Contaminated Air: The Invisible Threat to Patients and Staff

Dr. Linda Lee, DrPH, MBA, CIC
UV Angel, Chief Science and Medical Officer

Presenter Introduction

UV Angel's technology is clinically based & back by science & engineering under the leadership of Dr. Linda Lee. Dr. Lee is a leading expert in environmental health science, with a specialty in the relationship of opportunistic environmental pathogens and disease transmission.

Dr. Linda D Lee DrPH, MBA, CIC

UV Angel, Chief Medical Affairs & Science Officer

- Chief Medical Affairs and Science Officer, UV Angel
- MD Anderson Cancer Center, AVP Admin Facilities and Campus Operations
- CH2M Hill, Global Practice Director - focusing on complex environmental health, threat detection, mitigation and response and biological-chemical safety projects
- Founding member of Stericycle
- WM Healthcare Solutions, Director of Operations
- Faculty University of Texas Health and Science Center, School of Public Health
- ASHRAE Committee Member - Environmental Health, 185 UVC chair 185.3 in room air treatment
- American Hospital Association Speaker
- Speaker - SHEA, AIHce, IPAC-Canada, C. Diff Foundation, APIC, ASHRAE
- Awarded as a Top 25 Woman Leader in Health & Technology of 2022
- Published author - AHA

Learning Objectives

Describe	Describe the behavior of airborne microbes.
Align	Align technology implementation with regulatory needs.
Contrast	Contrast episodic disinfection with continuous disinfection.
Evaluate	Evaluate technologies designed to reduce airborne contamination and their application to high-risk areas.

Contaminated Air: The Invisible Threat.

What do we do about it?

The Pandemic Reinforced Once Again:

- **Air Matters**
- **Infection Prevention Vs Infection Response**

Emerging Threats

Especially, H5-N1

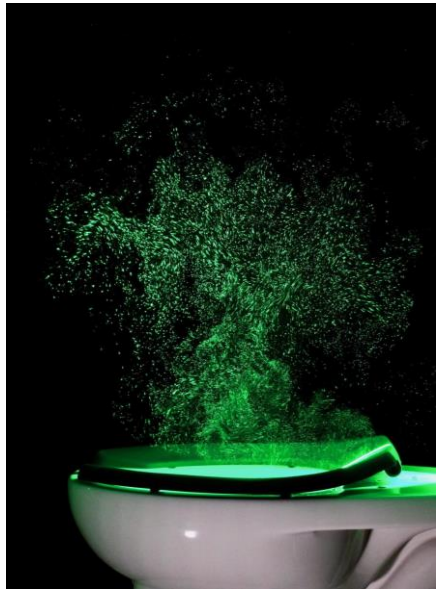
Trifecta of respiratory diseases

RSV
Influenza
Covid

The recent Covid-19 pandemic killing over **6,000,000 people** globally

CDC expecting up to **400,000 flu hospitalizations** in 2022

Contaminated Air: What is The Invisible Threat?



People are the major source of contamination & transmission

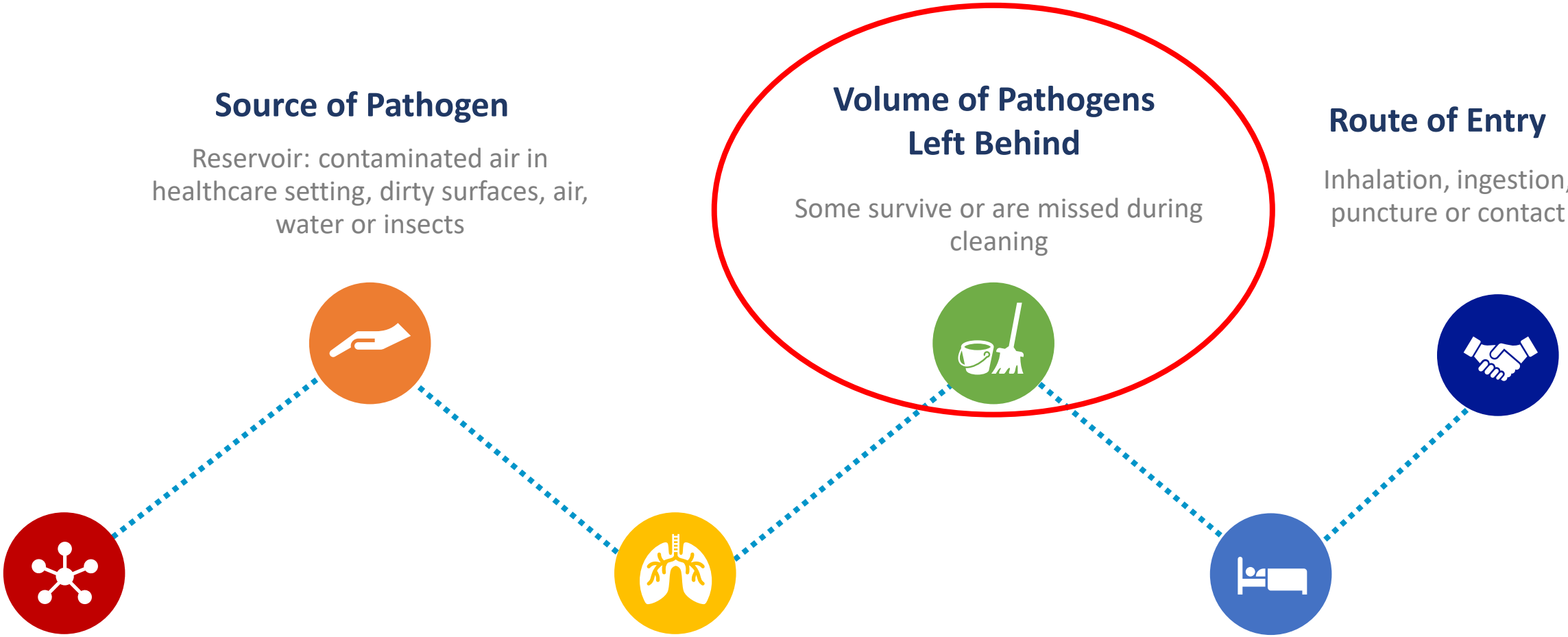
Many Indoor Air Quality (IAQ) and surface related problems

- Foot traffic sends **100,000 particles** per step into the air
- Humans shed **37 million bacteria** per hour
- Study shows hospital room dirtiest 1.5 hrs after cleaning
- Pathogens **can travel on air to surfaces**; resulting in direct and indirect transmission

Snow Globe Affect

What Goes Up Must Come Down

Breaking the Chain of Airborne Transmission



Source of Pathogen

Reservoir: contaminated air in healthcare setting, dirty surfaces, air, water or insects

Volume of Pathogens Left Behind

Some survive or are missed during cleaning

Route of Entry

Inhalation, ingestion, puncture or contact

Portal of Exit

How pathogens exit body: AGPs, coughing, sneezing, loud talking, signing, bleeding, open wounds

Susceptible Host

Pathogens travel on air currents and land on surfaces

Pathogens Settle and Survive on Surfaces

High-touch surfaces

Pathogen Survival Rates	
C. difficile	200 days [2,7,8]
MRSA	300 days [1,5,10]
VRE	200 days [2,3,4]
E. Coli	480 days [7,9]
Klebsiella	900 days [6,7]
Acinetobacter	300 days [7,11]
Mycobacterium TB	120 days [7]
Candida albicans	120 days [7]

1. Beard-Pegler et al. 1988.. *J Med Microbiol*. **26**:251-5.
2. BIOQUELL trials, unpublished data.
3. Bonilla et al. 1996. *Infect Cont Hosp Epidemiol*. **17**:770-2
4. Boyce. 2007. *J Hosp Infect*. **65**:50-4.
5. Duckworth and Jordens. 1990. *J Med Microbial*. **32**:195-200.
6. French et al. 2004. *ICAAC*.
7. Kramer et al. 2006. *BMC Infect Dis*. **6**:130.
8. Otter and French. 2009. *J Clin Microbial*. **47**:205-7.
9. Smith et al. 1996. *J Med*. **27**: 293-302.
10. Wagenvoort et al. 2000. *J Hosp Infect*. **45**:231-4.
11. Wagenvoort and Joosten. 2002. *J Hosp Infect*. **52**:226-7.

Pathogens Settle and Survive on Surfaces

Low-touch surfaces

Pathogen Survival Rates	
C. difficile	200 days [2,7,8]
MRSA	300 days [1,5,10]
VRE	200 days [2,3,4]
E. Coli	480 days [7,9]
Klebsiella	900 days [6,7]
Acinetobacter	300 days [7,11]
Mycobacterium TB	120 days [7]
Candida albicans	120 days [7]

1. Beard-Pegler et al. 1988.. *J Med Microbiol*. **26**:251-5.
2. BIOQUELL trials, unpublished data.
3. Bonilla et al. 1996. *Infect Cont Hosp Epidemiol*. **17**:770-2
4. Boyce. 2007. *J Hosp Infect*. **65**:50-4.
5. Duckworth and Jordens. 1990. *J Med Microbial*. **32**:195-200.
6. French et al. 2004. *ICAAC*.
7. Kramer et al. 2006. *BMC Infect Dis*. **6**:130.
8. Otter and French. 2009. *J Clin Microbial*. **47**:205-7.
9. Smith et al. 1996. *J Med*. **27**: 293-302.
10. Wagenvoort et al. 2000. *J Hosp Infect*. **45**:231-4.
11. Wagenvoort and Joosten. 2002. *J Hosp Infect*. **52**:226-7.

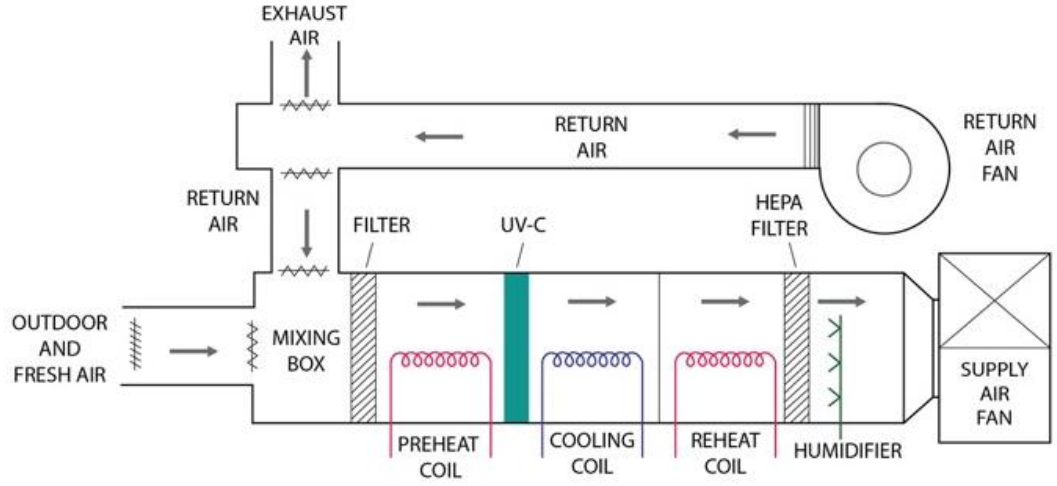
Prior Room Occupancy Increases Risk

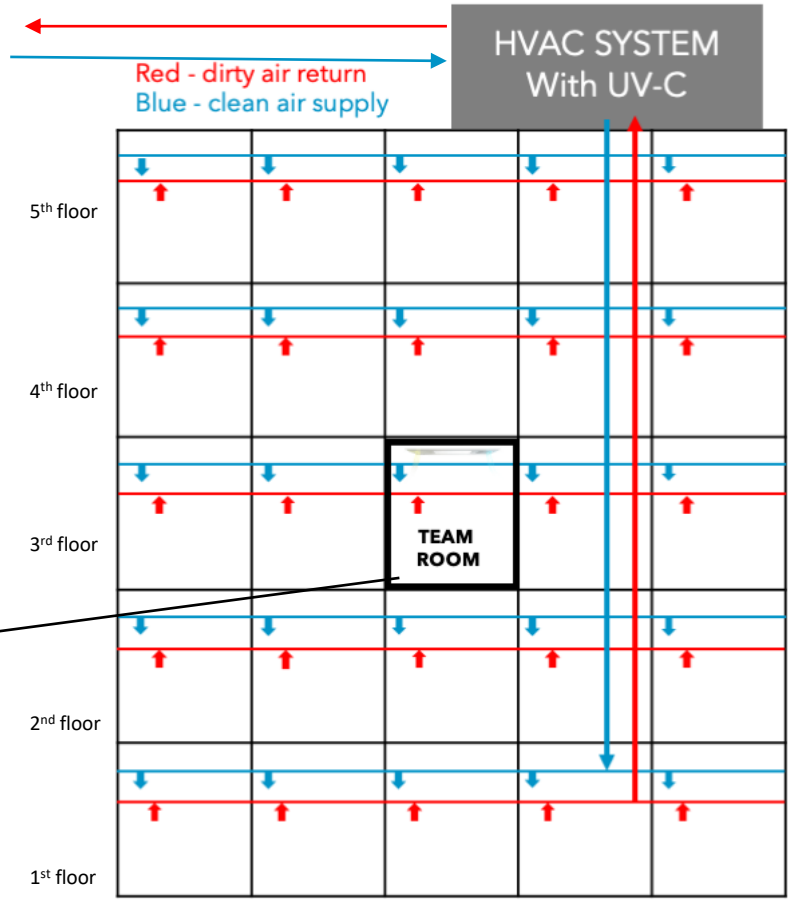
Study	Healthcare associated pathogen	Likelihood of patient acquiring HAI based on prior room occupancy (comparing previously 'positive' room with a previously 'negative' room)
Martinez 2003 [7]	VRE – cultured within room	2.6x
Huang 2006 [8]	VRE – prior room occupant	1.6x
	MRSA – prior room occupant	1.3x
Drees 2008 [9]	VRE – cultured within room	1.9x
	VRE – prior room occupant	2.2x
	VRE – prior room occupant in previous two weeks	2.0x
Shaughnessy 2008 [10]	*C. difficile* – prior room occupant	2.4x
Nseir 2010 [11]	*A. baumannii* – prior room occupant	3.8x
	P. aeruginosa – prior room occupant	2.1x

7. Matinez et al. 2003. *Arch Intern Med* 163: 1905-12.
8. Huang SS et al. 2006. *Arch Intern Med* 166: 1945-51.
9. Drees M et al. 2008. *Clin Infect Dis* **46**: 678-85.
10. Shaughnessey M et al. 2008. Eval of hospital room assignment and acquisition of C. diff diarrhea (CDAD). In: Program and Abstracts of the 48th Annual Interscience Conf. ICCAAC / ISDA 46th Annual Meeting. Abstract 14194.
11. Nseir S et al. 2011. *Clin Microbiol Infect* **17**: 1201-8.

HVAC Purpose

HVAC system supplies air for entire building.
Air travels from one source to reach all areas.



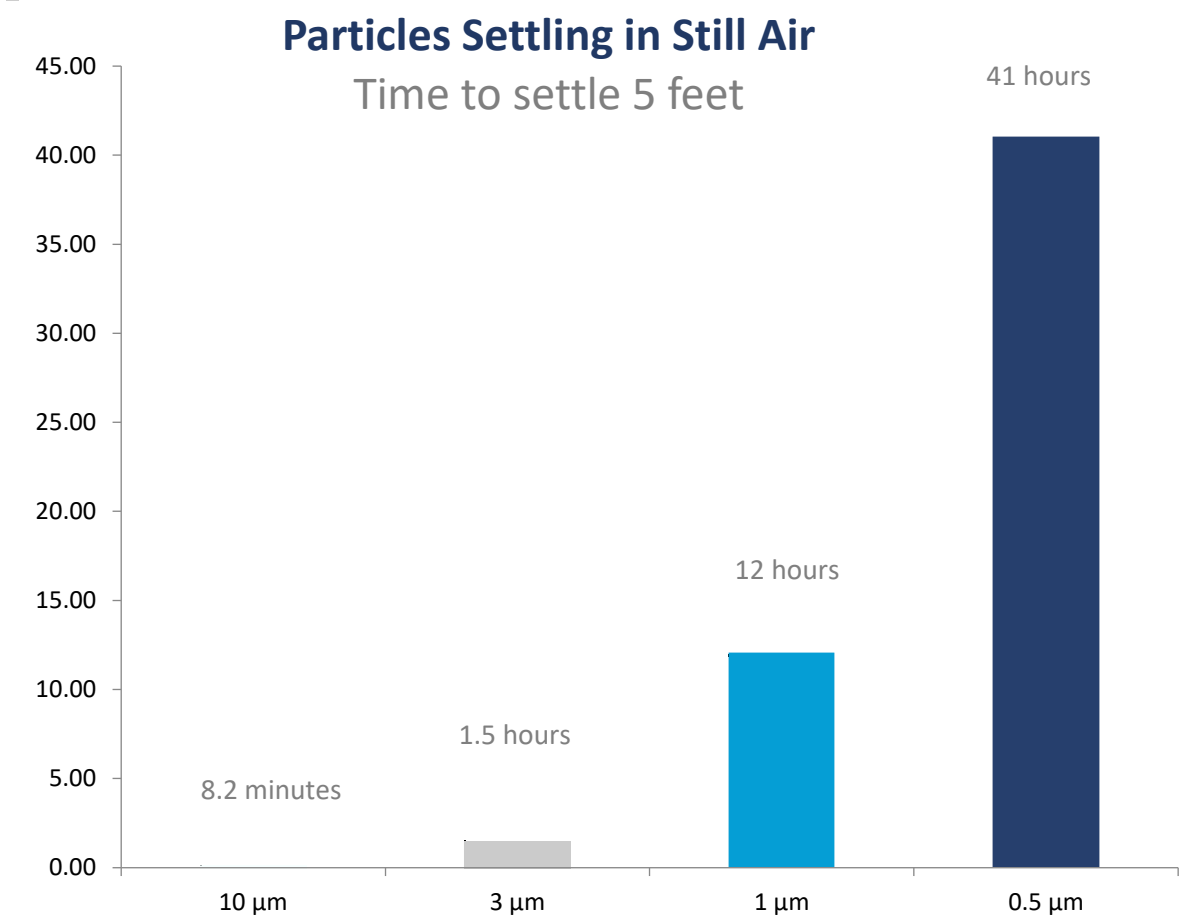


HVAC additions don't affect room level contamination which is directly correlated with the presence of people.

TEAM BREAK ROOM

Remember – Conventional HVAC creates clean air going in, but it's the people who contaminate the space!

Particles float on air



Microbe	Type	Size - µm
Paravovirus B19	Virus	0.022
Rhinovirus	Virus	0.023
Coxsakievirus	Virus	0.027
Norwalk virus	Virus	0.029
Rubella virus	Virus	0.061
Rotavirus	Virus	0.073
Reovirus	Virus	0.075
Adenovirus	Virus	0.079
Influenza A virus	Virus	0.098
Coronavirus (SARS)	Virus	0.110
Measles virus	Virus	0.158
Mumps virus	Virus	0.164
VZV	Virus	0.173
Mycoplasma pneumoniae	Bacteria	0.177
RSV	Virus	0.190
Parainfluenza virus	Virus	0.194
Bordetella pertussis	Bacteria	0.245
Haemophilus influenzae	Bacteria	0.285
Proteus mirabilis	Bacteria	0.494
Pseudomonas aeruginosa	Bacteria	0.494
Legionella pneumophila	Bacteria	0.520
Serratia marcescens	Bacteria	0.632
Mycobacterium tuberculosis	Bacteria	0.637
Klebsiella pneumoniae	Bacteria	0.671
Corynebacterium diphtheriae	Bacteria	0.698
Streptococcus pneumoniae	Bacteria	0.707
Neisseria meningitidis	Bacteria	0.775
Staphylococcus aureus	Bacteria	0.866
Staphylococcus epidermis	Bacteria	0.866
Streptococcus pyogenes	Bacteria	0.894
Clostridium perfringens spores	Bacteria	1.000
Mycobacterium avium	Bacteria	1.118
Nocardia asteroides	Bacteria	1.118
Acinetobacter	Bacteria	1.225
Enterobacter cloacae	Bacteria	1.414
Enterococcus	Bacteria	1.414
Haemophilus parainfluenzae	Bacteria	1.732
Clostridium difficile spores	Bacteria	2.000
Aspergillus spores	Fungi	3.354
Cryptococcus neofrmans spores	Fungi	4.899
Rhizopus spores	Fungi	6.928
Mucor spores	Fungi	7.071
Fusarium spores	Fungi	11.225
Blastomyces dermatitidis spores	Fungi	12.649

National Institute for Occupational Safety and Health NIOSH

Regulatory

The intent of the presentation is to provide highlights and an overview of regulations/standards.. This presentation is not intended to supplement the requirements or be all-encompassing of the requirements of ASHRAE 241 or any other requirements by ASHRAE or authority having jurisdiction. It is also not intended to avoid or circumvent any health, safety, or comfort regulations required by an *authority having jurisdiction*. This presentation in no way is a substitute for a copy of the full ASHRAE standard.

***The opinions presented here are those of UV Angel and not specifically ASHRAE.**

ASHRAE 170

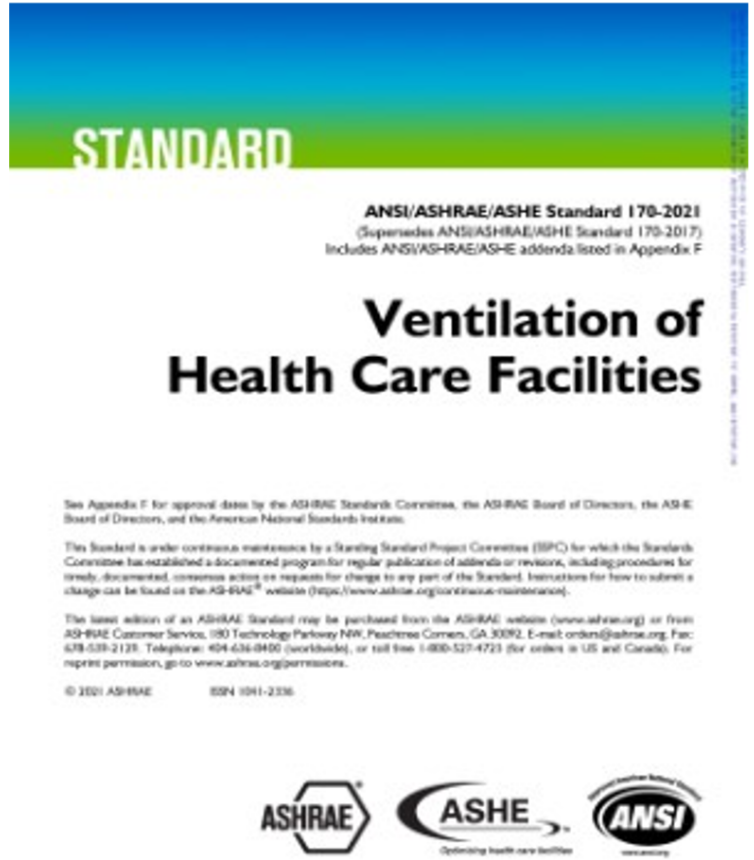
2. SCOPE

2.1 The requirements in this standard apply to patient care areas, resident care areas, and related support areas within health care facilities.
2.2 This standard applies to new buildings, additions to existing buildings, and those alterations to existing buildings that are identified within this standard.
2.3 This standard considers chemical, physical, and biological contaminants that can affect the delivery of medical care to patients and residents; the convalescence of patients and residents; and the safety of patients, residents, health care workers, and visitors.
2.4 This standard establishes design requirements for temperature and humidity.
2.5 This standard establishes design requirements for odor control and asepsis.
2.6 This standard establishes design requirements for ventilation rates, including, but not limited to, outdoor air to serve health care facilities.
2.7 This standard does not establish comprehensive thermal comfort design requirements.

Requirement for:
airborne infection isolation (AII): the isolation of patients infected with organisms spread by airborne droplet nuclei less than 5 µm in diameter. For the purposes of this standard, the abbreviation "AII" refers to the room that provides isolation. ***Informative Note:*** See FGI [2018a, 2018b, 2018c], CDC [2003], and CDC [2005] in Informative Appendix E.)

airborne infection isolation (AII) room: a room that is designed according to the requirements of this standard and that is intended to provide airborne infection isolation.

infection control risk assessment (ICRA): a determination of the potential risk of transmission of various infectious agents in the facility, a classification of those risks, and a list of required practices for mitigating those risks during construction or renovation.



ASHRAE 170 (Example of Requirements)

Table 7-1 Design Parameters—Inpatient Spaces

Function of Space (ee)	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)	Unoccupied Turndown	Minimum Filter Efficiencies (cc)	Design Relative Humidity (k), %	Design Temperature (l), °F/°C
NURSING UNITS AND OTH & ER PATIENT CARE AREAS									
AII anteroom *(FGI 2.1–2.4.2.3)* (u)	(e)	NR	10	Yes	No	Yes	MERV-8	NR	NR
AII room *(FGI 2.1–2.4.2)* (u)	Negative	2	12	Yes	No	Yes	MERV-14	Max 60	70–75/21–24
Cesarean Delivery room *(FGI 2.2–2.9.11.1)* (m), (o)	Positive	4	20	NR	No	Yes	MERV-16	20–60	68–75/20–24
Combination AII/PE anteroom *(FGI 2.2–2.2.4.5)*	(e)	NR	10	Yes	No	No	HEPA	NR	NR
Combination AII/PE room *(FGI 2.2–2.2.4.5)*	Positive	2	12	Yes	No	No	HEPA	Max 60	70-75/21-24
Continued care nursery *(FGI 2.2–2.10.3.2)*	N/R	2	6	N/R	No	Yes	MERV-14	30–60	72–78/22–26
Critical care patient care station *(FGI 2.2–2.6.2)*	NR	2	6	NR	No	Yes	MERV-14	30–60	70–75/21–24
Emergency department exam/treatment room *(FGI 2.2–3.1.2.6 & 2.2–3.1.3.6)* (p)	NR	2	6	NR	NR	Yes (ff)	MERV-14	Max 60	70–75/21–24
Emergency department human decontamination *(FGI 2.2–3.1.3.6[8])*	Negative	2	12	Yes	No	Yes (ff)	MERV-14	NR	NR
Emergency department public waiting area *(FGI 2.2–3.1.2.4 & 2.2-3.1.3.4)*	Negative	2	12	Yes (q)	NR	Yes (ff)	MERV-8	Max 65	70–75/21–24
Emergency department trauma/resuscitation room *(FGI 2.2–3.1.3.6[4])* (c)	Positive	3	15	NR	No	Yes	MERV-14	20–60	70–75/21–24
Emergency service triage area *(FGI 2.2–3.1.3.3)*	Negative	2	12	Yes (q)	NR	Yes (ff)	MERV-8	Max 60	70–75/21–24
Intermediate care patient room *(FGI 2.2–2.5)* (s)	NR	2	6	NR	NR	Yes	MERV-14	Max 60	70–75/21–24
Labor/delivery/recovery (LDR) *(FGI 2.2–2.9.3)* (s)	NR	2	6	NR	NR	Yes	MERV-14	Max 60	70–75/21–24
Labor/delivery/recovery/postpartum (LDRP) *(FGI 2.2–2.9.3)* (s)	NR	2	6	NR	NR	Yes	MERV-14	Max 60	70–75/21–24
Laser eye room *(FGI Table T2.2-1)*	Positive	3	15	NR	No	Yes	MERV-14	20–60	70–75/21–24
Neonatal intensive care *(FGI 2.2–2.8)*	Positive	2	6	NR	No	Yes	MERV-14	30–60	72–78/22–26
Newborn nursery *(FGI 2.2–2.10.3.1)*	NR	2	6	NR	No	Yes	MERV-14	30–60	72–78/22–26
Nourishment area or room *(FGI 2.1–2.8.9)*	NR	NR	2	NR	NR	Yes	MERV-8	NR	NR
Nursery workroom *(FGI 2.2–2.10.8.5)*	NR	2	6	NR	No	Yes	MERV-8	Max 60	72–78/22–26
Operating room *(FGI 2.2–3.3.3)* (m), (o)	Positive	4	20	NR	No	Yes	MERV-16 (hh)	20–60	68–75/20–24

Informative Notes: (1) NR = no requirement; (2) FGI paragraph numbers are shown in parentheses in the "Function of Space" column.

USP 797

USP 797 refers to chapter 797 “Pharmaceutical Compounding – Sterile Preparations” in the USP National Formulary. It is the first set of enforceable sterile compounding standards issued by the United States Pharmacopeia (USP).

It describes the guidelines, procedures and compliance requirements for compounding sterile preparations and sets the standards that apply to all settings in which sterile preparations are compounded.

USP applies to the compounding of both hazardous and non-hazardous drugs

Prevent Patient Harm From

- Microbial contamination
- Excessive bacterial endotoxins
- Variability in the intended strength of correct ingredients
- Unintended chemical and physical contaminants
- Ingredients of inappropriate quality

Clean Air Challenge

“Clean Air in Buildings Challenge” from the group: the CDC, White House, EPA, and DOE.

1. Optimize Fresh Air Ventilation

2. Enhance Air Filtration

3. UVGI

ASHRAE 241 - Key Take Aways

Standard 241 is a companion standard to 62.1, 62.2, 170, and others.

First standard ventilation rates based on infectious aerosol modeling.

First ASHRAE standard on infectious aerosols

Building Readiness Plan

Temporary isolation areas
Masking protocols
Risk models (known infectious)
Documentation of special operation procedures when in IRMM mode.

Air Distribution

Select air cleaners appropriately for the type of air distribution pattern delivered by the ventilation system
Infectious aerosol modeling
There are no more air change per hour (ACH) numbers.
Don't throw away your clean air (Figure 6-1)

The intent of the presentation is to provide highlights and an overview of ASHRAE 241. This presentation is not intended to supplement the requirements or be all-encompassing of the requirements of ASHRAE 241 or any other requirements by ASHRAE or authority having jurisdiction. It is also not intended to avoid or circumvent any health, safety, or comfort regulations required by an *authority having jurisdiction*. This presentation in no way is a substitute for a copy of the full ASHRAE standard. ***The opinions presented here are those of UV Angel and not specifically ASHRAE.**

ASHRAE 241 Key Take Aways (cont.)

Air Cleaning

- Every cleaner must be rated and tested
- how air cleaners should be deployed
- testing air cleaners for performance and safety (specifically, hazards from air cleaner emissions – primary and secondary) and requirements for determining the contribution to meeting the required equivalent clean air target
- requirements for air cleaners are technology agnostic – they apply to all equally
- Consensus testing standards are referenced and methods for testing equipment not subject to existing standards are provided.

ASHRAE 241 Key Take Aways (cont.)

- **Requirements for assessment, planning, operation, and maintenance**
  - defines the process for determining the need for upgrades and what upgrades should be selected, defining what special operating procedures are needed in IRMM
  - systems fail to perform not because of design flaws, but because they have not been maintained properly, new requirements for testing (to the extent possible) the installed performance of systems and provides informative guidance on how to do in-situ testing
- **Equivalent Clean Air Rate**
  - Key Performance target
  - Multiple options in each room
  - No room pressure requirements
  - There are no more air change per hour (ACH) numbers
- ASHRAE Standard 241 is a continuous maintenance standard.
- Changes are coming
- Adoption

Equivalent Clean Airflow For Infection Risk Mitigation

Minimum *Equivalent Outdoor Airflow* per person for in Breathing Zone in IRMM Occupancy Category

Occupancy category	EOAi	
	CFM/person	L/s/person
Correctional Facilities		
Cell	30	15
Dayroom	40	20
Commercial/Retail		
Food & Beverage Facilities	60	30
Gym	80	40
Office	30	15
Retail	40	20
Transportation Waiting	60	30
Educational Facilities		
Classroom	40	20
Lecture Hall	60	30
Industrial		
Manufacturing	50	25
Sorting, Packing, Light Assembly	20	10
Warehouse	20	10

Occupancy category	EOAi	
	CFM/person	L/s/person
Healthcare		
Exam Room	40	20
Group Treatment Area	70	35
Patient Room	70	35
Resident Room	50	25
Waiting Room	90	45
Public Assembly/Sports & Entertainment		
Auditorium	50	25
Place of Religious Worship	50	25
Museum	60	30
Convention	60	30
Spectator Area	50	25
Lobbies	50	25
Residential		
Common Space	50	25
Dwelling Unit	30	15

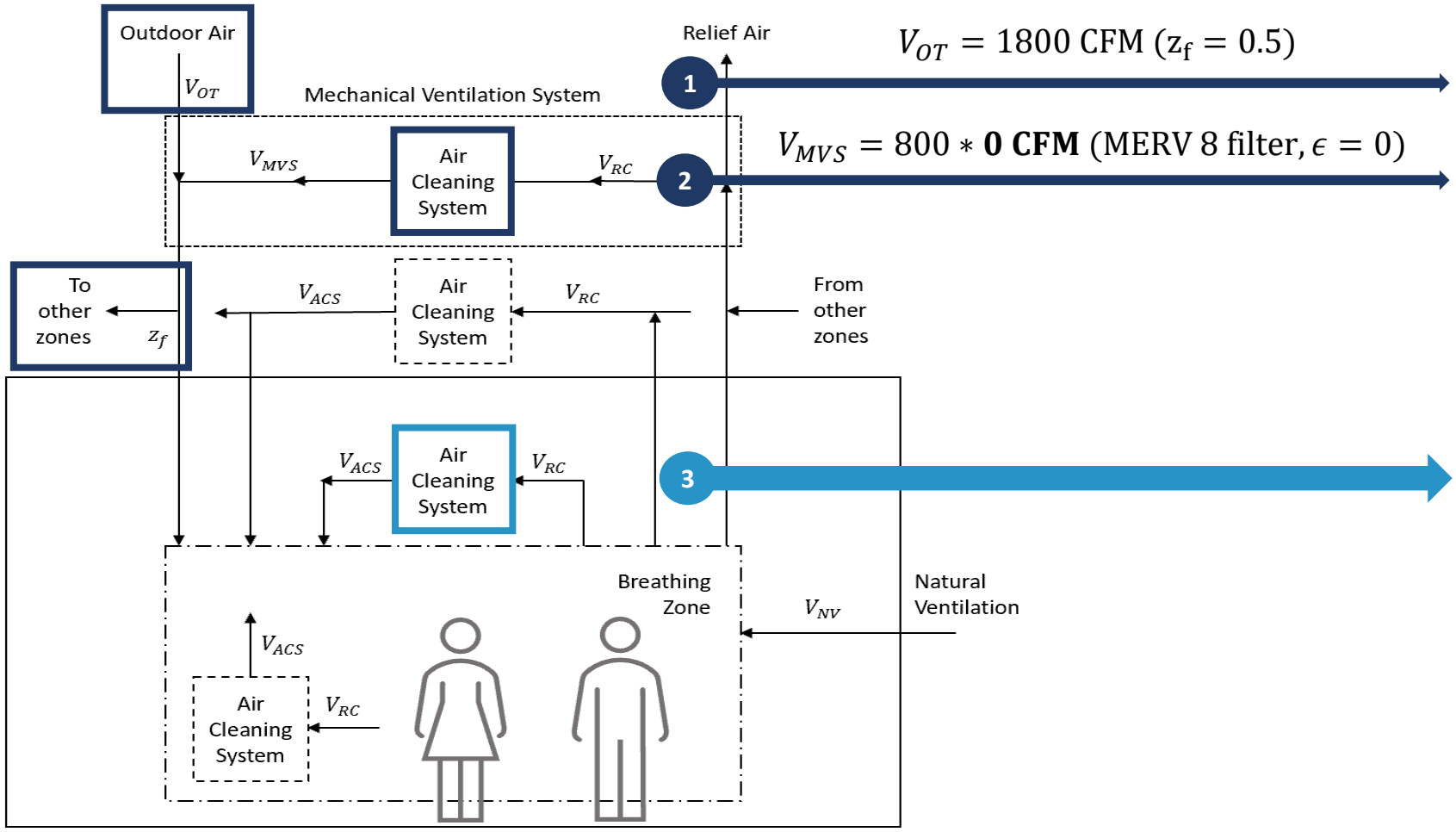
EQ Clean Airflow For IRMM

ER Waiting Room

Example: 30 people

- 90 cfm per person (IRMM) = 2,700 cfm Total

1. Mechanical HVAC
2. In Duct
3. In Room



Outside Air
0.5 x 1800=900

Recirculated Clean Air = 0

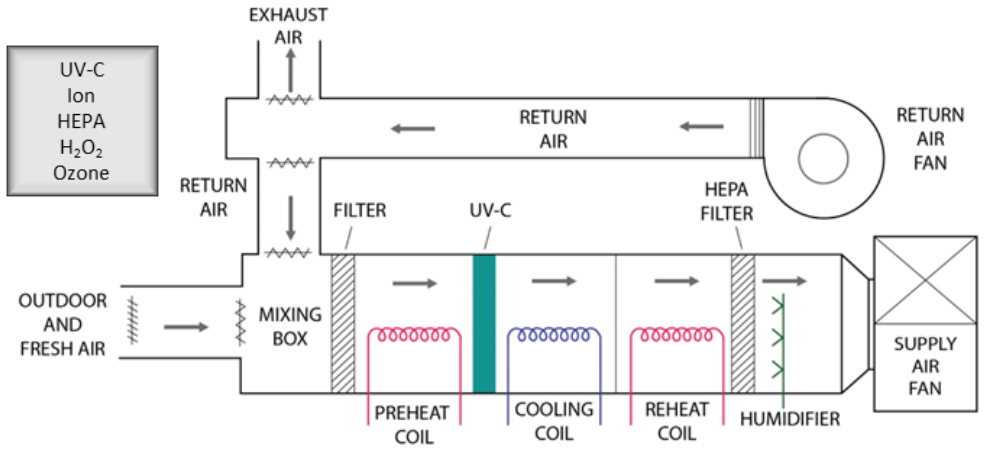
In Room = 2,000 cfm

Total = 2,900 cfm

ASHRAE Standard 62.1

"ASHRAE has determined that HVAC ventilation rates in commercial buildings, **do not address transmission of airborne viruses, bacteria, and other infectious contagions"**

Building HVAC systems supply air for entire building and air travels from one source to reach ALL areas. The systems are not designed to destroy pathogens at the occupied room level



Engineering Controls
Episodic vs Continuous

SOLUTION

Engineered Source - Control

Engineering Controls – by design protect people by automatically eliminating hazards or reduce exposure to hazards, without human intervention. At UV Angel we focus on the development of intelligent automated engineered-controls for infection prevention & control

OSHA®

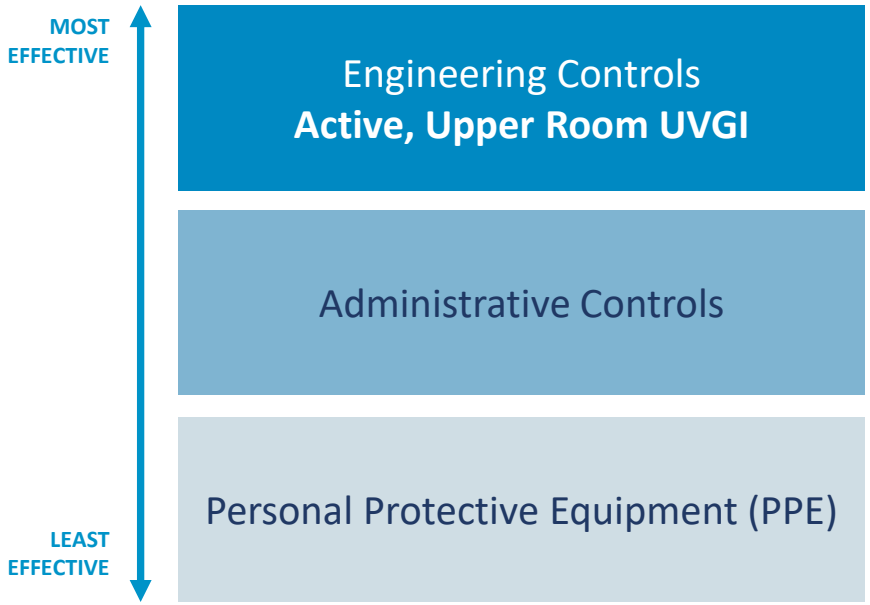
The most effective protection measures are listed in the table to the right (from most effective to least effective). In most cases, a combination of control measures will be necessary to protect workers from exposure to SARS-CoV-2. Engineering controls reduce exposure to hazards without relying on worker behavior and can be the most cost-effective solution to implement.

CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION

Recommends using ultraviolet germicidal irradiation (UVGI) as a supplement to help inactivate the virus.

ASHRAE®

Strongly recommend; good evidence –Upper-room UVGI as a supplement to supply airflow



Important Decision Criteria

Environmental Mitigation Approach:

ADDITIVE vs SUBTRACTIVE

Upper Room Applications:

ACTIVE vs PASSIVE

UV-C Wavelengths for Occupied Spaces:

SHIELDED UVC 254 vs UNSHIELDED UVC 222

Episodic Routine Controls – Use a Layered Approach – Continuous Automated

Cleaning typically happens when people are not present…

Yet people are the major source of disease transmission and contamination…

The room environment gets contaminated again after the people re-occupy the space…

EPISODIC CLEANING – EVEN WITH BEST INTENT ERRORS EXIST

The laboratory vs. the real world + continuous treatment

Laboratory Versus Real-Word Settings

"A person typically sheds some **37 million bacteria** into the surrounding air or onto surfaces touched."

Kills 99.99%?
Small Snapshot

Treatment technology in a lab setting

Constant Loading

Hospital without continuous treatment technology

Continuous Cleaning =
Continuous Reduction

Hospital with continuous treatment technology

Designing a Hospital to Better Fight Infection - April 27, 2015 – By Robert Lee Hotz - The Wall Street Journal

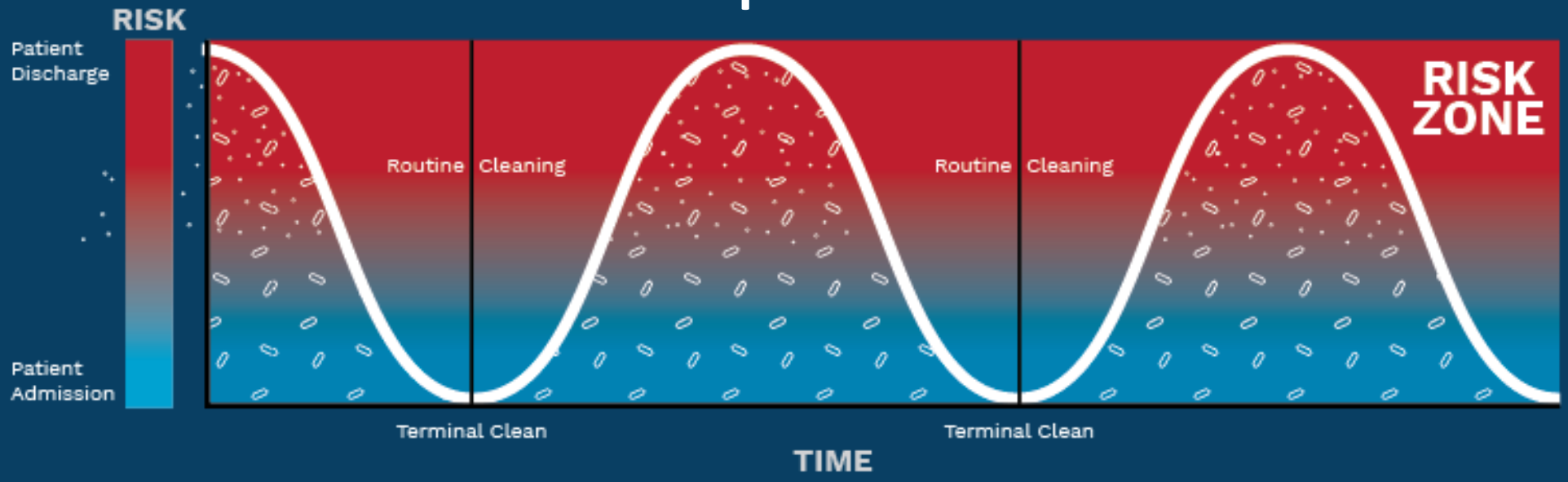
Why should you be concerned

- Often good to visualize this to truly understand – but essentially if I have 10,000 E.coli – after using a product there should be roughly 1 left.
- Now – Given the fact that E.coli has a doubling time (1 -> 2, 2->4) of 20 minutes. That 1 E.coli that survived that initial volley of germicidal will become 2.1 million in 7 hours. After just one more hour it becomes 16.8 million strong.[1]
- We apply our device that's "99.99%" effective – and now we've brought the load down from 2.2 billion to 220,000 colony forming units.
- So, while 99.99% is very good – it's important understand it's application in microbiology as the 99.xx% term is thrown around quite a bit.

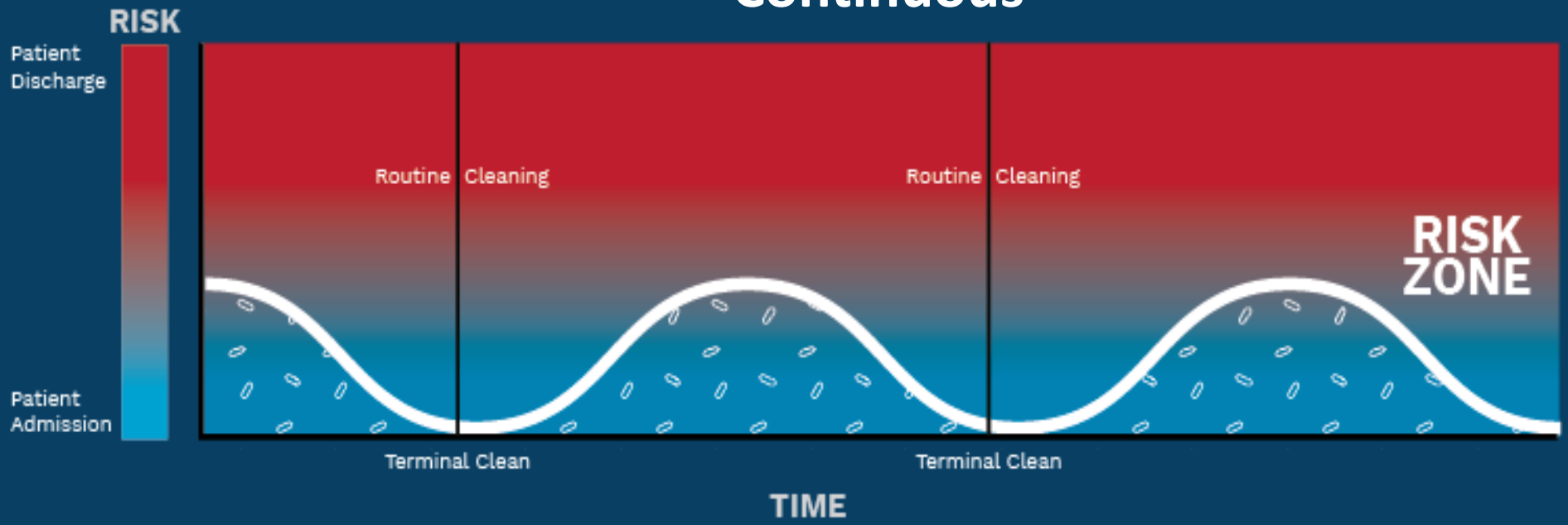
1. https://microbiologysociety.org/why-microbiology-matters/what-is-microbiology/bacteria.html Compliments of Nicholas Unger, Intertek

Episodic Cleaning Protocols Have Inherent Risk

Episodic



Continuous



What Air and Surface Environmental Sampling Tells Us

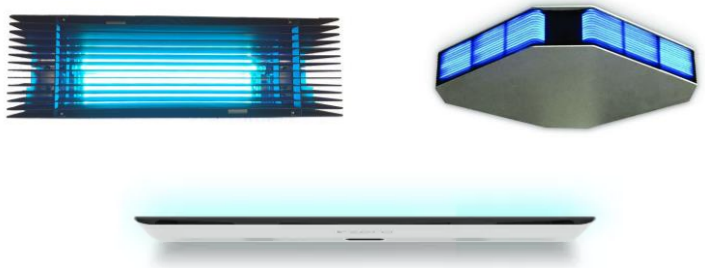
THE INVISIBLE THREAT

CONTAMINATED AIR

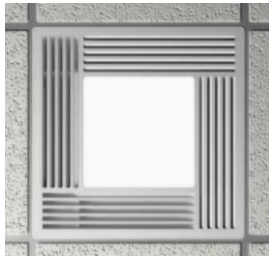
What to do about it?
Active Upper-Room UVGI Technology

UVGI Disinfection Products

Passive Upper Room UV



Active Upper Room UVGI

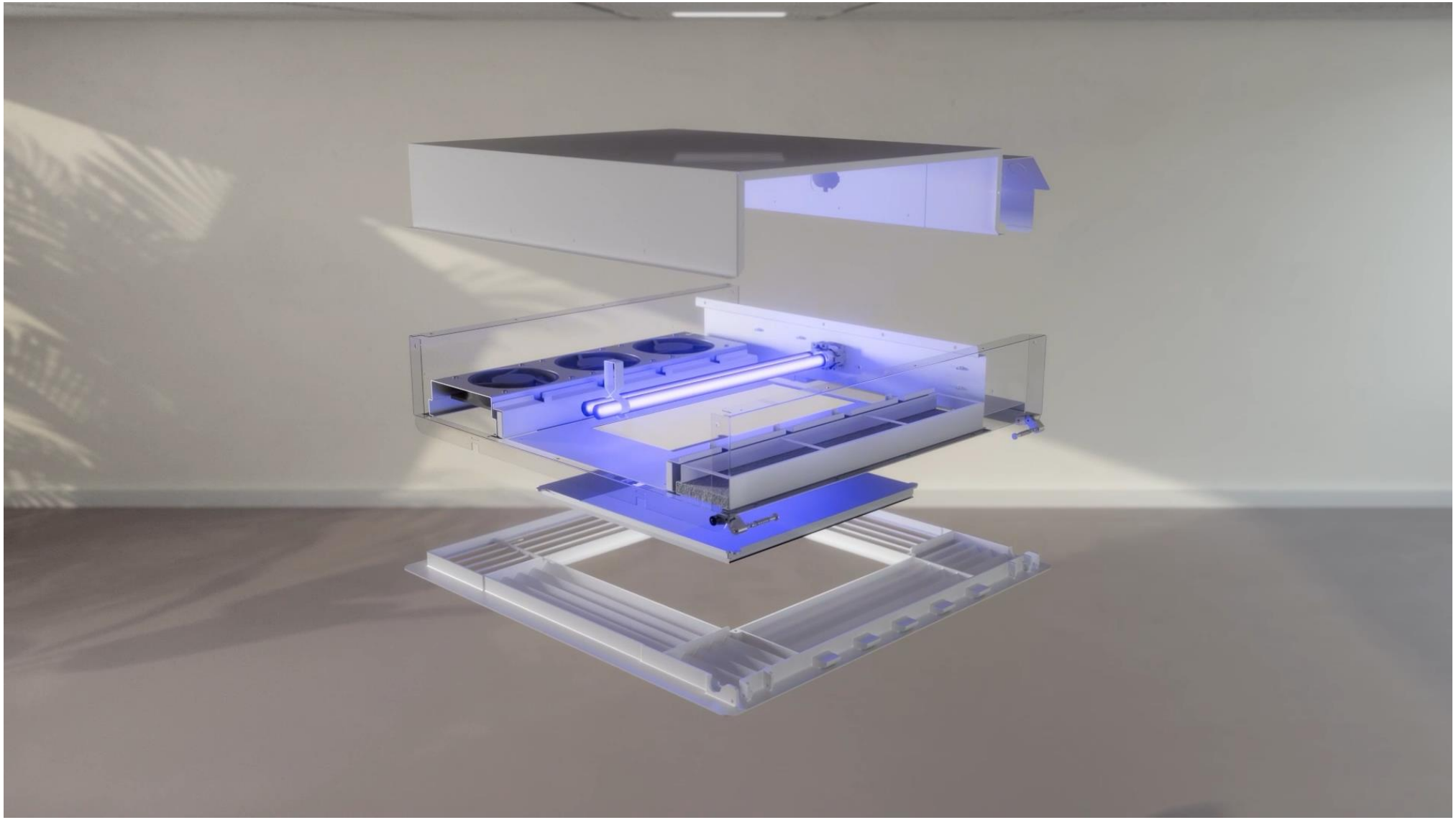


Whole Room Surface (Episodic)

Passive Surface (222)

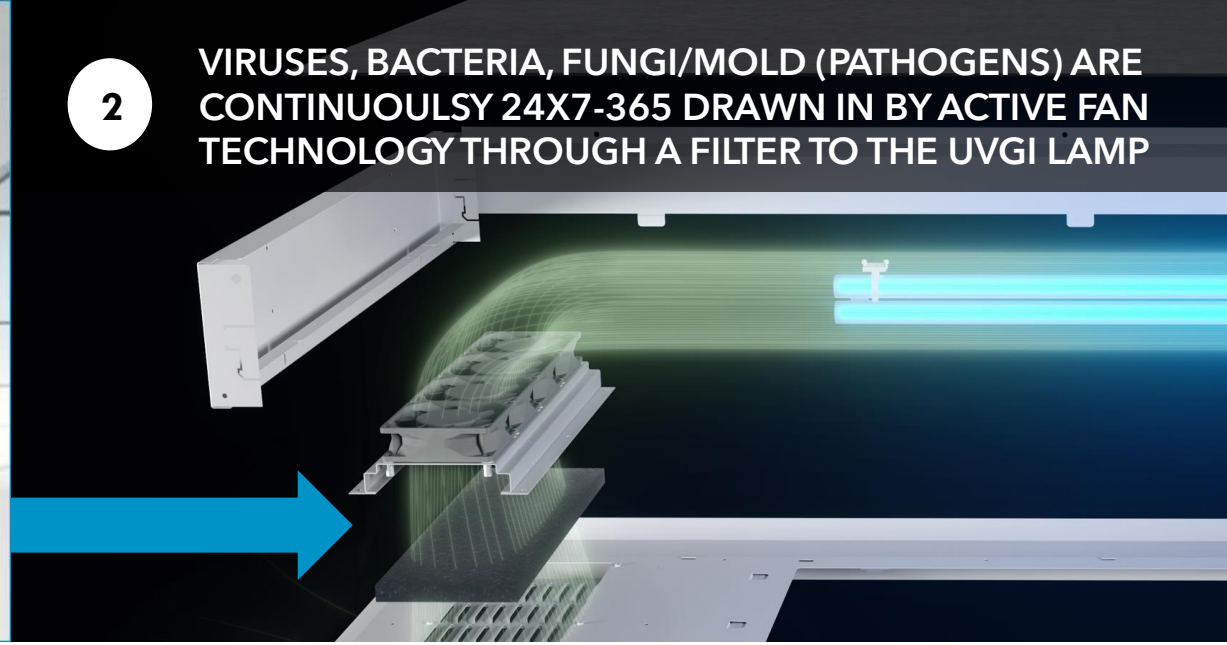
HVAC Air Handler

Active Upper Room UVGI



1 OPERATING SEPARATE FROM HVAC - ROOM AIR IS ACTIVLY DRAWN IN WITH FANS INTO THE SEALED UPPER ROOM UVGI DISENFECTION CHAMBER

2 VIRUSES, BACTERIA, FUNGI/MOLD (PATHOGENS) ARE CONTINUOULSY 24X7-365 DRAWN IN BY ACTIVE FAN TECHNOLOGY THROUGH A FILTER TO THE UVGI LAMP

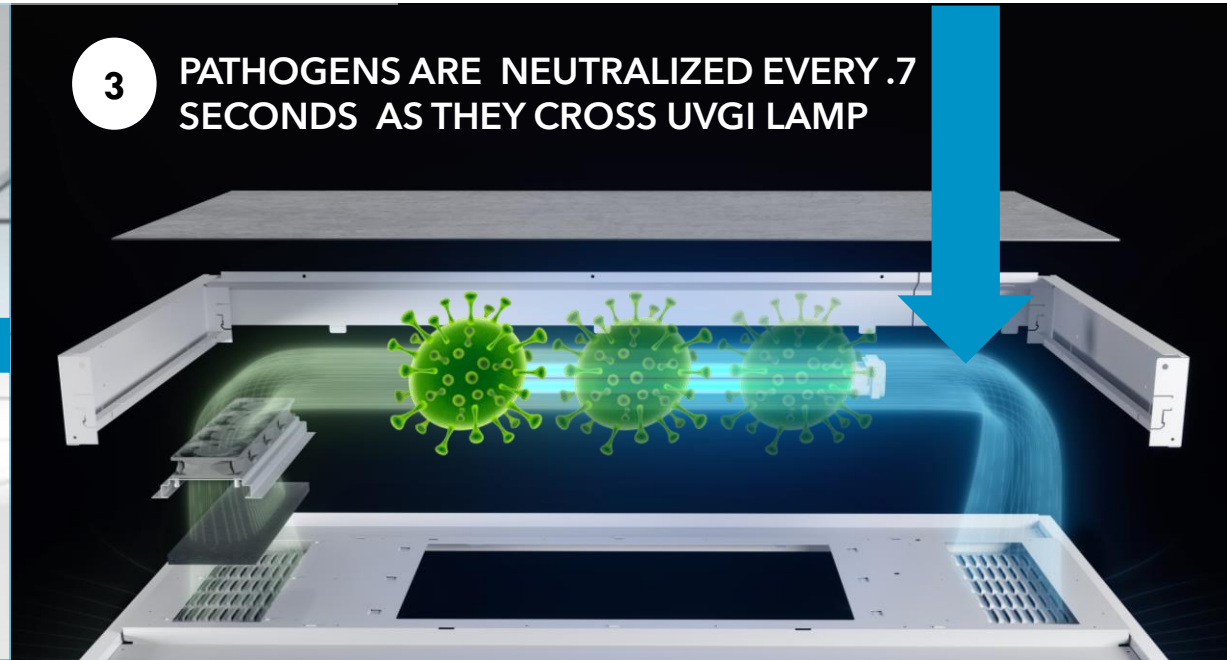


HOW IT WORKS

4 CLEAN, DISENFECTED AIR IS GENTLY RETURNED BACK TO THE ROOM

84,000 TIMES A DAY HIGH-INTENSITY UVGI IS DISENFECTING ROOM AIR FROM VIRUSES, BACTERIA, FUNGI/MOLD

3 PATHOGENS ARE NEUTRALIZED EVERY .7 SECONDS AS THEY CROSS UVGI LAMP



How to Evaluate Technologies

Good Science Should Drive Clarity

The Importance of Technology Due Diligence

1. Review results that should include ***independent third-party laboratory studies***

2. Review ***company and user testimonial testing documentation of use in real-world*** applications

3. Review results that should include ***peer-reviewed published studies*** that show the effectiveness of actual use cases

Get The Facts – Step 1

Test conclusively support that Active Upper Room UVGI treats bacteria fungus and viruses in the air, including:

Gram negative and gram-positive bacteria, fungal pathogens and viral surrogates and SARS CoV2. Active Upper Room UVGI results show elimination rates up to 99.9%.

39

Company Information and Additional Information

Table 4: Combined UV + Filter Removal Rates					
Microbe	Type	Size µm	Filter %	UV Rate %	Total %
Acinetobacter	Bacteria	1.225	21	100	100.00
Adenovirus	Virus	0.079	9	100	100.00
Aeromonas	Bacteria	2.098	35	100	100.00
Aspergillus	Fungi	3.354	45	93	96.30
Bacillus anthracis	Bacteria	1.118	19	61	68.20
Bacteroides fragilis	Bacteria	3.162	44	100	100.00
Blastomyces dermatitidis	Fungi	12.649	50	99	99.65
Bordetella pertussis	Bacteria	0.245	4	100	100.00
Burkholderia cenocepacia	Bacteria	0.707	11	100	100.00
Burkholderia mallei	Bacteria	0.674	10	100	100.00
Burkholderia pseudomallei	Bacteria	0.494	7	100	100.00
Candida albicans	Fungi	4.899	49	79	89.19
Candia auris	Fungi	4.899	49	75	87.31
Chlamydia pneumoniae	Bacteria	0.548	8	100	100.00
Chlamydophila psittaci	Bacteria	0.283	4	100	100.00
Cladosporium	Fungi	8.062	50	98	98.75
Clostridium botulinum	Bacteria	1.975	33	100	100.00
Clostridium difficile	Bacteria	2	34	100	100.00
Clostridium perfringens	Bacteria	5	49	100	100.00
Coronavirus (Wuhan)	Virus	0.11	6	100	100.00
Corynebacterium diphtheriae	Bacteria	0.698	10	100	100.00
Coxsackievirus	Virus	0.027	19	100	100.00
Cryptococcus neoformans	Fungi	4.899	49	99	99.67
Curvularia lunata	Fungi	11.619	50	71	85.57
Ebola virus	Virus	0.09	8	100	100.00
Echovirus	Virus	0.024	20	100	99.89
E. coli	Virus	0.5	7	100	100.00
Enterobacter cloacae	Bacteria	1.414	24	100	100.00
Enterococcus	Bacteria	1.414	24	100	100.00
Enterococcus faecalis	Bacteria	0.707	11	100	100.00
Francisella tularensis	Bacteria	0.2	4	91	91.49
Fusarium	Fungi	11.225	50	92	96.23
Haemophilus influenzae	Bacteria	0.285	4	100	100.00
Haemophilus parainfluenzae	Bacteria	1.732	30	100	99.99
Hantaan virus	Virus	0.096	7	100	100.00
Helicobacter pylori	Bacteria	2.1	35	100	100.00
Histoplasma capsulatum	Fungi	2.236	36	99	99.56
Influenza A virus	Virus	0.098	7	100	100.00
Junin virus	Virus	0.122	6	100	100.00
Klebsiella pneumoniae	Bacteria	0.671	10	100	100.00
Lassa virus	Virus	0.122	6	100	100.00
LCV	Virus	0.087	8	100	100.00
Legionella pneumophila	Bacteria	0.52	7	100	100.00
Listeria monocytogenes	Bacteria	0.707	11	99	98.98

Table 4: Combined UV + Filter Removal Rates

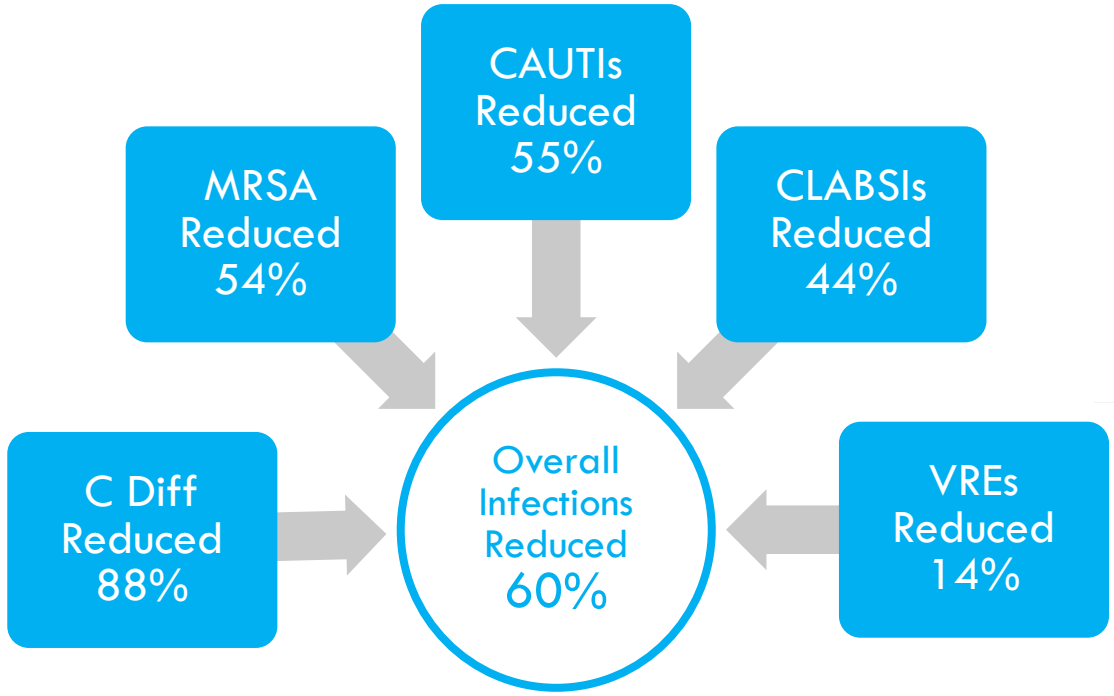
Microbe	Type	Size µm	Filter %	UV Rate %	Total %
Marburg virus	Virus	0.039	15	100	100.00
Measles virus	Virus	0.158	5	100	100.00
MERS virus	Virus	0.11	6	89	90
Mucor	Fungi	7.071	50	95	98
Mumps virus	Virus	0.164	5	100	100
Mycobacterium avium	Bacteria	1.118	19	100	100
Mycobacterium kansasii	Bacteria	1.118	19	100	100
Mycobacterium tuberculosis	Bacteria	0.637	9	100	100
Mycoplasma pneumoniae	Bacteria	0.177	5	100	100
Neisseria meningitidis	Bacteria	0.775	12	100	100
Nocardia asteroides	Bacteria	1.118	19	100	100
Norwalk virus	Virus	0.029	18	97	98
Parainfluenza virus	Virus	0.194	4	100	100
Parvovirus B19	Virus	0.022	21	100	100
Penicillium	Fungi	3.262	44	60	78
Proteus mirabilis	Bacteria	0.494	7	100	100
Pseudomonas aeruginosa	Bacteria	0.494	7	100	100
Reovirus	Virus	0.075	9	99	99
RSV	Virus	0.19	5	100	100
Rhinovirus	Virus	0.023	21	99	99
Rhizopus	Fungi	6.928	50	93	96
Rickettsia prowazeki	Bacteria	0.6	9	100	100
Rotavirus	Virus	0.073	9	100	100
Rubella virus	Virus	0.061	11	67	71
Salmonella typhi	Bacteria	0.806	13	100	100
SARS virus	Virus	0.11	6	100	100
Serratia marcescens	Bacteria	0.632	9	100	100
Stachybotrys chartarum	Fungi	5.623	49	12	55
Staphylococcus aureus	Bacteria	0.866	14	100	100
Staphylococcus epidermis	Bacteria	0.866	14	100	100
Streptococcus pneumoniae	Bacteria	0.707	11	77	80
Streptococcus pyogenes	Bacteria	0.894	14	100	100
Trichophyton	Fungi	4.899	49	71	85
Ustilago	Fungi	5.916	50	46	73
VZV	Virus	0.173	5	100	100
Yersinia pestis	Virus	0.707	11	100	100

AIR: PUBLISHED DATA

Study Departments – Pharmacy, OR, ICU, Nursing Home VU, Outpatient Clinic

Infection Reduction Results - Hospital

ICU, KY




ARTICLE IN PRESS

American Journal of Infection Control

Major Article

Cleaning the air with ultraviolet germicidal irradiation lessened contact infections in a long-term acute care hospital

Tina Ethington MSN, RN, CEN, NE-BC, Sherry Newsome BSN, RN, MBA/MNA, Jerri Waugh BSN, RN, MBA/MHA, Linda D. Lee DrPH, MBA

EMERGING TECHNOLOGIES

Surface and air: What impact does UV-C at the room level have on airborne and surface bacteria?

Linda D. Lee, DrPH, MS, MBA, Executive Vice President and Chief Science Officer, VidaShield

ARTICLE IN PRESS

American Journal of Infection Control

Brief Report

Effectiveness of a shielded ultraviolet C air disinfection system in an inpatient pharmacy of a tertiary care children's hospital

EMERGING TECHNOLOGIES

UV-C light and infection rate in a long term care ventilator unit

Douglas W. Kane, MD, Cynthia Finley, RRT, Diane Brown, RRT

ARTICLE IN PRESS

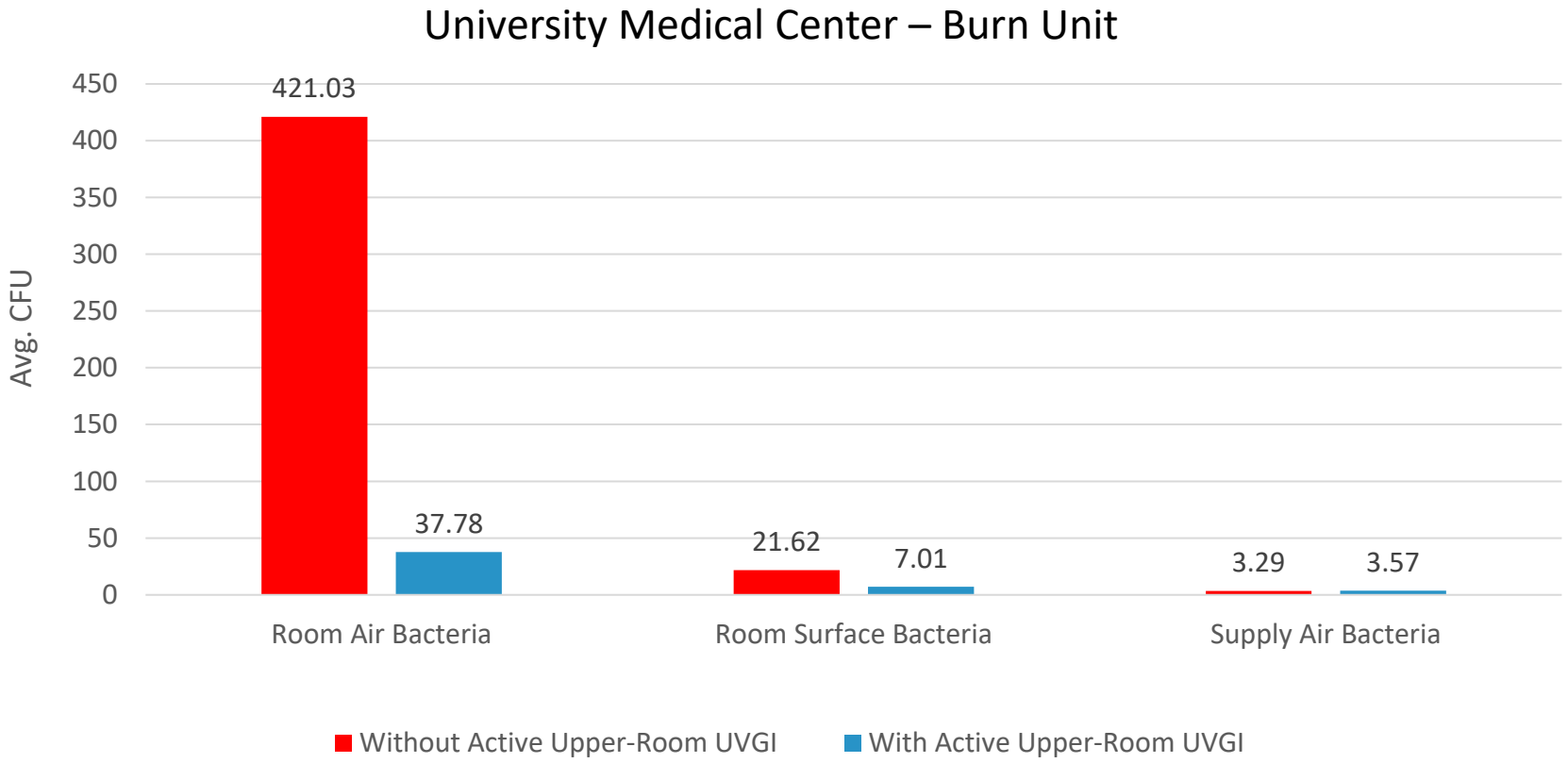
American Journal of Infection Control

Major Article

Effect of a shielded continuous ultraviolet-C air disinfection device on reduction of air and surface microbial contamination in a pediatric oncology outpatient care unit

Hana Hakim MD, MS, CIC, Craig Gilliam BS, CIC, FAPIC, Li Tang PhD, Jiahui Xu MSPH, Linda D. Lee DrPh, MBA

Pre & Post Testing Study Summary



91% overall reduction of Room Air Bacteria.

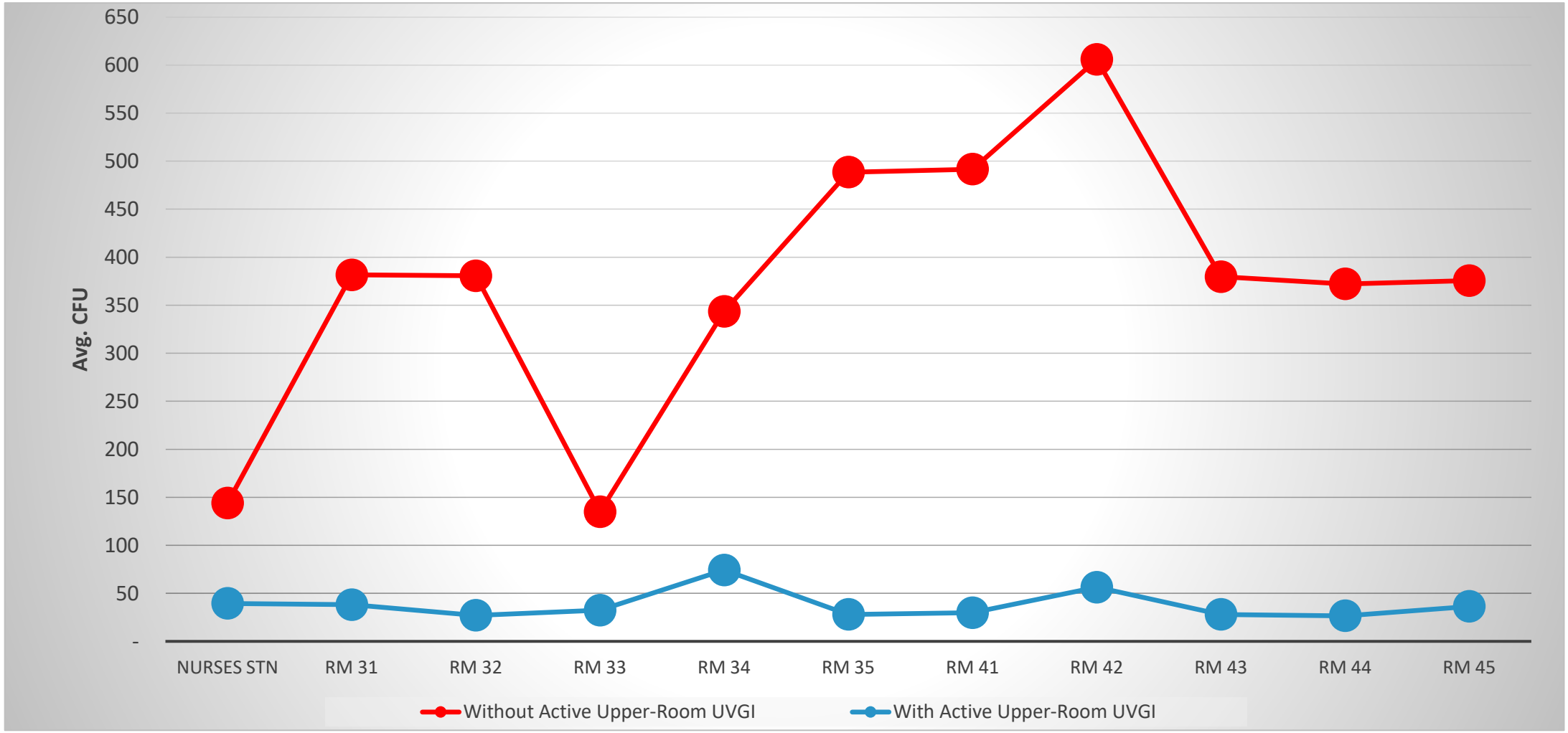
68% overall reduction of Room Surface Bacteria.

Virtually no change in bacteria counts in air supplied to the room.

*The Air, Surface and Supply Bacteria is reported in CFU's.

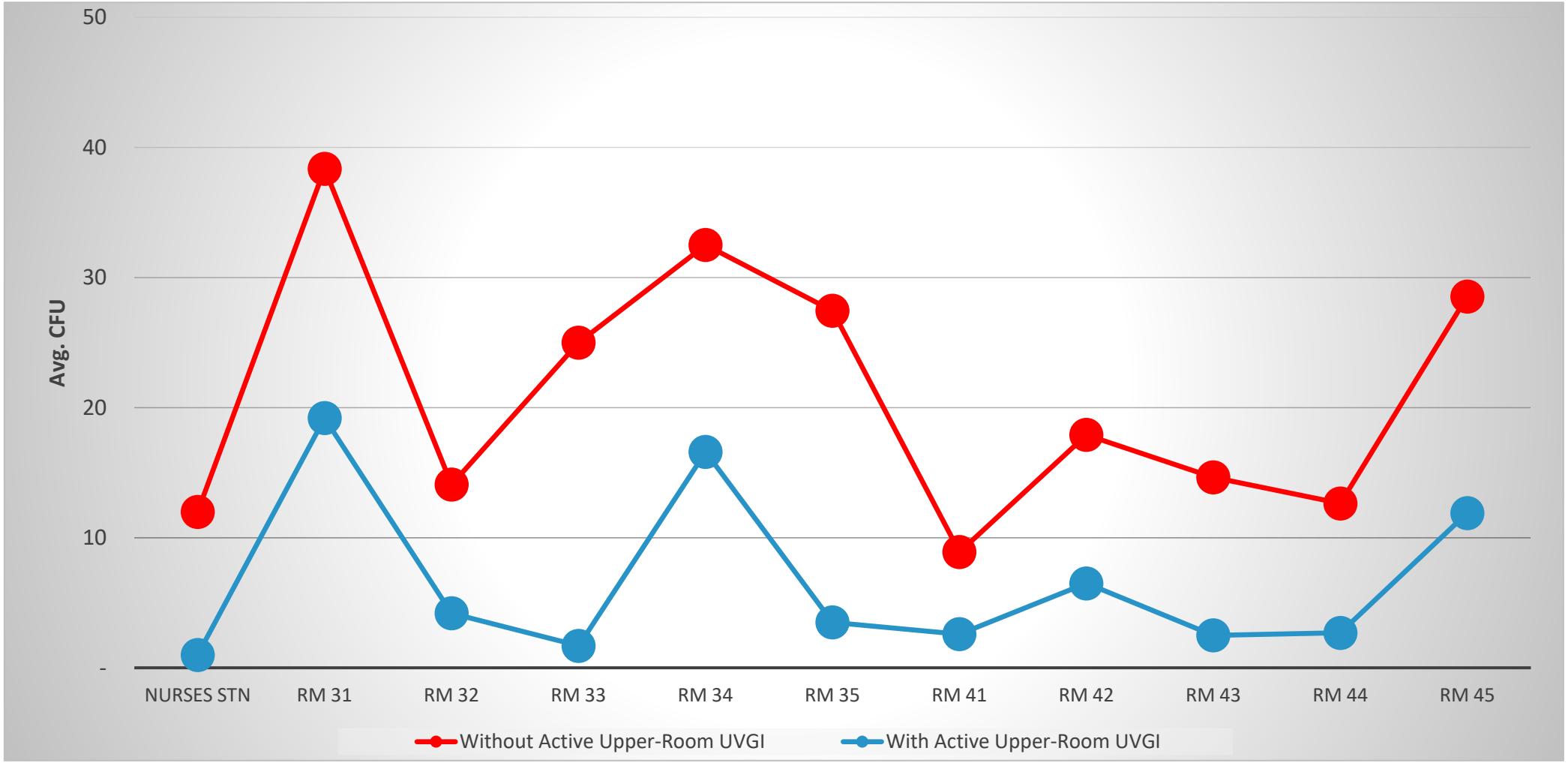
Pre & Post Testing Study Summary

Average Room Air Bacteria CFU counts – comparing pre and post installation sampling



Pre & Post Testing Study Summary

Average Room Surface Bacteria CFU counts – comparing pre and post installation sampling



Lebanon VAMC Technology Study

Table 2 - Infection Rates	Avg Rate
No Mitigation	2.58
Device #1 GUV	1.67
Device #2 405 nm	3.22

Table 3 - Infection Rate Comparison	% Change in Infection Rates
No Mitigation v GUV	35% decrease
GUV v 405 nm	88% increase
no mitigation v 405nm	23% increase

Theresa Haley

Director, Infection Prevention

Lebanon VA Medical Center

Lead for Infection Control, Veterans Integration Service, VISN 4

Learning Objectives

Describe	Describe the behavior of airborne microbes.
Align	Align technology implementation with regulatory needs.
Contrast	Contrast episodic disinfection with continuous disinfection.
Evaluate	Evaluate technologies designed to reduce airborne contamination and their application to high-risk areas.

QUESTION & ANSWER