innovative Infection Prevention

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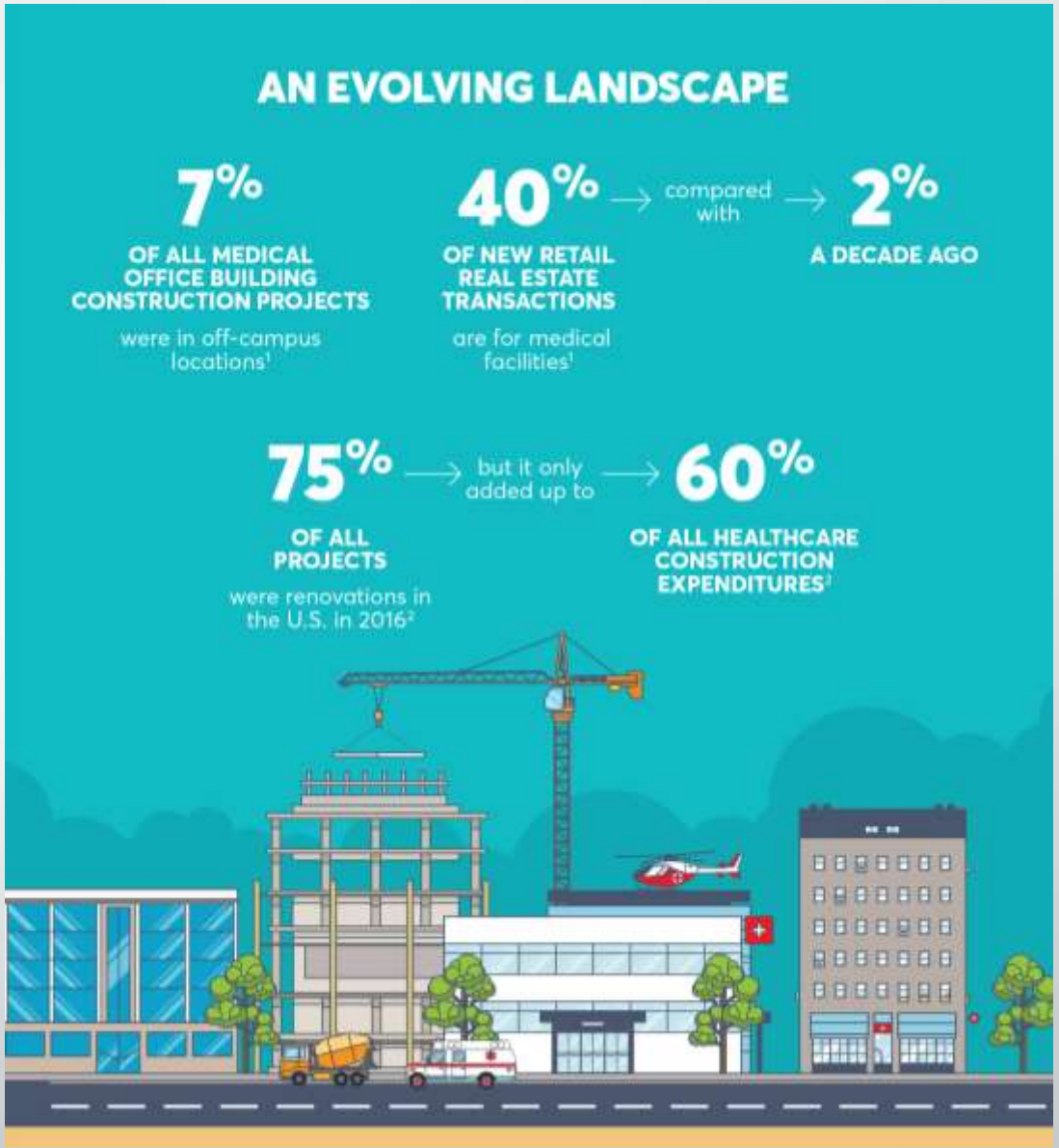
Objectives

Justify	Justify design features that contribute to prevention of diseases transmitted through air, water or through surface contact
Identify	Identify at least one pathogen for which the physical environment can play a significant role in preventing transmission
Build	Build key practices during construction that can prevent the spread of infection.

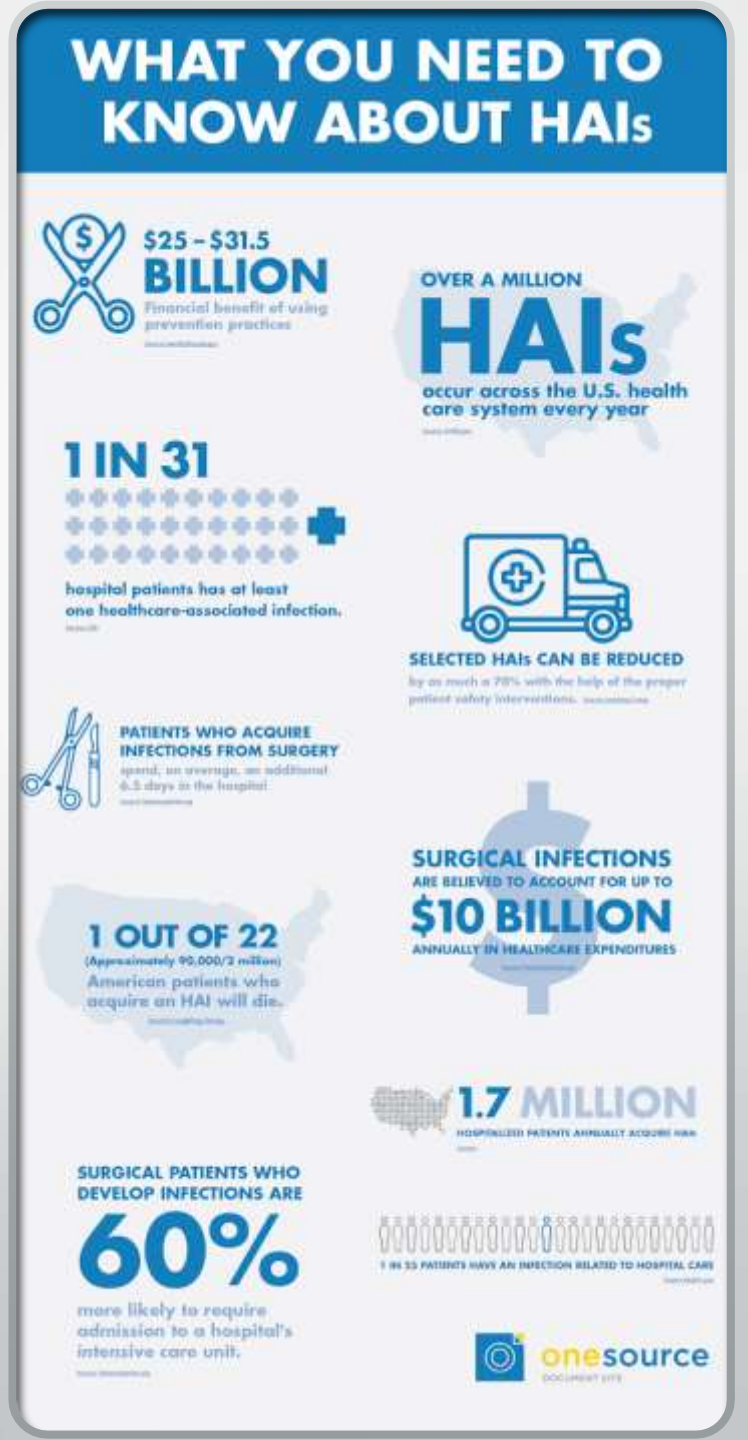
Why is this important?



https://constructionblog.autodesk.com/healthcare-construction/

Healthcare Associated Infections (HAIs): ***The Unknown Killer***

HAIs affect millions of people and add billions of dollars to healthcare costs in the U.S. annually. HAIs are an unintended consequence of care delivered in healthcare organizations. Scientific evidence suggests that most HAIs are preventable.



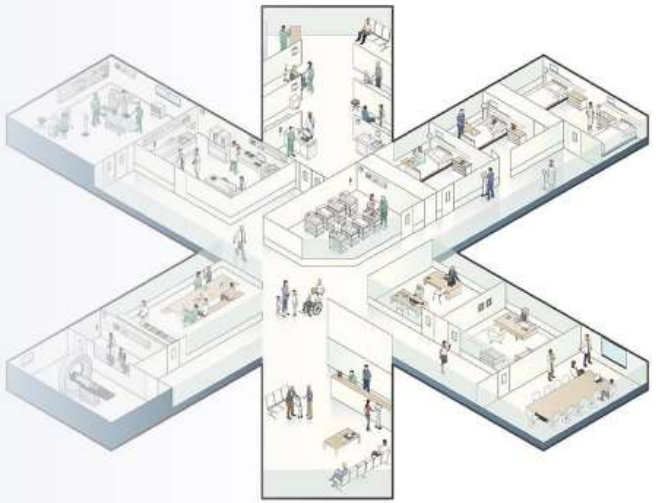
https://www.healthcarefacilitiestoday.com/posts/Infographic-Controlling-HAIs--22573

The Joint Commission

The Physical Environment

Create a safe environment.

Protecting patients from harm involves more than safe treatments and procedures. We must also consider where patients receive care, and minimize risks associated with the physical environment.



The Physical Environment

- Utility Systems - EC.02.05.01 +
- Means of Egress - LS.02.01.20 +
- Built Environment - EC.02.06.01 +
- Fire Protection - EC.02.03.05 +
- General Requirements - LS.02.01.10 +
- Protection - LS.02.01.30 +
- Automated Suppression - LS.02.01.35 +
- Life Safety Code

Joint Commission Top Findings Related to the Physical Environment

NPSG.15.01.01, EP 1 (requires the suicide risk assessment of the physical environment)

IC.02.01.01, EP 1 (a very basic requirement to implement your infection prevention practices)

EC.02.05.01, EP 15 (deals with air pressure relationships in critical spaces such as operating rooms, sterile compounding, or central sterile supply areas)

EC.02.06.01, EP 1 (another "catch all" EP where just about any defect in the environment from torn furniture to suicide hazards have been scored)

EC.02.02.01, EP 5 (requires the organization to minimize risks associated with hazardous chemicals)

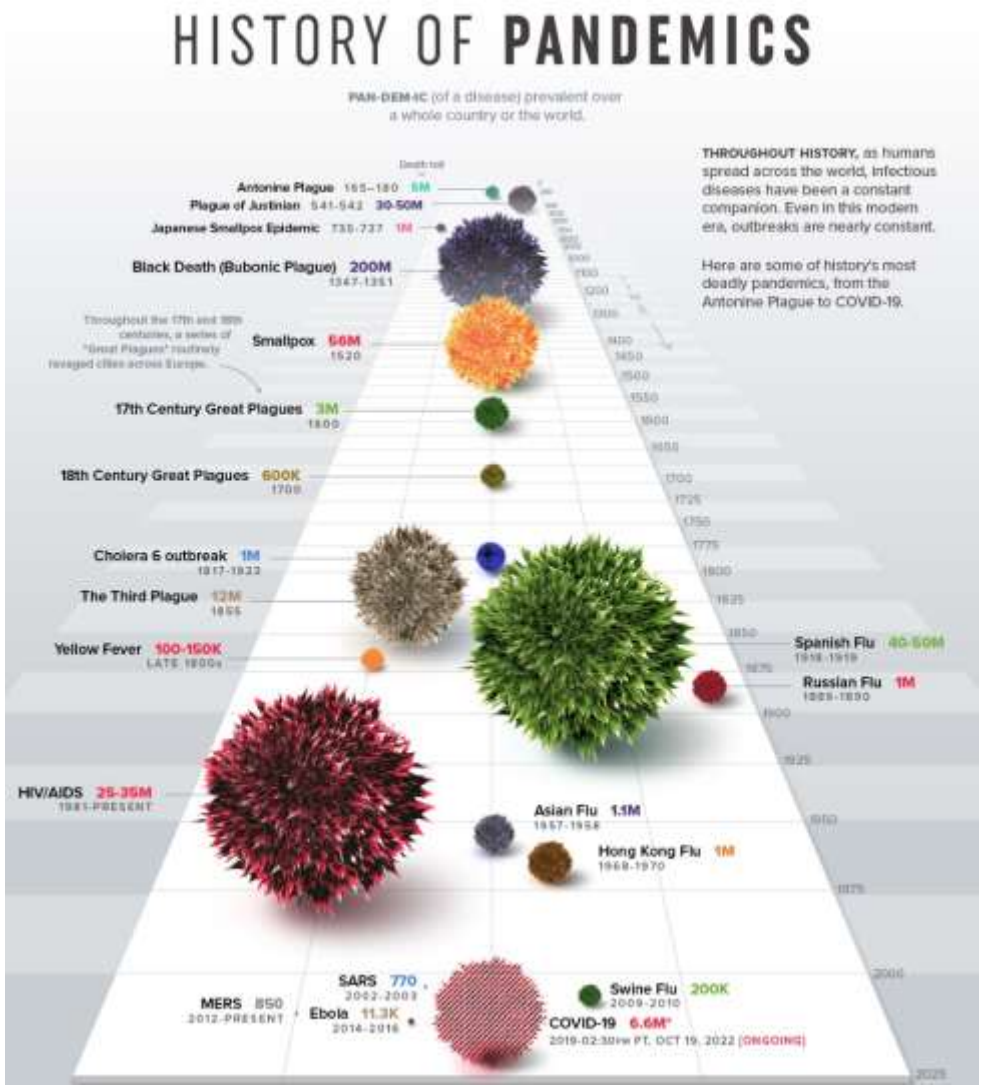
IC.02.02.01, EP 4 (establishes infection prevention requirements for safe storage of medical equipment, devices, and supplies)

Impact of Healthcare Construction

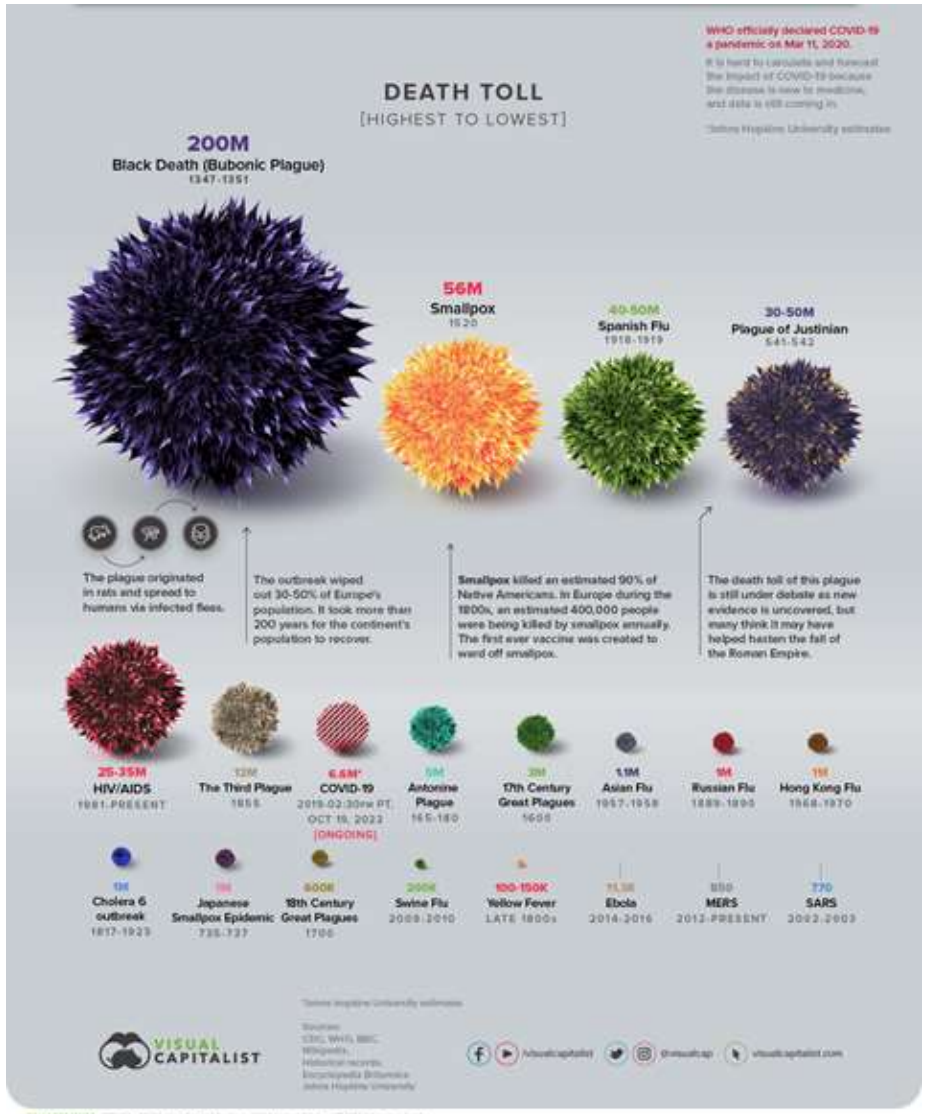
- Optimal patient outcomes
- Enhanced work environment for healthcare providers
- Improved organizational performance

Just in time? Or just in case?

- Hospital Resilience
  - External Resiliency
    - Hurricanes, Tornadoes, Flooding, Earthquakes
  - Internal Resiliency
    - Massive influx of patients
    - Future Technology
    - Location (ability to grow)
    - Mobile/Modular solutions
    - Flexible spaces
  - Value engineering

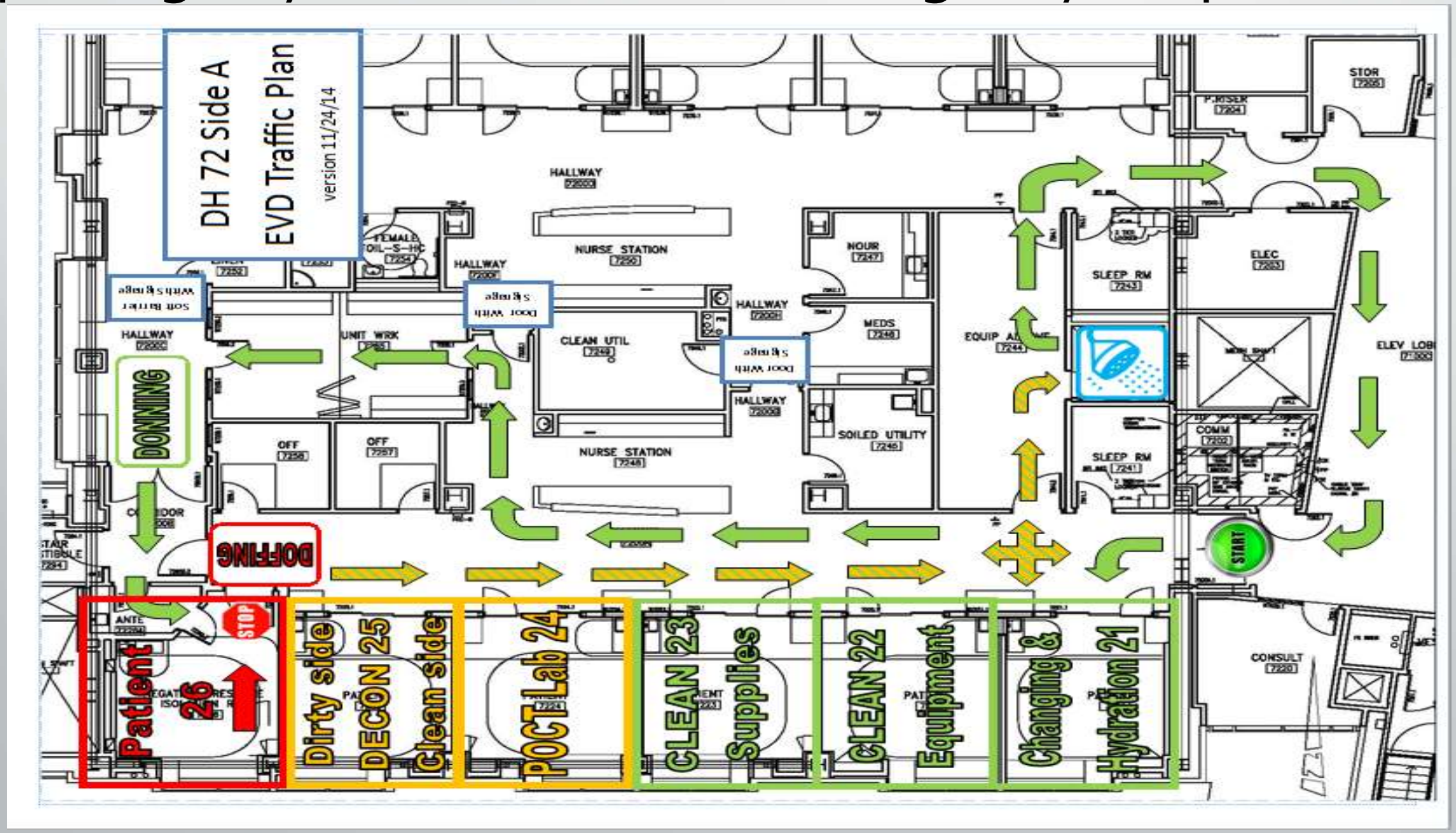


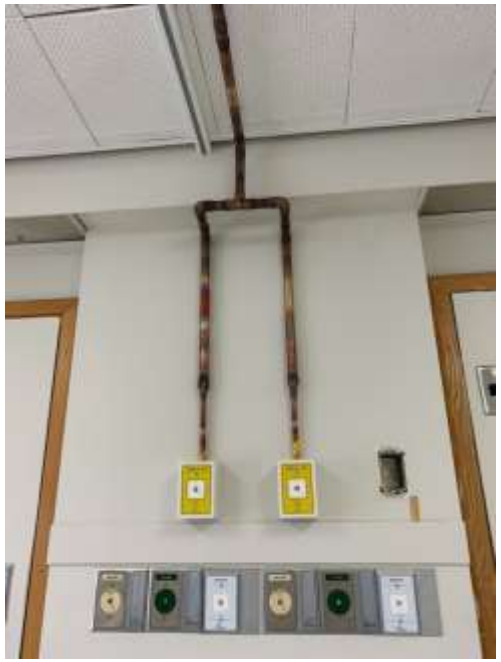
https://www.visualcapitalist.com/history-of-pandemics-deadliest/



https://www.visualcapitalist.com/history-of-pandemics-deadliest/

Exploring beyond minimums: Emergency Preparedness






THIS ELEVATOR IS FOR
COVID-19 PATIENT
TRANSPORT ONLY.

Air, Water, & Surfaces, Oh My!

Where do the germs in healthcare come from?

Patients

Person to Person

Contaminated Surfaces

Contaminated Medical Products

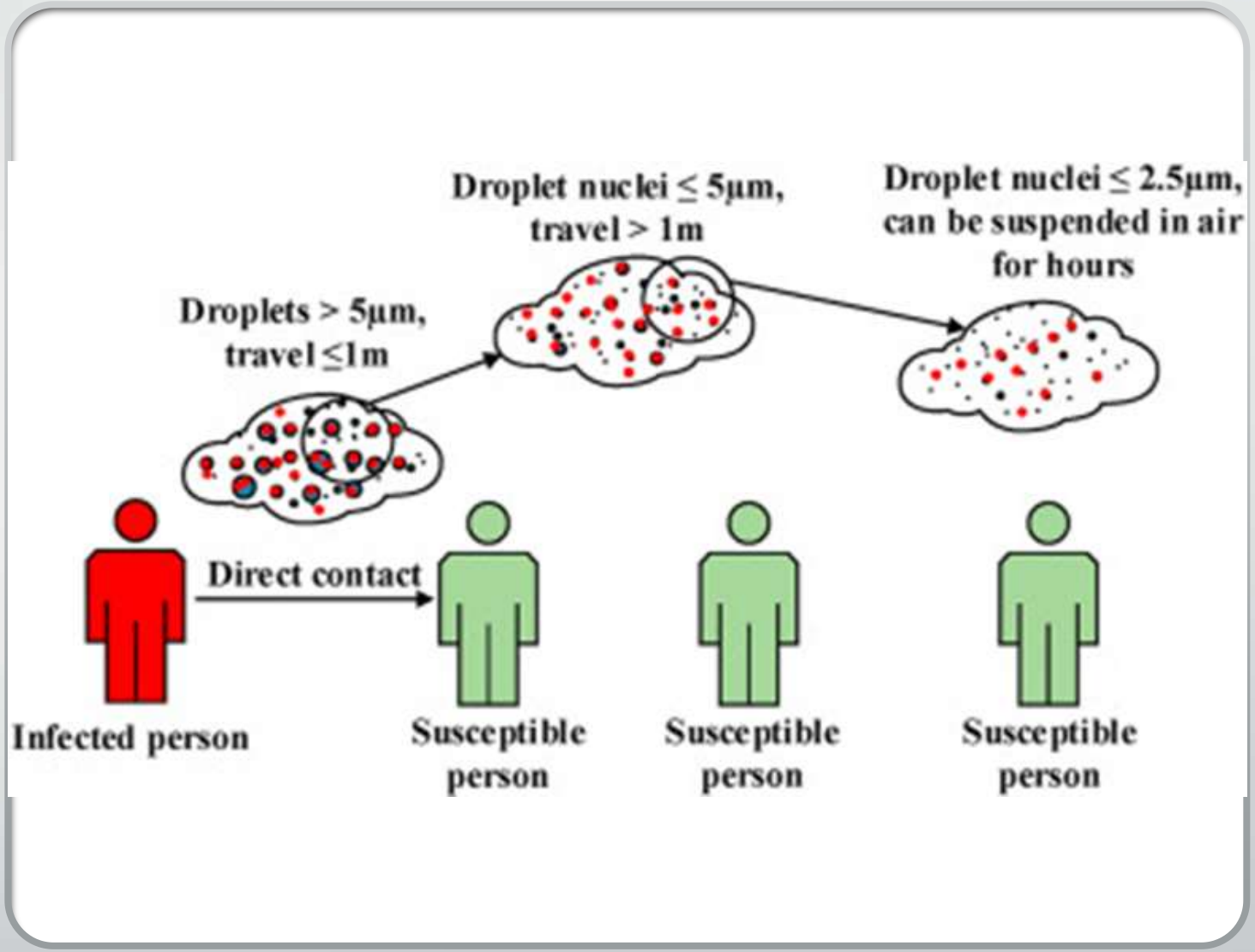
Contaminated Medical Equipment

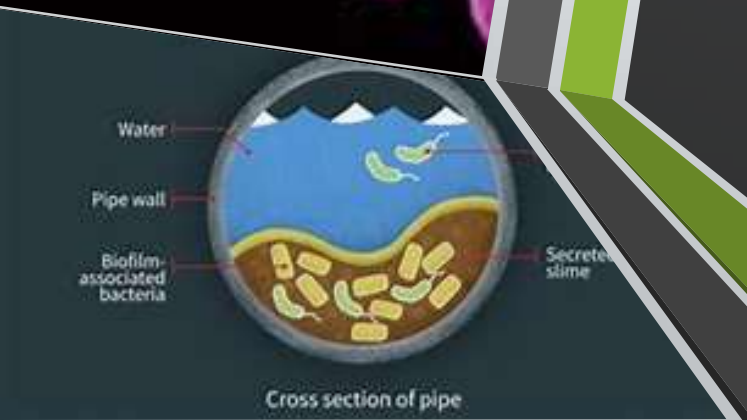
Contaminated Water

Contaminated Air

AIR

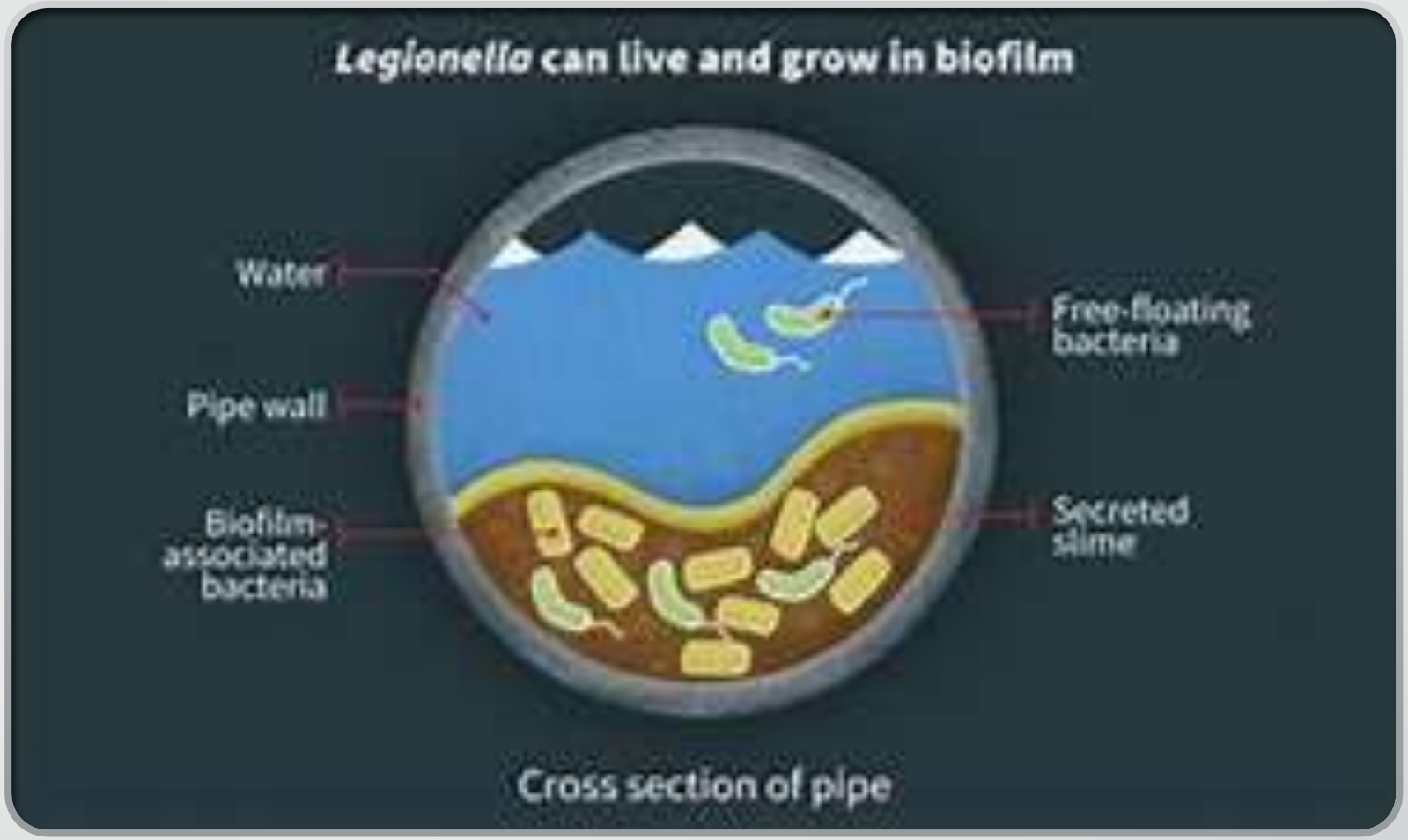
- TB
- COVID
- Influenza/Other Respiratory Viruses
- Measles
- Airborne vs Droplet





WATER

- Legionella
- Pseudomonas
- Acinetobacter
- NTM (dental clinics, heater/cooler)
- Pneumonia
- Wound Infections
- Polio
- Diarrheal illness


Legionella can live and grow in biofilm
Water
Pipe wall
Biofilm-associated bacteria
Free-floating bacteria
Secreted slime
Cross section of pipe

Legionella

Water Aerosols

Surfaces & Space

Even the most effective hand hygiene is invalid if surfaces are contaminated

Hands Can Pick Up Pathogens From Everywhere

X = positive *Enterococcus culture*

Abstract: The Risk of Hand and Glove Contamination after Contact with a VRE (+) Patient Environment. Hayden M, ICAAC, 2001, Chicago, IL.

Survival of Pathogens on Environmental Surfaces

Pathogen	Presence on Surfaces
C. Difficile	> 5 months
Staphylococci	7 months
VRE	4 months
Acinetobacter	5 months
Norovirus	3 weeks
Adenovirus Rotavirus	3 months
MRSA	3 months
SARS, HIV	Days to week

Prevention by Design

Design elements to prevent infection

Safety Risk Assessment

Infection Control

Patient Handling

Medication Safety

Falls

Behavioral Health

Security

Air

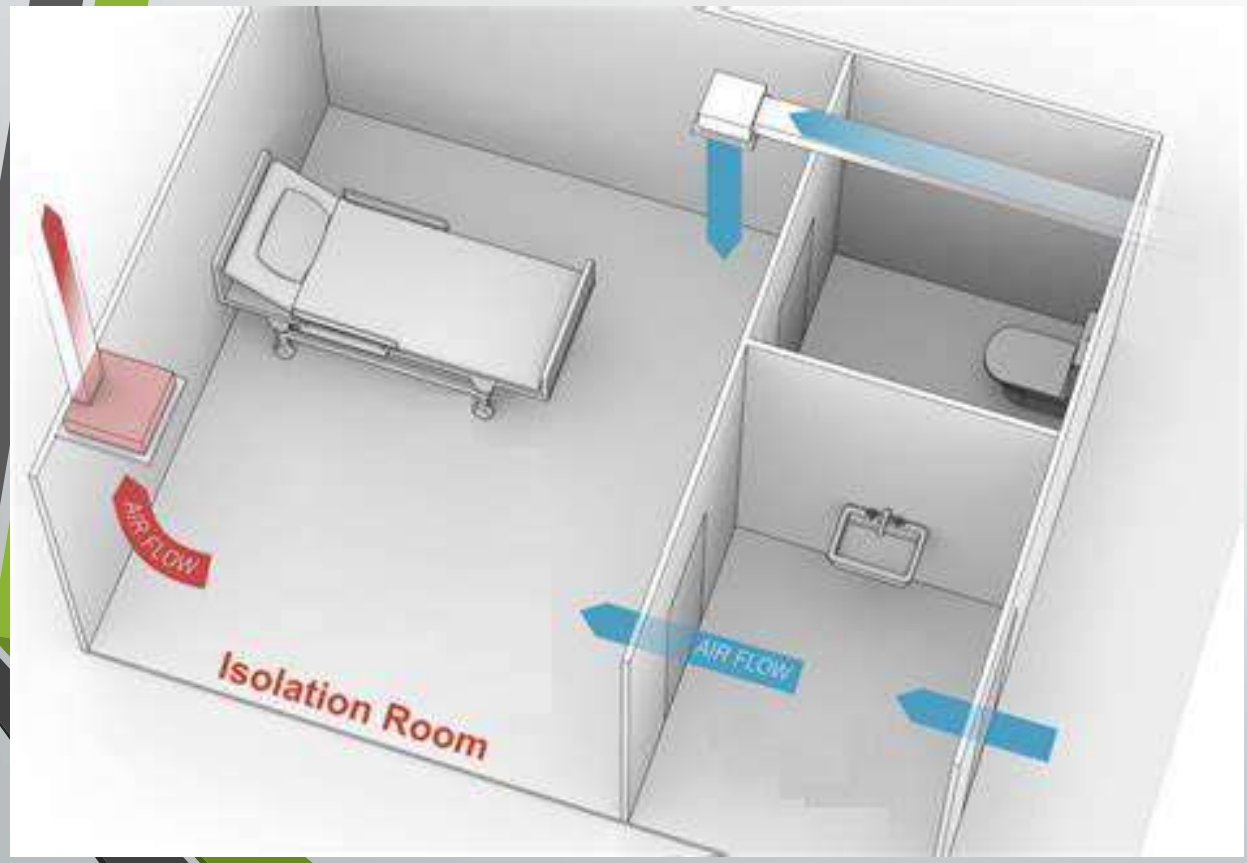
Patient Protection

- Air quality
- Room pressurization
- Humidity control

Occupant Comfort

- Temperature & humidity control

Air Quality



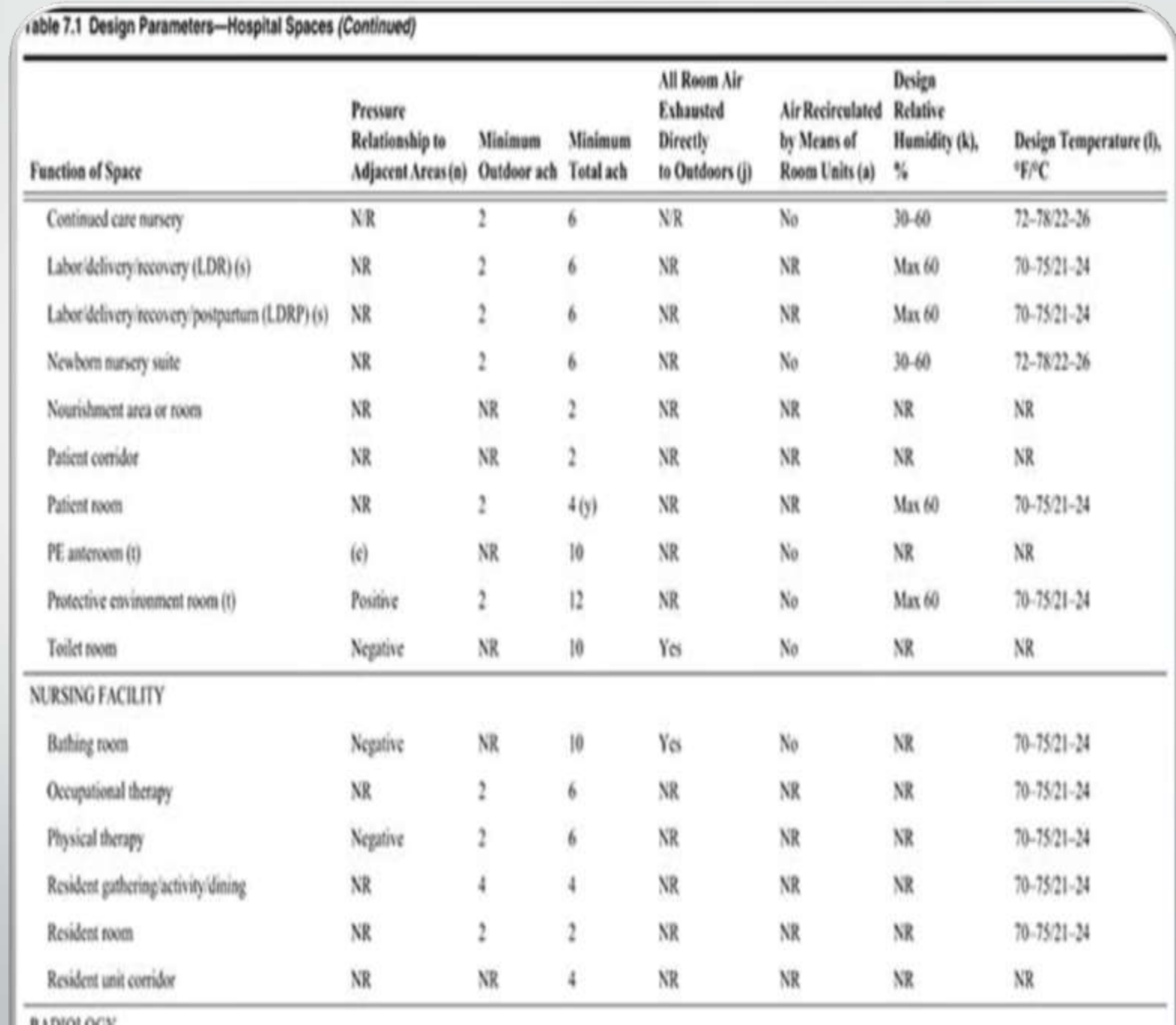
Air Exchanges

To keep air in spaces fresh, and flush out airborne contaminants, minimum volumes of air exchange rates (measured in air changes per hour – ACH) and proportion of fresh outside air are required

In certain critical environments like OR's and Procedure Rooms, filtered airflow is designed to drive away contaminants from high risk areas, creating a sterile field of laminar air.

Air

- Airborne Infection Isolation (AII)
- HVAC/flexible



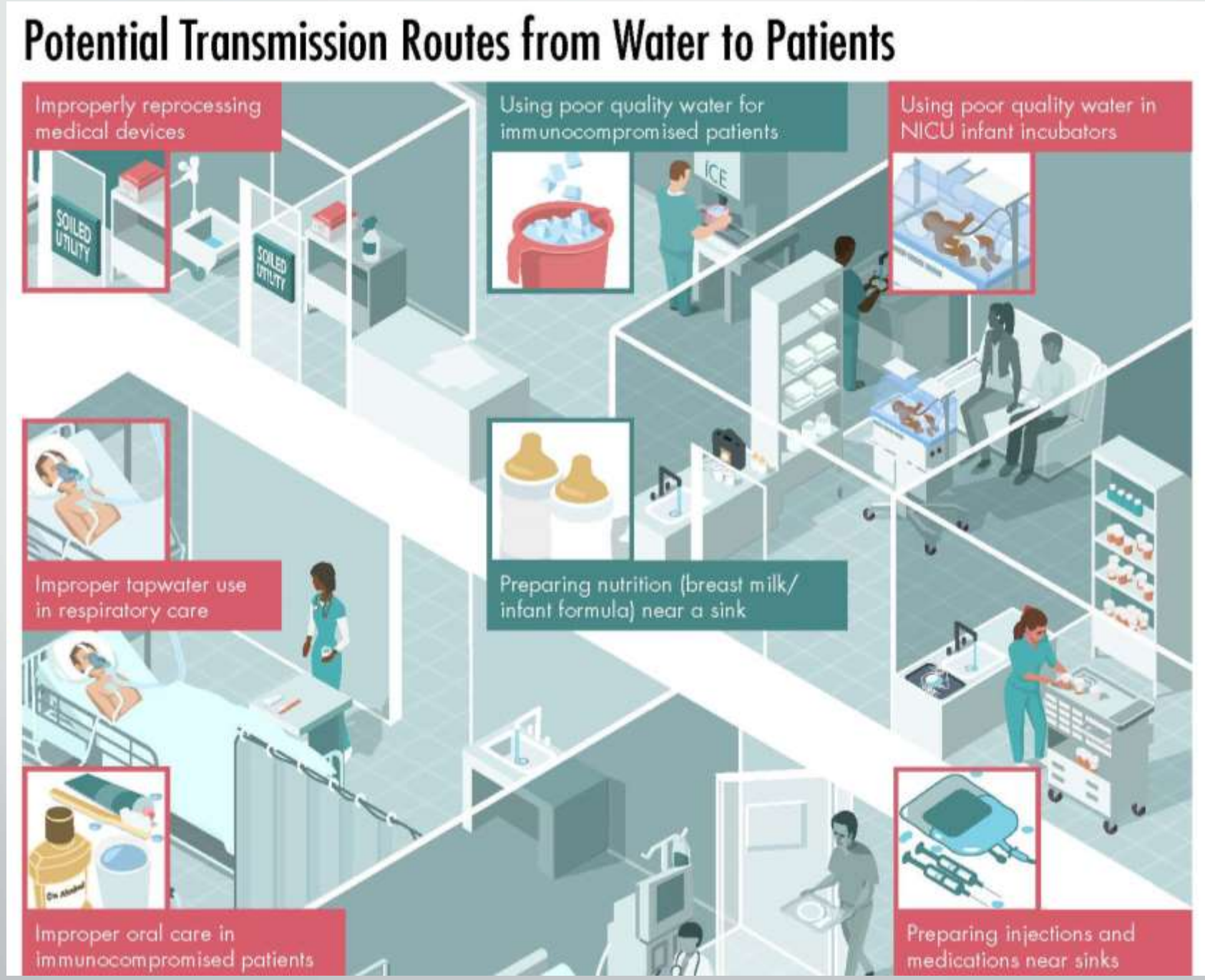
able 7.1 Design Parameters—Hospital Spaces *(Continued)*

Function of Space	Pressure Relationship to Adjacent Areas (n)	Minimum Outdoor ach	Minimum Total ach	All Room Air Exhausted Directly to Outdoors (j)	Air Recirculated by Means of Room Units (a)	Design Relative Humidity (k), %	Design Temperature (l), °F/°C
Continued care nursery	N/R	2	6	N/R	No	30–60	72–78/22–26
Labor/delivery/recovery (LDR) (s)	NR	2	6	NR	NR	Max 60	70–75/21–24
Labor/delivery/recovery/postpartum (LDRP) (s)	NR	2	6	NR	NR	Max 60	70–75/21–24
Newborn nursery suite	NR	2	6	NR	No	30–60	72–78/22–26
Nourishment area or room	NR	NR	2	NR	NR	NR	NR
Patient corridor	NR	NR	2	NR	NR	NR	NR
Patient room	NR	2	4 (y)	NR	NR	Max 60	70–75/21–24
PE anteroom (t)	(e)	NR	10	NR	No	NR	NR
Protective environment room (t)	Positive	2	12	NR	No	Max 60	70–75/21–24
Toilet room	Negative	NR	10	Yes	No	NR	NR
NURSING FACILITY							
Bathing room	Negative	NR	10	Yes	No	NR	70–75/21–24
Occupational therapy	NR	2	6	NR	NR	NR	70–75/21–24
Physical therapy	Negative	2	6	NR	NR	NR	70–75/21–24
Resident gathering/activity/dining	NR	4	4	NR	NR	NR	70–75/21–24
Resident room	NR	2	2	NR	NR	NR	70–75/21–24
Resident unit corridor	NR	NR	4	NR	NR	NR	NR

Water

- Water management plan
- Dead legs
- Placement of fixtures
- Type of fixtures (aerator, auto-start)
- Hot water heaters/anti-scald valves
- Eye wash
- Dialysis
- Shut offs
- Material selection
- NO WATER FEATURES!!

Potential Transmission Routes from Water to Patients



Potential Transmission Routes from Water to Patients

Design Impacts RISK!

Bad Design = Risk!

Vs

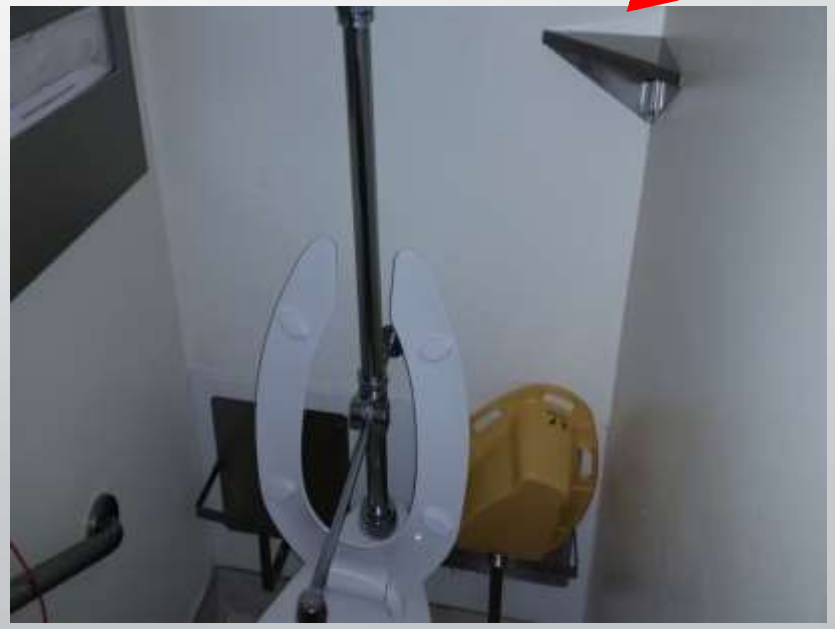
Surfaces & Space

- Material selection
  - Light fixtures
  - Copper
- Location – storage
  - PPE
  - Electrical Outlets
- Adequate spatial separation
- Separation of clean/ dirty
  - Soiled Utility/Decontamination
  - Reprocessing
- Workflow

Design Impacts
RISK

Design Impacts RISK

Label or separate for each patient



Details Matter: Separate space for clean & soiled items

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Anticipate the Future

- Providing support for new practices:
- Space for stocking product/Outlets
- Equipment that will be needed in future
- Connectivity for future devices

Teleoperated robot-assisted surgical system for minimally invasive procedures. (Credit: Intuitive Surgical, Inc.)

Health Care Flows

- Flow of Staff
- Flow of Patients
- Flow of Families/Care Partners
- Flow of Information
- Flow of Medications
- Flow of Supplies
- Flow of Equipment
- Flow of Waste

- Designing for hospital efficiency | HFM | Health Facilities Management (hfmmagazine.com)
- Using evidence-based strategies to design safe, efficient, and adaptable patient rooms - HCD Magazine (healthcaredesignmagazine.com)

Plan For Usability

Vs

Plan for Usability – Remember the Details


Failure To Anticipate
Needs IRL

Failure To Anticipate Needs IRL

Built Safe

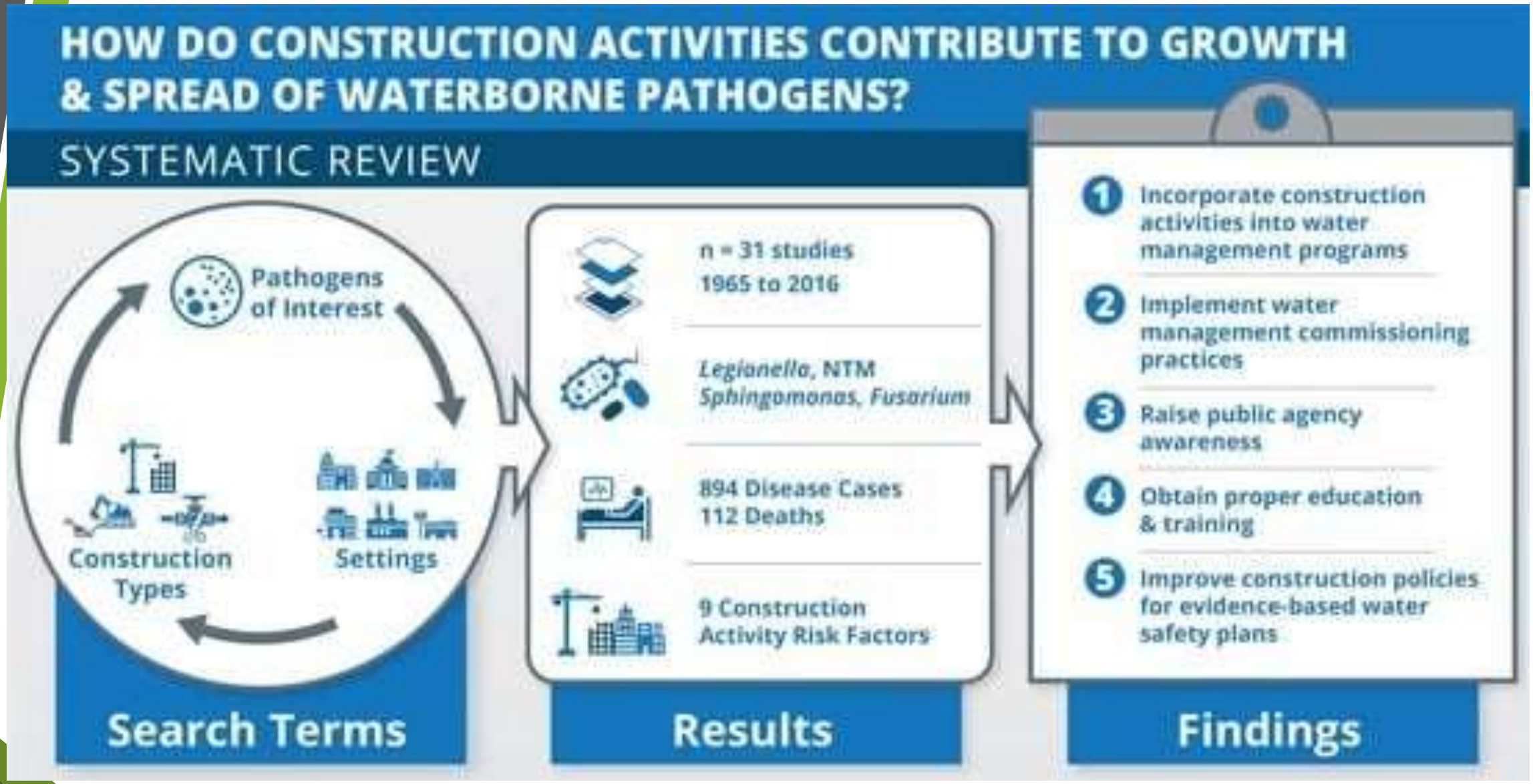
Construction practices to prevent infection

Aspergillus

- Fungus that is in dust and the environment
- 40% mortality rate for invasive cases
- Implicated in pneumonia and wound infections related to construction
- **Biggest risk of construction!**

ICRA 2.0

	TYPE A INSPECTION & Non-invasive activities	TYPE B Small-scale, short duration Minimal dust and debris	TYPE C Large-scale, longer duration Moderate dust and debris	TYPE D Major demolition & construction
LOW Risk Group **Non-patient care areas**	I	II	II	III
MEDIUM Risk Group **Patient support areas**	I	II	III	IV
HIGH Risk Group **Patient care areas**	I	III	IV	V
HIGHEST Risk Group **Procedural, invasive, sterile support and highly compromised patient care**	III	IV	V	V



Scanlon MM, et al.. Water Management for Construction: Evidence for Risk Characterization in Community and Healthcare Settings: A Systematic Review. *International Journal of Environmental Research and Public Health*. 2020; 17(6):2168. https://doi.org/10.3390/ijerph17062168

Barriers

- Not all barriers are created equal!
- Unless the project is VERY short in duration, plastic zip walls are hard to maintain
- Human Behavior is hard to overcome – zipping up and down each time seldom happens

Vs

Human Behavior Can = Danger

The names of the patients whose lives we save can never be known. Our contribution will be what did ***not*** happen to them. And, though they are unknown, we will know that mothers and fathers are at graduations and weddings they would have missed, and that grandchildren will know grandparents they might never have known, and holidays will be taken, and work completed, and books read, and symphonies heard, and gardens tended that, without our work, would never have been.

– Dr. Donald Berwick

Questions?

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