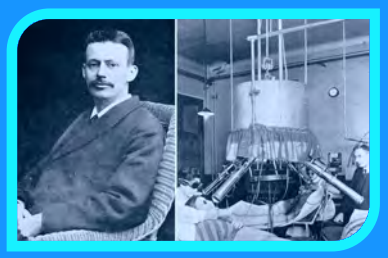
rzero

LOOK BEYOND THE OPERATING ROOM:

the role of ultraviolet disinfection in hospital disinfection

In recent decades, UV disinfection has become a mainstay of leading hospital's disinfection protocols in the highest-risk spaces, most commonly used in operating rooms.

However, hospitals are much bigger, of course — and the need to reduce the microbial loads of surfaces and the air is vastly broader — than the operating theater. Terrible and expensive hospital acquired conditions like C. diff are all too common. But even beyond them, hospitals are by definition full of ill and often immunocompromised patients. Patients' families and staff can walk in the door with a mild cold or flu that causes serious illness when caught by a patient. The odds of a patient walking into the emergency room with an infectious disease are much higher than the infectious rate in the community.



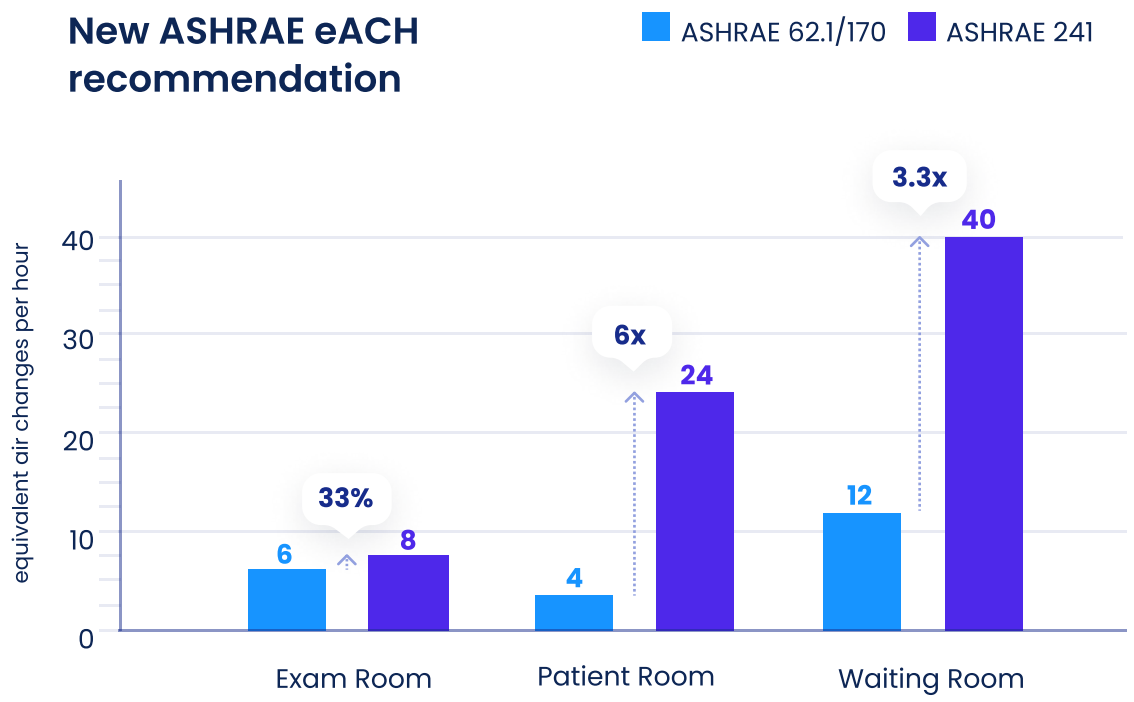
The concept of using ultraviolet (UV) light as a disinfection method dates to Niels Finsen's pioneering work in the late 19th century. His work treating a form of tuberculosis with UV-C light won Nobel Prize in Medicine. (UV-C is the lowest wavelength part of the UV spectrum.)

It’s time to rethink air disinfection

ASHRAE’s new 241 standard more than tripled the number of recommended air changes per hour for hospital waiting rooms when infection risk is high. And it's why hospitals take such care, and invest so much labor, in disinfection.

The CDC and The Lancet COVID-19 Commission Task Force on Safe Work, Safe School, and Safe Travel have also recommended higher air changes than past practice.

New ASHRAE eACH recommendation



calculated based on typical occupancy

Why UV has been stuck in the operating room

Given all this, why hasn't UV disinfection spread to every nook and cranny of your local hospital, not to mention, clinic and dentist's office?

Two main barriers have stood in the way:

1. **It's been incredibly expensive:** mobile UV towers mostly sell for $50,000, $75,000, $100,000, or more (that's changing — more below).

2. **Form factor:** UV towers that can be wheeled into empty operating rooms between surgeries work well in a surgical wing. But they aren't the right solution for continuously occupied spaces.

Thankfully, both of these barriers to adoption have collapsed. UV disinfection is now incredibly cost-effective and available in form factors that fit many hospital spaces. Leading hospitals have started bringing it across a much broader footprint.

Disinfection protocols in hospitals are critical for maintaining a safe environment for patients, staff, and visitors. They vary based on the specific needs and risks of each area in the hospital.

A look at current disinfection practice across the hospital

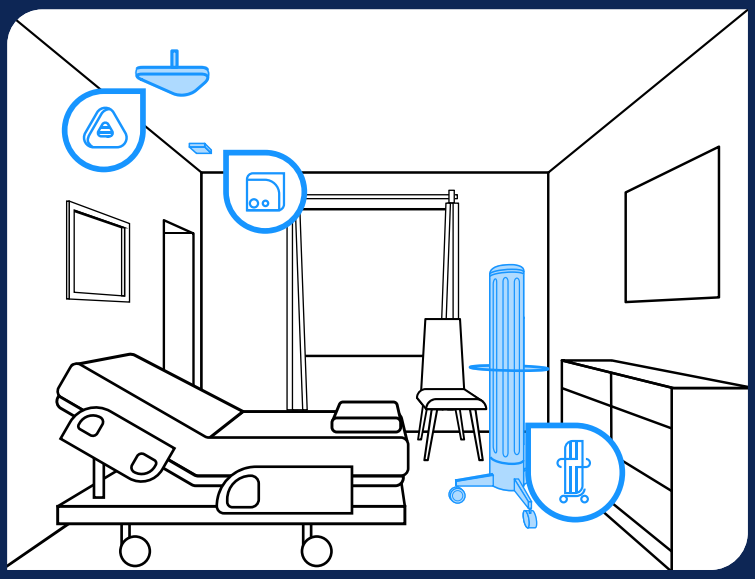
Let's use a large, 500-bed hospital as an example.

Industry estimates often suggest planning for around 2,000 square feet per bed for the total hospital size, or 1,000,000 square feet in total. That's a lot of space to disinfect, which is why it's not uncommon to have an environmental services staff in the hundreds.

Below, we look at the footprint of typical hospital spaces, the risk they present, and conventional disinfection approaches. Then we examine how UV can disinfect these spaces throughout the hospital while generating significant cost savings.

PATIENT ROOMS

These rooms generally span 250 to 350 square feet each, adding up to between 125,000 and 175,000 square feet — a substantial portion of the hospital's space.



Risk

As shown earlier, ASHRAE's 241 standard published this year recognized the high transmission risk in patient room air, and increased the required clean air requirement seven-fold.

Nearly 1 in 100 patients catch C diff infections from infected surfaces. Each costs close to $35,000 each — money that cuts into net patient services revenue and increases expenses and/or bad debt. [1]

More generally, patient rooms have many high-touch surfaces where pathogens can be introduced, linger, and be passed on to others, like bedrails, bedside tables, equipment, and so on.

Patient rooms have significant visitor traffic, from family and friends to doctors and nurses to environmental services workers.

Patient care itself, like changing linens, bathing, and wound care can expose and spread pathogens.

Typical Cleaning Procedure

SURFACE

Daily cleaning of high-touch surfaces (e.g., bed rails, IV poles, and call buttons) with EPA-approved disinfectants. Thorough cleaning between patients is a must, with additional measures for patients known to have contagious conditions.

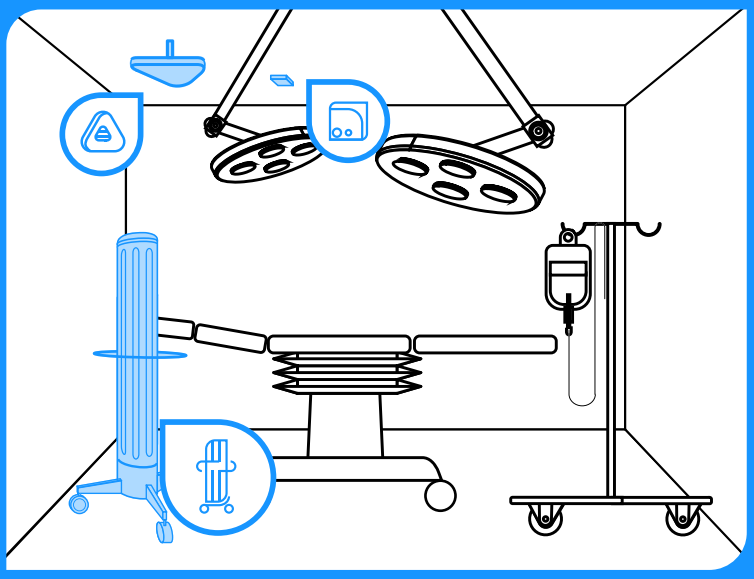
AIR

HEPA filtration units are often used, especially for patients with airborne diseases. Some facilities may also use UV-C light devices for air sterilization.

1 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5000548/

OPERATING ROOMS

A large hospital can have between 12 to 20 operating rooms. Each room requires sufficient space for equipment and staff movement, typically 600 to 800 square feet. This amounts to a total of 7,200 to 16,000 square feet dedicated to surgical procedures.



Risk

Operating rooms are already the gold standard for disinfection, and yet operating rooms average 1 surgical site infection per month, costing about $30,000 each that isn't reimbursed. [2]

The reason hospitals invest so much in OR disinfection is that it's the highest risk location for patients. Surgeries expose internal tissues and organs, creating a risk of introducing infections directly into the body.

However, operations are highly complex events: intricate equipment and machines can be difficult to sterilize completely between procedures, and surgeons, nurses, and technicians moving frequently through the room can stir airborne pathogens, which can settle on surfaces or open surgical sites.

Typical Cleaning Procedure

SURFACE

Rigorous cleaning and disinfection after each surgery, focusing on all surfaces, including surgical lights, tables, and equipment, using high-grade disinfectants. Some hospitals use automated systems like hydrogen peroxide vapor for terminal cleaning.

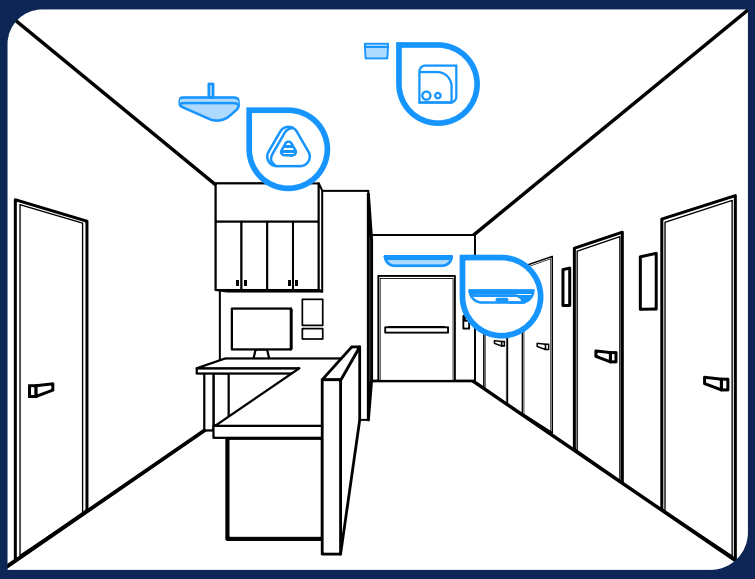
AIR

High-efficiency particulate air (HEPA) filters are standard to maintain clean air. Positive air pressure is used to prevent outside contamination, and air change rates are monitored to reduce infection risks.

2 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5000548/

EMERGENCY DEPARTMENT

The emergency department includes multiple treatment stations that add up to roughly 20,000 - 50,000 square feet.



Risk

Much like patient rooms, EDs are high risk spaces.

One area to be particularly wary of is the emergency department waiting room, where crowding and long wait times can increase the risk of transmission.

In addition, emergency departments are a location for last-resort care. This increases the patient load of undiagnosed and unmanaged conditions that increase both patients' immune susceptibility and the odds that they carry pathogens inadvertently.

Finally, emergency rooms are high-stress environments for staff that may lead to lapses in infection control practices.

Typical Cleaning Procedure

SURFACE

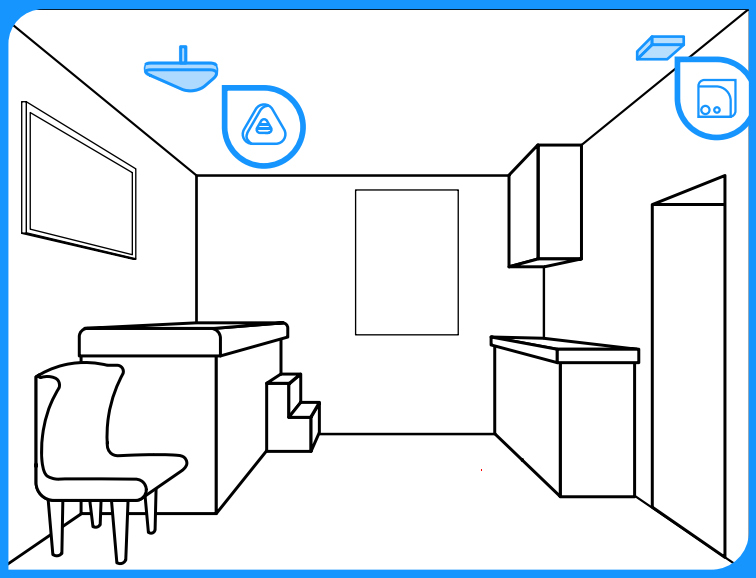
Continuous cleaning protocol for high-touch areas, with immediate cleaning of surfaces exposed to bodily fluids. Spills are immediately contained and cleaned.

AIR

Air purification systems or portable HEPA units are commonly used. Isolation rooms might be equipped with negative pressure systems.

RADIOLOGY/ IMAGING ROOMS

Radiology often includes 5-10 imaging rooms that are each 400 to 800 square feet.



Risk

Shared equipment used for multiple patients without proper disinfection can become a transmission vector, especially because many procedures require patients to remove protective clothing for imaging procedures.

Typical Cleaning Procedure

SURFACE

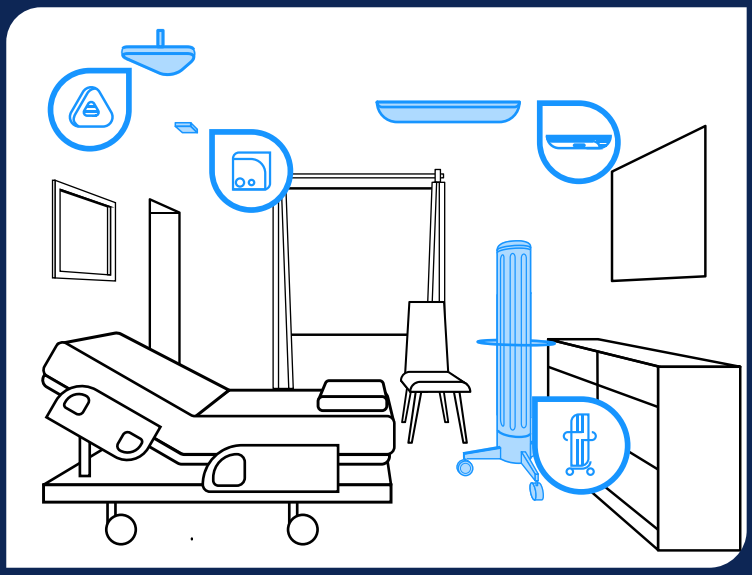
Disinfection of equipment and surfaces between patients, with additional precautions for patients with infectious diseases. Specialized cleaning for sensitive imaging equipment.

AIR

Standard air filtration is common, with specific rooms potentially utilizing higher-grade air purification based on procedural requirements.

INTENSIVE CARE UNIT

For a 500-bed hospital, the ICU might have 20-40 beds; because of the complexity of patient care in the ICU, the rooms are usually a bit bigger than other patient rooms to accommodate medical equipment and staff accessibility. Consequently, total ICU space can extend from 6,000 to 16,000 square feet.



Risk

The ICU hosts a high concentration of patients with compromised immune systems, increasing susceptibility to infections. Worse, frequent and invasive procedures can expose internal tissues to the environment.

High staffing levels in the ICU boost the presence of healthcare workers and medical equipment, which may harbor and transmit pathogens if not sanitized correctly.

Typical Cleaning Procedure

SURFACE

Enhanced cleaning protocols due to the vulnerability of ICU patients, with frequent disinfection of touchpoints and patient care equipment.

AIR

Use of HEPA filters and, in certain cases, UV air purifiers. Rooms housing patients with airborne infections will have specialized ventilation systems.

LABORATORIES

Facilities vary widely from one hospital to the next, but typically add up to 5,000 to 20,000 square feet.

Risk

Handling potentially infectious samples can expose surfaces to pathogens, and complex equipment can be difficult to clean. Additionally, working quarters are typically tight, increasing the risk of transmission between staff members.

Typical Cleaning Procedure

SURFACE

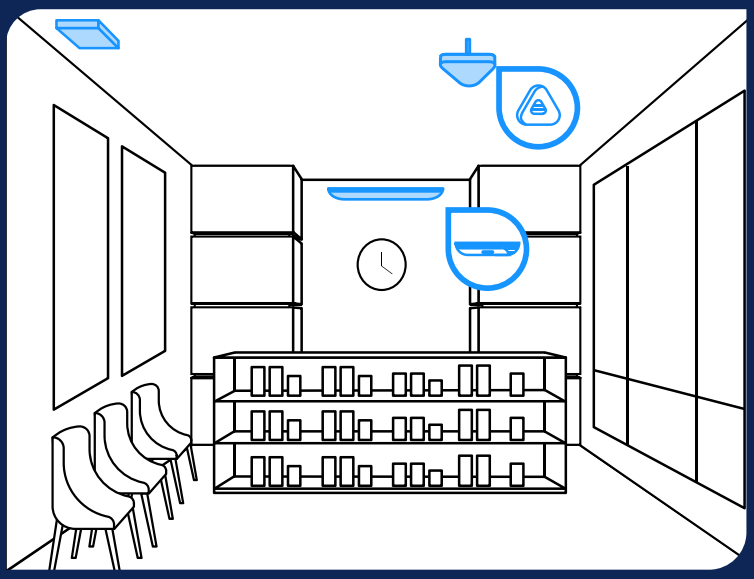
Strict protocols for disinfecting work surfaces, especially before and after sample analysis. Use of appropriate disinfectants for different types of microbes.

AIR

May include fume hoods, biosafety cabinets, and other specialized ventilation systems to protect against airborne pathogens and hazardous chemicals.

PHARMACY

Most hospitals feature one or more pharmacies that require 2,000 - 5,000 square feet in total.



Risk

High-touch areas like countertops, where prescriptions are passed, can harbor germs.

Shared items, like pens or electronic signature pads, can be transmission points. Finally, the pharmacy is often a high traffic area with both staff and potentially ill patients coming in for medication.

Typical Cleaning Procedure

SURFACE

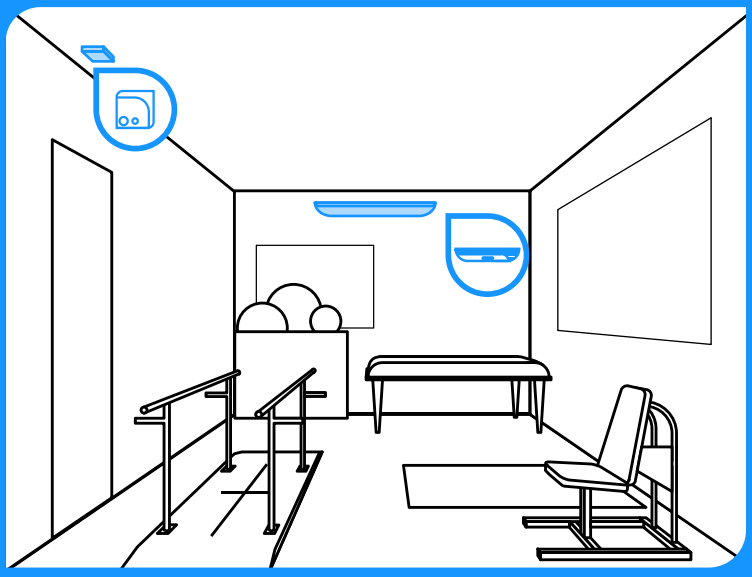
Regular cleaning of compounding areas and critical surfaces with disinfectants suitable for sterile environments. Compliance with USP standards for sterile compounding is essential.

AIR

Use of laminar air flow hoods in compounding areas. Monitoring of air quality, especially in compounding sterile preparations (CSP) areas.

PHYSICAL THERAPY

Typically 5,000 to 10,000 square feet.



Risk

Physical contact between therapists and patients can contribute to direct transmission, and exercise-induced heavy breathing in close quarters can increase airborne pathogen presence.

Typical Cleaning Procedure

SURFACE

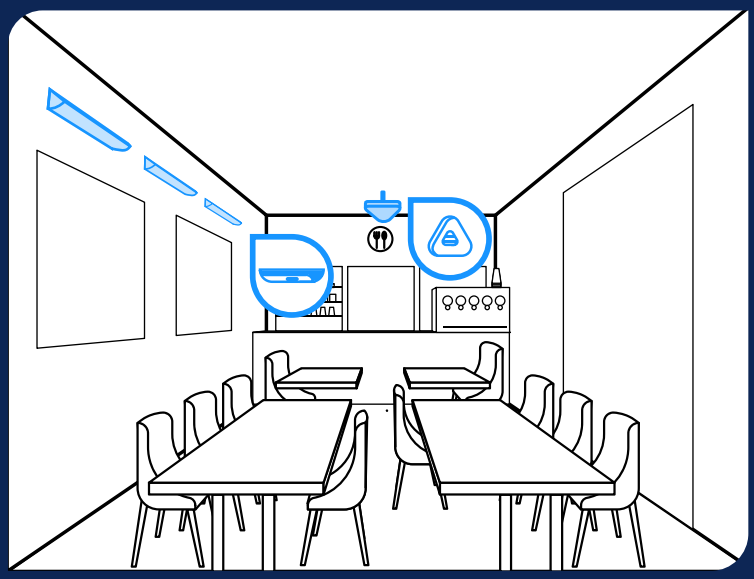
Equipment cleaned and disinfected between patients. Special attention to communal items and any shared therapeutic devices.

AIR

Standard air filtration, with attention to maintaining good indoor air quality, as physical therapy can involve aerobic activities.

CAFETERIA/ DINING

Most hospitals usually have one main cafeteria, alongside smaller adjunct cafes, altogether requiring about 10,000 to 15,000 square feet.



Risk

Cafeterias host a high occupancy level of maskless people during meal times. High touch surfaces like tables, chairs, food handling and serving all present transmission opportunities.

Typical Cleaning Procedure

SURFACE

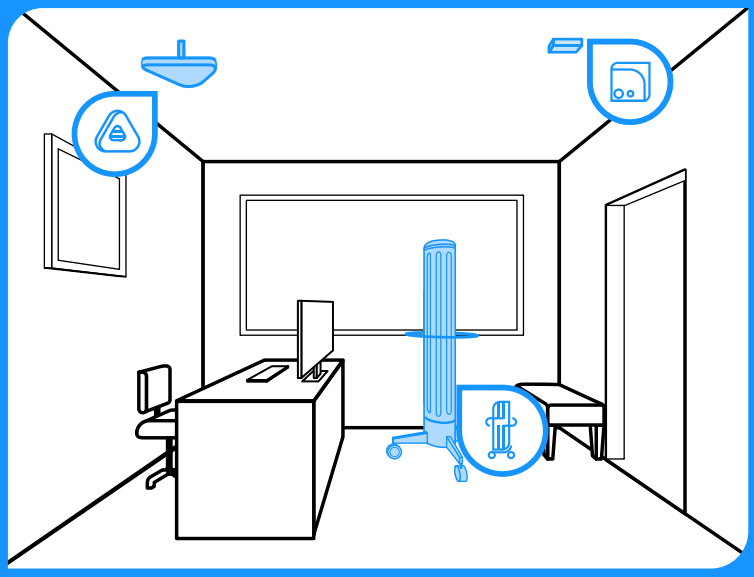
Routine cleaning protocol similar to food service regulations, focusing on food contact surfaces, tables, and chairs. Frequent disinfection during peak hours.

AIR

Standard HVAC systems, with potential use of portable air cleaners. Emphasis on odors and food particle removal.

ADMINISTRATIVE OFFICES

Typically, 20,000 to 40,000 square feet.



Risk

Risks are similar to general office space, but given much of the staff spends a portion of their time in a clinical setting, there is a higher risk of bringing in pathogens that are more common in a clinical setting than a corporate one.

Typical Cleaning Procedure

SURFACE

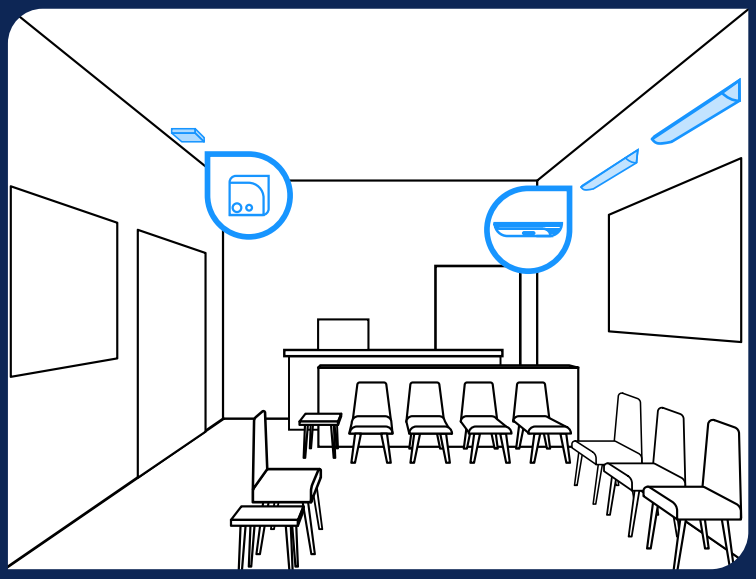
Regular cleaning of high-touch surfaces like door handles, desks, phones, and computers.

AIR

Regular cleaning of high-touch surfaces like door handles, desks, phones, and computers.
Standard air filtration practices, similar to general office environments.

LOBBY/ WAITING AREAS

Hospitals design lobbies and waiting areas to accommodate visitors comfortably, typically allocating about 10,000 to 20,000 square feet combined.



Risk

Waiting areas are one of the highest risk spaces in the hospital, especially for airborne viruses. They host a diverse range of occupants, including sick individuals, family members, and others who can bring pathogens in from outside.

Long wait times increase risk as does crowding.

Typical Cleaning Procedure

SURFACE

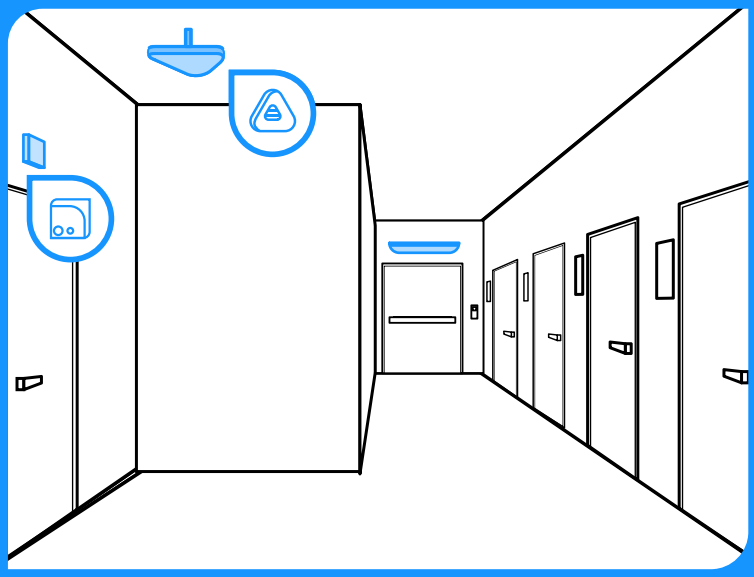
Frequent cleaning schedule for seating, door handles, and reception areas. Use of disinfectant wipes or sprays on shared items like magazines or toys.

AIR

General HVAC filtration, sometimes complemented by air purifiers, especially during periods of increased respiratory illnesses.

CIRCULATION (CORRIDORS, ELEVATORS, STAIRS, ETC.)

Can be 25-30% of the total hospital square footage.



Risk

High foot traffic areas touching handrails, elevator buttons, and door handles.

Enclosed spaces (like elevators) where social distancing is difficult.

Air circulation might be limited, depending on the HVAC design in these transitional areas.

Typical Cleaning Procedure

SURFACE

Regular disinfection of handrails, elevator buttons, and other high-touch surfaces. Increased frequency during daily peak hours.

AIR

Regular HVAC filtration. In certain high-risk areas or during outbreaks, portable HEPA units may be employed.

Improving disinfection practices with UV while saving money

Given all the different spaces and risks across a large hospital, how can hospital management improve disinfection without breaking the bank?

The dramatic cost reductions of UV-C over recent years, while manual labor and chemical costs have increased significantly, means it's time to rethink and expand the role of UV-C. There are several form factors for UV-C disinfection that can help in different ways in different spaces:

- **Mobile UV-C towers.** The most powerful UV-C form factor, mobile towers can be wheeled in and out of operating theaters between procedures. Leading hospitals also use them to replace electrostatic spraying for terminal patient room turnover. The best models can inactivate 99.99% of pathogens in the air and on surfaces in just a few minutes. EVS staff can cut time spent per room by over 10% and avoid exposure to the harmful chemicals used in electrostatic spraying. But mobile towers aren't a panacea. They use a highly germicidal wavelength of UV-C that isn't safe for human exposure, so spaces have to be unoccupied during disinfection cycles.
- **Upper room systems use similar wavelengths.** But they avoid exposing people by shining the UV light across the top of a room, typically from 7 feet up to the ceiling. As occupants talk and breathe, their warm breath rises and hits the UV light, which inactivates any harmful microbes. The cleaned air then naturally recirculates back down. Upper room systems are great for addressing airborne pathogens in large rooms. But because the light doesn't shine everywhere, pathogens on surfaces aren't disinfected.
- **Finally, ceiling-mounted Far-UV systems generate UV light at the shortest wavelengths of the UV spectrum.** It takes longer to inactivate pathogens, but Far-UV is safe for humans. That means it can be used to disinfect air and surfaces continuously in small, occupied rooms.

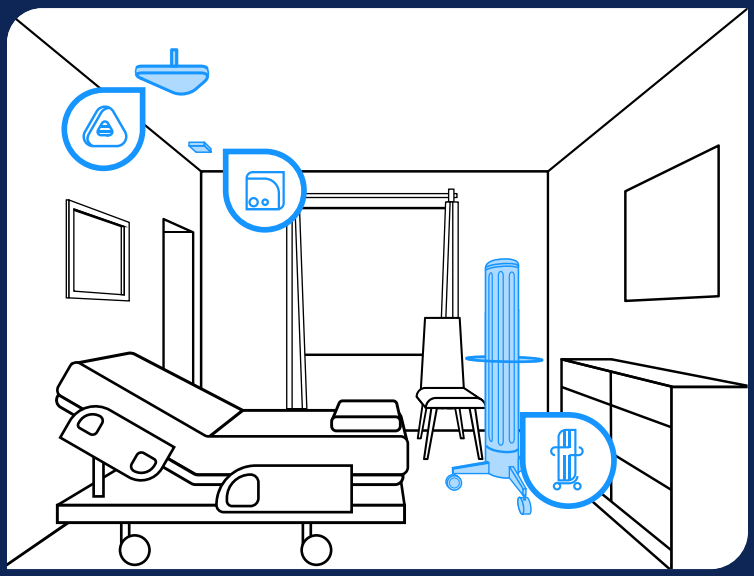
With that in mind, let's take a look at the same set of spaces and consider where UV-C makes sense.

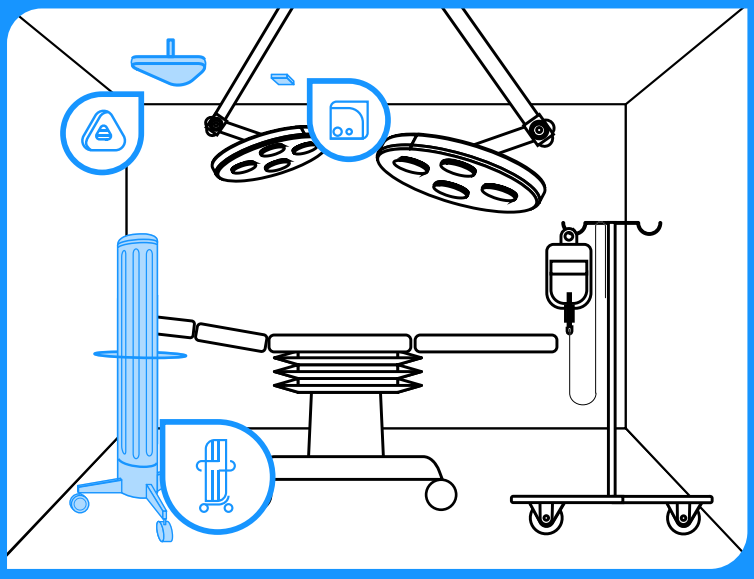
PATIENT ROOMS

UV Disinfection

Far-UV ceiling mounted fixtures are an excellent solution for patient rooms and bathrooms, because they provide continuous air and surface disinfection in the most important zone — around a patient — and in the bathroom, use less energy than HEPA filters and are noise-free.

Additionally, terminal disinfection between patients is a great use case for UV-C towers.





OPERATING ROOMS

UV Disinfection

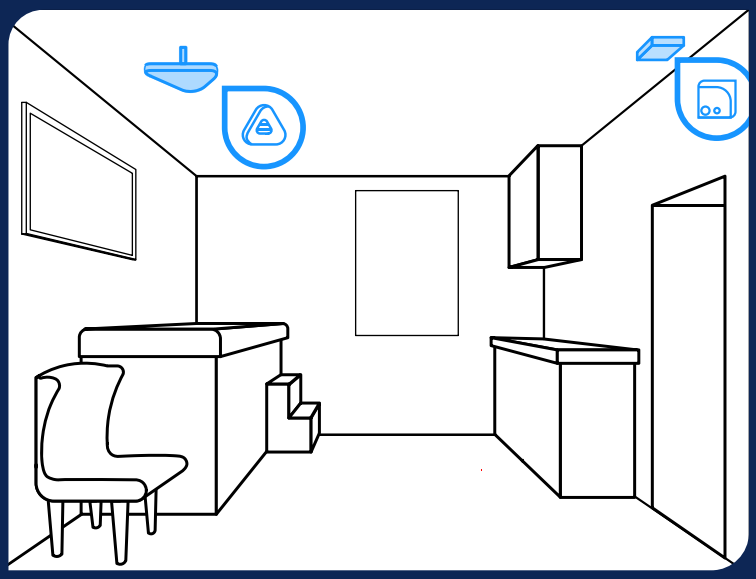
Operating rooms are the traditional use case for UV-C towers between procedures to inactivate microbial loads in the air and on surfaces.

EMERGENCY DEPARTMENT

UV Disinfection

The waiting room is an ideal use case for upper-room air disinfection to ensure a constant high flow of equivalent air changes per hour at dramatically lower cost than delivering those air changes with HVAC.

Far-UV ceiling mounted fixtures are great for treatment rooms and bathrooms, because they provide continuous air and surface disinfection, use less energy than HEPA filters and are noise-free.



RADIOLOGY/ IMAGING ROOMS

UV Disinfection

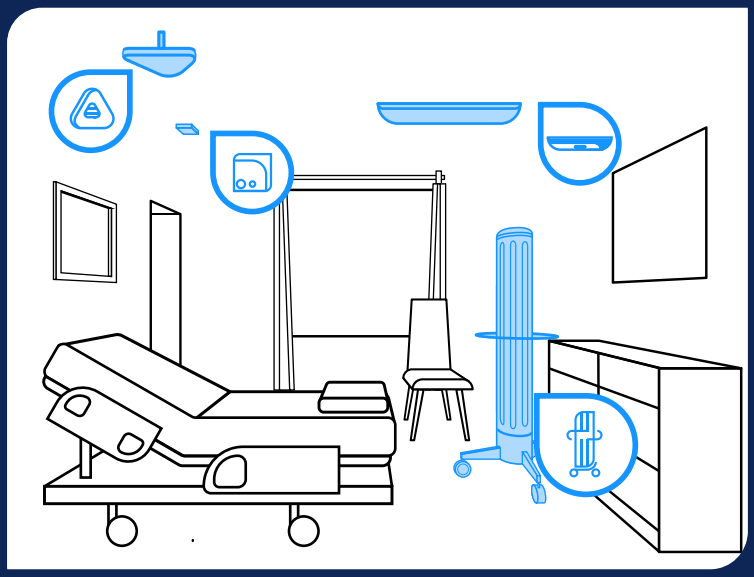
Far-UV ceiling mounted fixtures are an excellent solution for imaging, because they provide continuous air and surface disinfection to reduce the risk of cross-contamination.

INTENSIVE CARE UNIT

UV Disinfection

Far-UV ceiling mounted fixtures are useful for treatment rooms and bathrooms given the vulnerability of ICU patients, because they provide continuous air and surface disinfection to lower microbial loads. To prioritize continuous air disinfection in infectious patients, upper-room UV is a more powerful solution.

Additionally, terminal disinfection between patients is a great use case for UV-C towers.



LABORATORIES

UV Disinfection

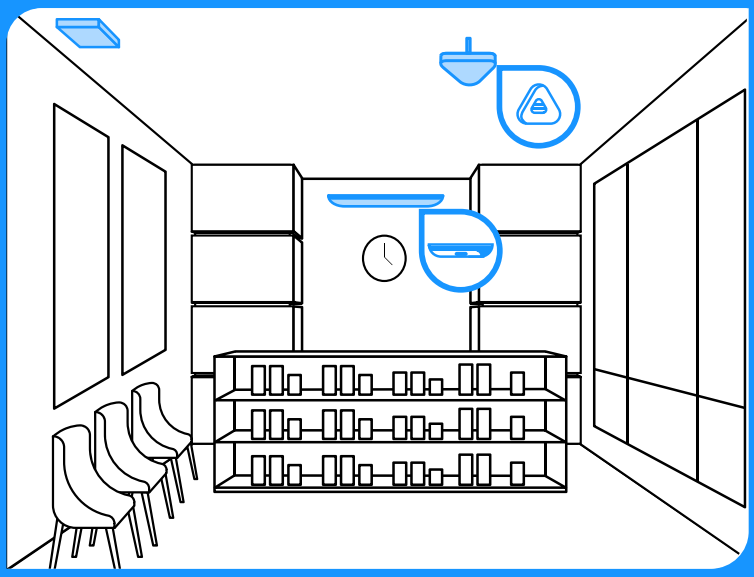
Upper-room UV air disinfection can be a great complement to existing disinfection protocols to add an additional layer of microbial reduction.

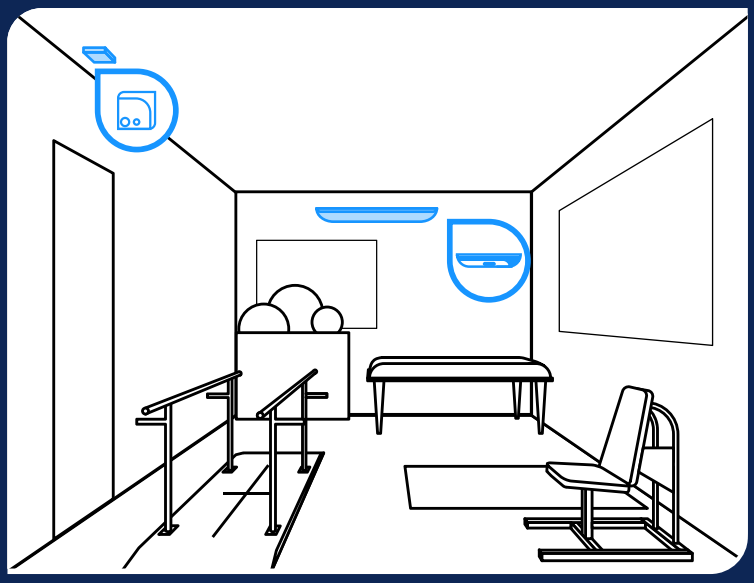
PHARMACY

UV Disinfection

Far-UV can be used above key work areas and at the counter to continuously disinfect countertops, medication carts, computer keyboards, payment pads, pens, and other surfaces that can harbor and transmit pathogens between manual cleanings.

The waiting room is an ideal use case for upper-room air disinfection to ensure a constant high flow of equivalent air changes per hour at dramatically lower cost than delivering those air changes with HVAC.





PHYSICAL THERAPY

UV Disinfection

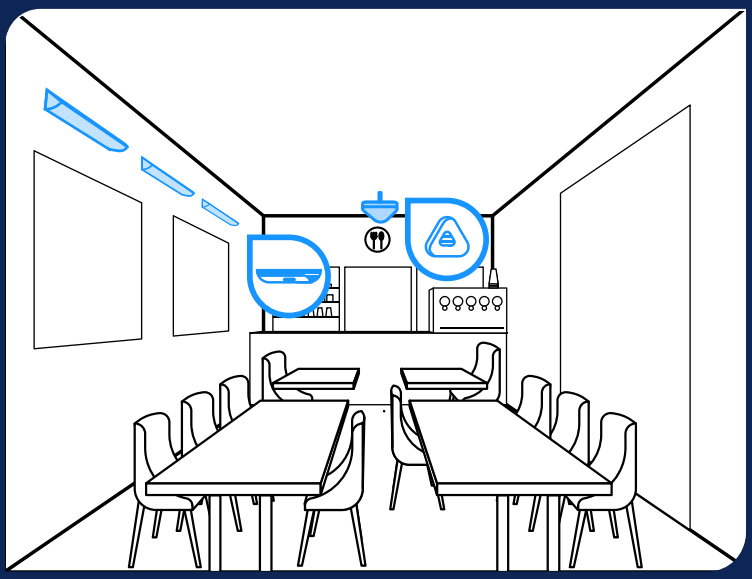
Upper-room air disinfection with UV ensures high equivalent air changes per hour, keeping airborne pathogens at a low level in spite of the heavy breathing common in physical therapy, without the high cost of achieving similar results with HVAC.

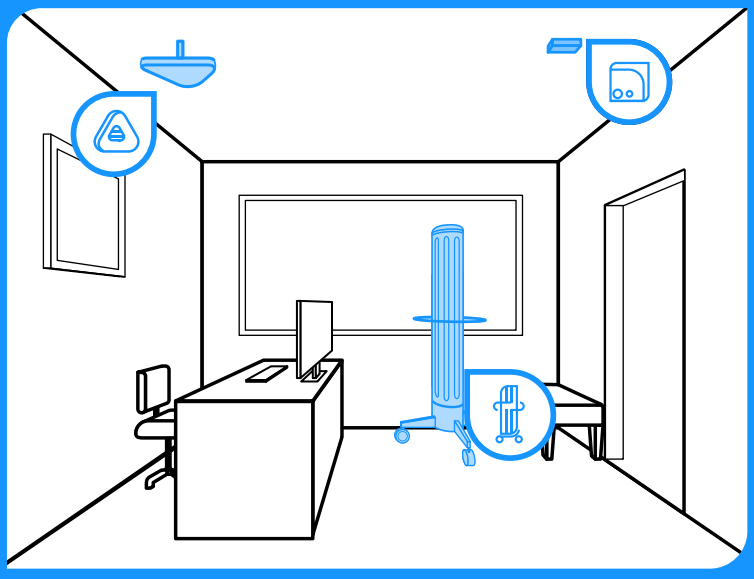
CAFETERIA/ DINING

UV Disinfection

Cafeterias are a perfect setting for upper-room UV air disinfection, which can very efficiently protect larger spaces continuously at dramatically lower cost than HVAC.

In the food service area, Far-UV ceiling mounted systems can continuously disinfect serving areas to minimize pathogen load on high-touch trays, plates, serving utensils, and register areas.





ADMINISTRATIVE OFFICES

UV Disinfection

Meeting rooms and classrooms are good settings for upper-room disinfection, which can very efficiently protect them continuously when occupied.

Bathrooms in administrative areas are excellent locations for ceiling-mounted UV-C mounted systems to continuously disinfect high-touch surfaces like sinks, counters, and toilets. The same systems can be run on a longer off-hours cycle for deep disinfection overnight.

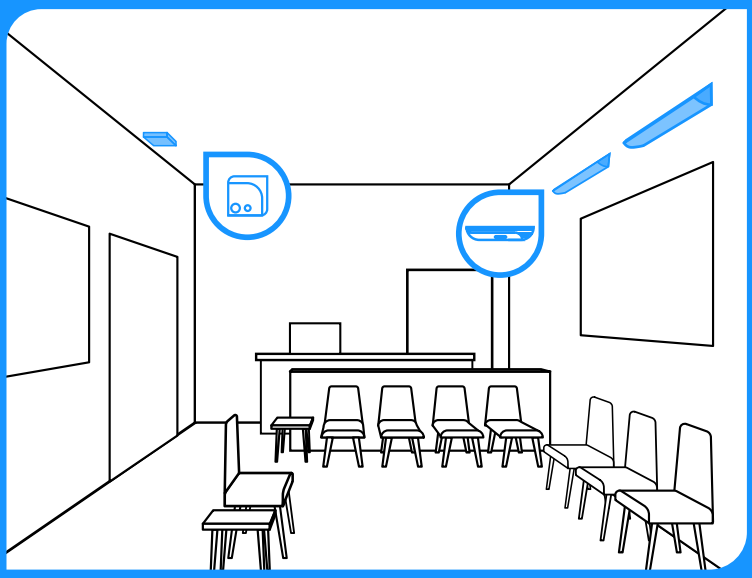
LOBBY/ WAITING AREAS

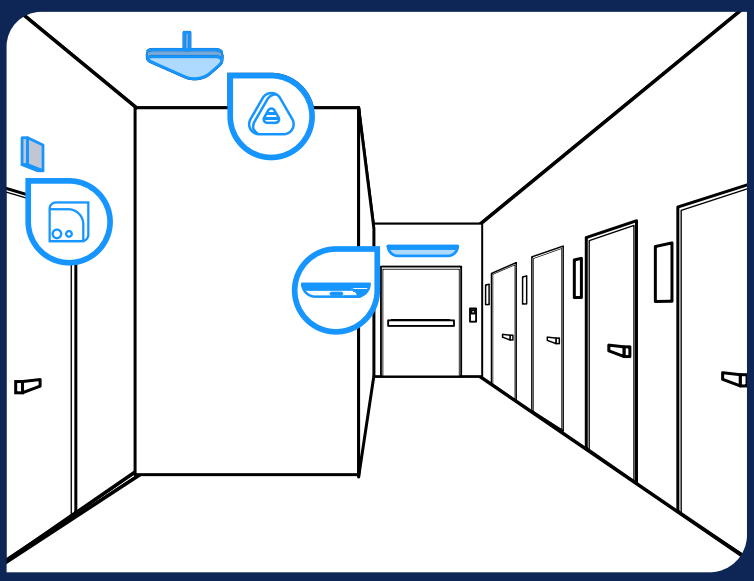
UV Disinfection

Waiting rooms are a smart location for upper-room air disinfection to ensure a constant high flow of equivalent air changes per hour at dramatically lower cost than delivering those air changes with HVAC.

In pediatrics, consider a Far-UV ceiling fixture over high-touch children's play areas.

Reception areas are also well-suited to Far-UV ceiling fixtures due to high touch surfaces like pens, credit card processing pads, and counters.





CIRCULATION (CORRIDORS, ELEVATORS, STAIRS, ETC.)

UV Disinfection

Due to elevators' high use, ceiling mounted Far-UV can be extremely useful to ensure continuous disinfection of high-touch surfaces like buttons and rails and air in the enclosed space.

What's the ROI?

The ROI for reducing microbial loads that cause patient illness is tremendous. But it's far from the only hard-dollar savings a hospital can achieve through a broader application of UV-C.

A 500-bed hospital might have about 250 people on its environmental services team. At Carle Health in Illinois, the environmental services (EVS) team was responsible for electrostatic spraying for terminal room disinfection of about 150 rooms per day. Team members took 40 minutes to spray and clean each room. For each room, they had to put on and then throw away isolation overalls, respirators, goggles, and shoe covers. Each day they consumed and disposed of any excess spray solutions. And they sometimes got sick from the harsh chemicals. The EVS team now uses mobile UV-C towers to shave 10% off the time it takes to turn a room, and avoid chemicals altogether. At current prices for our Arc mobile UV tower, time savings alone could pay for a deployment multiple times over within the first year.

Air disinfection with upper room UV-C can generate extra air changes per hour at a cost 80% below using HVAC.. In non-clinical settings, many HVAC systems are not even designed to meet the latest indoor airflow recommendations no matter how hard you run them.

And across the board, providing a safer environment for patients, staff, and visitors means a healthier community.

If you'd like to learn more about how UV-C can help your hospital make life worse for microorganisms while making it better for humans, please reach out.

Learn More

R-Zero provides a healthy buildings platform that helps you learn about your indoor environmental health, understand the risk of your spaces, and help you mitigate and remediate risk through a suite of UV-C devices. UV-C has been used for decades in hospitals for best in class disinfection and our technology provides that same level of efficacy for more types of businesses, where you work, live, and play, disinfecting the air and surfaces to eliminate 99.99% of infection risk in a given space.

www.rzero.com | sales@rzerosystems.com