

Background

- Nosocomial mould infections carry significant morbidity, mortality and cost to hospitals; recent outbreaks have been linked to bioaerosols.^{1,2}
- Active and passive environmental sampling is a primary method of quantifying airborne contamination in the hospital.
- Currently, there are no standardized occupational exposure limits for the avoidance of nosocomial infections.³

Objective

- To quantify fungal bioaerosols across various hospital wards & compare to outdoor controls at an institution which did not record nosocomial fungal infections during sampling period.

Methods and Study Design

- 186 post-construction/post-cleaning air samples were collected across wards of a 1,082-bed hospital in Houston, Texas between March 2016 - December 2019 and retrospectively compared with outdoor controls obtained simultaneously.
- Particle counts (defined size criteria) and viable air fungal cultures were sampled via Lighthouse handheld particle counters and Anderson single stage N6 viable particulate sampler.
- Areas were cleared for occupancy if...
 - Counts of particles ≤ 0.3 microns were reduced by the expected efficacy of the HVAC unit.
 - Indoor fungi airborne concentrations (cfu/m³) were reduced or did not exceed the outdoor ambient reference levels for each separate day of site assessment.
- Zero nosocomial fungal infections occurred in this hospital during the study period.

Results

Mean Count of Particles ≤ 0.3 microns

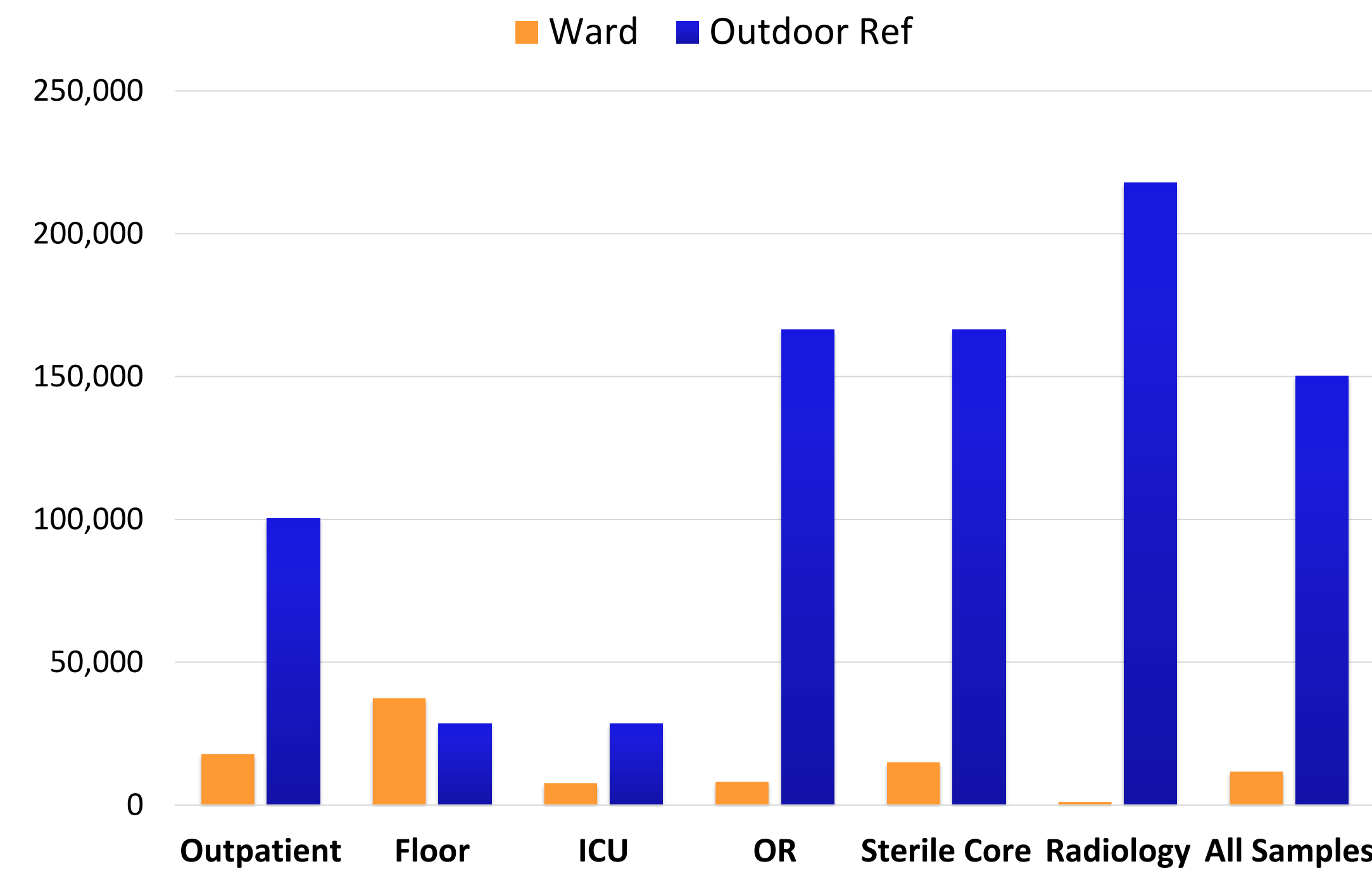


Figure 1. Mean count of fungal particles ≤ 0.3 microns across wards compared to outdoor control samples.

Mean Fungal Density (cfu/m³)

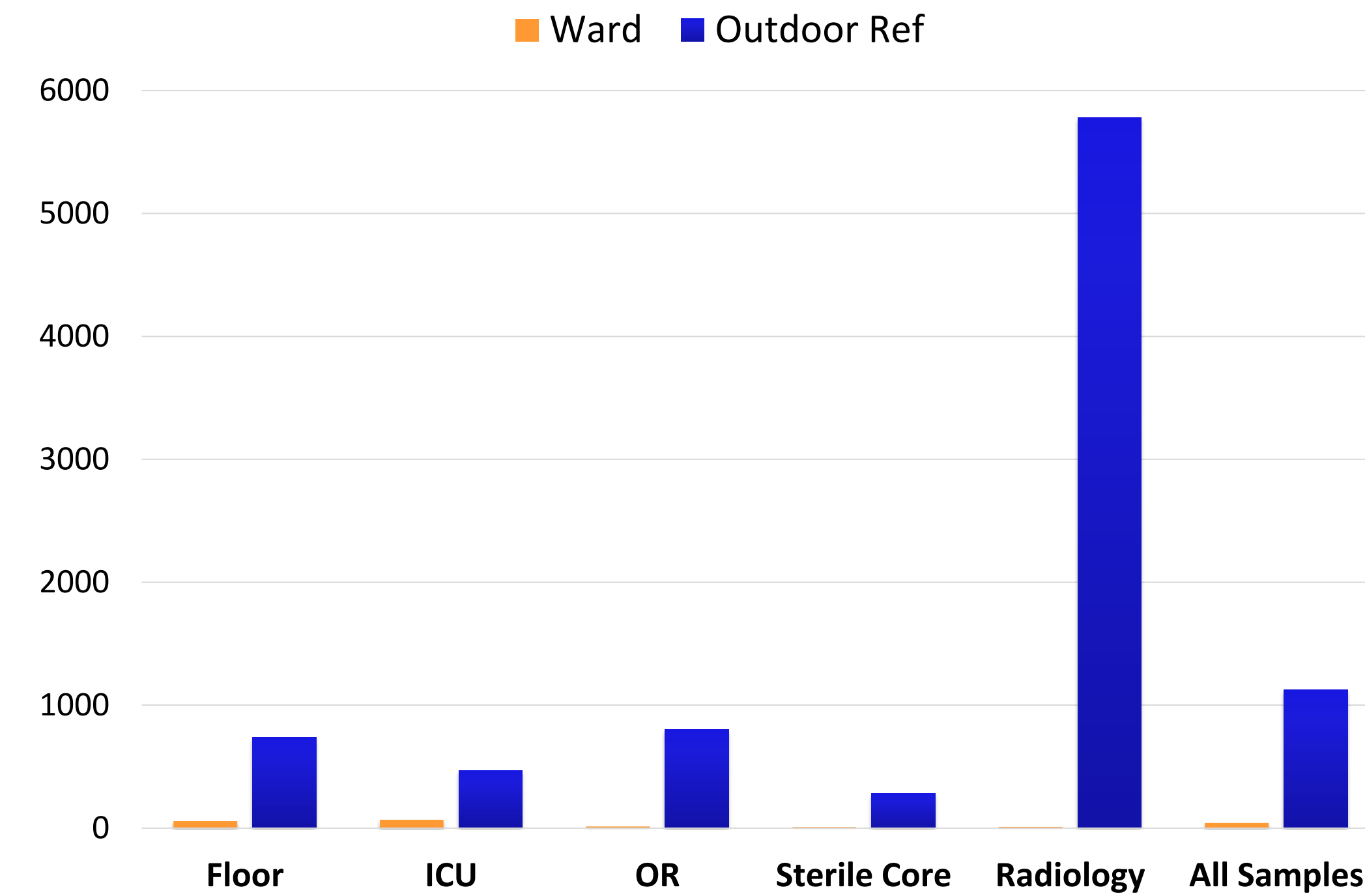


Figure 2. Mean total density (cfu/m³) of fungi across wards compared to outdoor control samples.

	Outpatient (n=12)	Floor (n=2)	ICU (n=20)	OR (n=46)	Sterile Core (n=49)	Radiology (n=4)	All Indoor (n=133)	Outdoor Ref (n=45)
Mean Avg Particle Count	17,891 (11,302-27,034)	37,427 (36,349-38,506)	7,640 (252-46,631)	8,164 (6-51,410)	15,001 (410-141,294)	1,046 (239-1972)	11,709 (6-141,294)	150,141 (15,031-548,843)
Percent Reduction	82.2%	0	93.1%	95.1%	91.0%	99.5%	92.2%	

Table 1. Mean fungal particle counts (≤ 0.3 microns) & percent reduction from matched outdoor samples.

	Floor (n=4)	ICU (n=20)	OR (n=26)	Sterile Core (n=49)	Radiology (n=4)	All Indoor (n=53)	All Outdoor Ref (n=34)
Mean Avg cfu/m ³	57 (9-130)	68 (9-210)	14 (9-26)	9	11 (18-27)	43 (9-210)	1,126 (35-14,000)
Percent Reduction	92.3%	85.4%	98.3%	96.8%	99.8%	96.1%	

Table 2. Mean total density of cultured fungi & percent reduction from matched outdoor samples.

Conclusions

The following are potentially correlated with avoidance of nosocomial mould infections...

- An indoor air quality standard comprised of particle count data reduced by the expected efficacy of the operating HVAC.
- Indoor viable fungi levels (measured in units of CFU/m³) that did not exceed the outdoor reference levels.

Genus ± Species	Floor	ICU	OR	Sterile Core	Radiology	All Indoor Locations	Outdoor Reference
All Isolates	25.44	28.19	12.79	9	22.50	24.53	292.37
<i>Acremonium strictum</i>	-	-	-	-	-	-	53
<i>Alternaria alternata</i> *	-	9	-	-	-	9	67.18
<i>Aspergillus fumigatus</i>	-	-	-	-	-	-	46.67
<i>Aspergillus niger</i> *	-	9	-	-	-	9	47
<i>Aspergillus ochraceus</i>	-	9	-	-	-	9	-
<i>Aspergillus sydowii</i>	9	9	9	-	-	9	-
<i>Aspergillus ustus</i>	-	-	9	-	-	9	-
<i>Aspergillus versicolor</i>	-	-	-	-	-	-	53
<i>Basidiomycetes</i> *	-	18	13.5	-	-	15.75	184.59
<i>Chaetomium</i>	-	-	9	-	-	9	-
<i>Cladosporium</i> *	13.5	42.67	14.2	9	27	31.68	873.33
<i>Curvularia lunata</i> *	-	9	-	-	-	9	71
<i>Epicoccum nigrum</i> *	-	9	9	-	-	9	110
<i>Exophiala</i>	-	-	18	-	-	18	-
<i>Fusarium solani</i> *	-	15.75	-	-	-	15.75	35
<i>Geotrichum</i>	-	-	-	-	-	-	71
<i>Gliocladium</i>	-	-	-	-	-	-	35
<i>Hormoglyphella</i>	-	-	-	-	-	-	141
<i>Mucor plumbeus</i>	-	-	-	-	-	-	35
<i>Nigrospora sphaerica</i>	-	17.75	9	-	-	16	-
Non-sporulating fungi*	-	10.8	9	-	-	10.5	44
<i>Paecilomyces</i>	-	-	-	-	-	-	9
<i>Paecilomyces variotii</i> *	9	-	-	-	-	9	35
<i>Penicillium</i> *	9	63.14	18	-	-	48.7	112.64
<i>Pithomyces chartarum</i> *	-	42.68	-	-	-	42.86	71
<i>Rhizopus</i>	-	-	-	-	-	-	35
<i>Rhodotorula mucilaginosa</i> *	18	9	27	-	18	18	563.75
<i>Sterile dematiaceous mold</i>	-	-	-	-	-	-	353
<i>Sterile hyaline mold</i>	-	-	-	-	-	-	191.5
<i>Verticillium</i>	-	9	-	-	-	9	-
Yeasts, Other*	74	9	9	-	-	30.67	115.25

* indicates indoor isolate matched outdoor reference isolate

Table 3. Mean density (cfu/m³) of individual fungal species cultured across wards and outdoor reference samples.

References

- Suleyman G, Alangaden G. Nosocomial Fungal Infections: Epidemiology, Infection Control, and Prevention. *Infectious Disease Clinics of North America*, 2016. 30:4:1023-1052.
- Kostanich K. (2020). 'Air Samples Find Aspergillus Mold Once Again at Seattle's Children Hospital.' KOMO News, 19 May. Available at: <https://libguides.ioe.ac.uk/harvard/newspaperonline>. (Accessed on Feb 21, 2020).
- Guidelines for Environmental Infection Control in Health-Care Facilities: Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC). http://www.cdc.gov/hicpac/pdf/guidelines/eic_in_hcf_03.pdf (Accessed on March 16, 2020).