Sources of Infection in Long-Term Care Facility - Environmental Issues

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March 2025

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Environmental Issues

- Environmental Sampling
- Hand Hygiene
- Surface Contamination
- Medical Waste
- Linen
- Plant Engineering
- Nutrition and Food Services
- Disinfection and Sterilization

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Infection Prevention in LTC Facilities

- With aging population, more population in LTC facilities than hospitals
- Nursing home residents have: multiple comorbidities; functional disabilities; indwelling devices; recent antibiotic exposures; and substantially colonized with MDROs leading to contamination of the environment
- Infection is one of the top five causes of death in nursing homes

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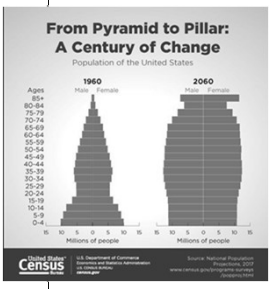
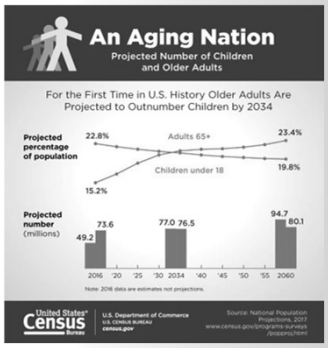
A Shifting Demographic

- *We are on a precipice*





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HAIs in nursing homes in the U.S.

- >1.7 million residents
- Up to 15% will acquire an infection
- Among top 5 causes of death
- Residents persistently colonized MDROs
- >2 million discharges/transfers to hospitals and other HC facilities

Sturm, L. et.al. Infect Dis Clinics NA 2021; 35: 803-825

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Prevalence of MDROs in LTC

SHIELD Study

- Random sample 50 adults in 21 NH/LTACs, screen for MDROs
- Prevalence:
  - 65% NHs, 80% LTACs
  - MDRO status was known only in 18% NH residents and 49% of LTAC patients
- High MDRO prevalence shows need for prevention efforts in NHs/LTACs

McKinnell JA, et.al., The SHIELD Orange County Project: Multidrug-resistant Organism Prevalence in 21 Nursing Homes and Long-term Acute Care Facilities in Southern California. Clin Infect Dis. 2019 Oct 15;69(9):1566-1573.

"Iceberg Effect"

- Point prevalence sampling in 28 NHs:
  - 50 residents per NH
  - 20 high touch objects in resident rooms/common areas
  - total of 2797 swabs were obtained from 1400 residents
- Median prevalence MDROs per NH= 50%
- Median 45% residents w/unknown history
- Environmental MDRO contamination
  - 74% resident rooms
  - 93% common areas

McKinnell JA,et. al., High Prevalence of Multidrug-Resistant Organism Colonization in 28 Nursing Homes: An "Iceberg Effect". J Am Med Dir Assoc. 2020 Dec;21(12):1937-1943.

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EPIDEMIOLOGY OF INFECTIONS IN EXTENDED CARE FACILITIES

- Relative contribution of the following unclear (limited studies)
  - Endogenous flora (40-60%)
  - Person-to-person transmission (direct and indirect, 20-40%)
    - **Other residents**
    - **Staff-to-patients**
    - **Visitors**
  - Role of the contaminated environment (20%?)

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Environmental Sampling

- The only routine microbiologic sampling recommended as part of quality assurance program is:
  - Biological monitoring of sterilization process by using bacterial spores (e.g., steam sterilizers should be monitored at least once per week with commercial preparation of *Gs* spores)
  - Monthly cultures of water used in hemodialysis applications (e.g., water <200mo/ml, and dialysate at the end of dialysis <2,000mo/ml)

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Microbiologic Sampling of the Environment Justification

- Will environmental sampling provide meaningful, interpretable, and actionable data that help identify actual or potential contamination problems associated with a specific procedure or instrument
- Should not be done if no plan for interpreting and acting on the results obtained
- Is it justified on epidemiological grounds
- No accepted criteria for defining surfaces or air as clean/safe in healthcare

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Environmental Sampling-CDC

- Situations
  - Quality assurance such as assuring that equipment or systems have performed to specifications
  - Support of an investigation of an outbreak of disease or infections if environmental reservoir is implicated
  - Research purposes using a well-designed and controlled experimental method
  - Monitor a potentially hazardous environmental condition

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Evidence of Transmission of Pathogens on Hands

- Transmission from patient-to-patient via HCW hands requires four elements
  - Organisms on HCWs hands (via patient or environment)
  - Organisms must survive for several minutes on hands
  - Hand hygiene must be inadequate or agent inappropriate
  - Contaminated hands of HCW must come in contact with another patient (or an inanimate object that will contact patient)

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Hand-borne Microorganisms

- Presence – bacterial counts on hands range from 10^4 to 10^6
  - resident microorganisms-attached to deeper layers of the skin and are more resistant to removal; less likely to be associated with HAIs.
  - transient microorganisms-colonize the superficial layers of skin and amenable to removable; acquired by direct contact with patients or contaminated environment surfaces; frequently associated with HAIs.

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Hand Hygiene Practices in Healthcare

- Hand hygiene has been reported to average 40% (34 studies)
  - Inaccessibility of hand hygiene supplies
  - Skin irritation from hand hygiene agents
  - Inadequate time for hand hygiene
  - Interference with patient care
  - Lack of knowledge of the guidelines
  - Lack of information on the importance of hand hygiene

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Hand Hygiene Practices in Healthcare

- Observational studies revealed that duration averages from 6.6 to 21 sec, and in 10/14 (71%) studies HW <15 sec, and in 8/14 (57%) studies HW $\leq$ 10 sec
- HCWs also fail to wash all surfaces of their hands and fingers effectively

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Hand Hygiene History

- Guidelines:
  - U.S. Public Health Service (1961)-soap and water, 1-2 min before and after patient contact
  - CDC (1975 and 1985)-nonantimicrobial handwashing between patient contacts, antimicrobial before invasive procedures
  - APIC (1988 and 1995)-similar to CDC, more discussion of alcohol-based handrubs
  - HICPAC (1996)-either antimicrobial soap or a waterless antiseptic agent be used for cleaning hands upon leaving MRSA/VRE patient rooms

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Guideline for Hand Hygiene in Healthcare Settings

JM Boyce, D Pittet, HICPAC/SHEA/APIC/IDSA
Hand Hygiene Task Force

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Indications for Handwashing and Hand Antisepsis

- Hands are visibly dirty or soiled, wash with nonantimicrobial soap and water or antimicrobial soap and water. Category IA
- If hands are not visibly soiled, use an alcohol-based handrub for routinely decontaminating hands in all other clinical situations. IA. Alternatively, wash hands with antimicrobial soap and water. IB
  - Before having direct contact with patients. IB
  - Before donning sterile gloves when inserting a central intravascular catheter. IB

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Indications for Handwashing and Hand Antisepsis

- Decontaminate hands not visibly soiled with handrub/antimicrobial (continued)
  - Before inserting urinary catheter, peripheral vascular catheter, or other invasive device. IB
  - After contact with a patient's intact skin. IB
  - After contact with body fluids, mucous membrane, nonintact skin or wound dressings, as long as hands are not soiled. IA
  - If moving from a contaminated body site to clean site. II
  - After contact with inanimate objects in vicinity of patient. II
  - After removing gloves. IB

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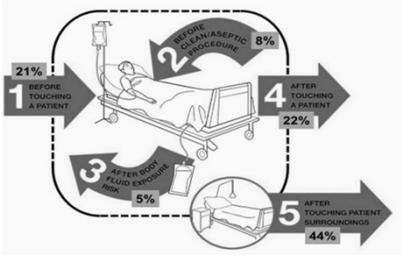
Simplify the Message: Clean In, Clean Out



Diller T, AJIC 2014 June

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Indications for Handwashing and Hand Antisepsis

- Use nonantimicrobial/antimicrobial before eating and after using a restroom. IB
- Antimicrobial towelettes may be an alternative to washing hands with nonantimicrobial soap and water. IB
- No recommendation on routine use of non-alcohol-based handrubs. Unresolved issue

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Alcohol-Based Handrubs

- Minimize factors adversely affecting adherence to hand hygiene protocols
  - Reduce bacterial counts more effectively than washing hands with nonantimicrobial and antimicrobial soaps
  - Can be made much more accessible
  - Require less time to use
  - Produce less skin irritation and dryness
  - Improved adherence to hand hygiene policies and reduce NI rates

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Hand Hygiene and "Clean Procedures"

- Personnel contaminate hands by performing "clean procedures"
- Nurses contaminate hands with 100-1000 CFU during such "clean" activities as lifting patients, taking the patient's pulse, blood pressure, or oral temperature, or touching the patient's hand, shoulder, or groin.

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Studies Comparing Relative Efficacy of Plain Soap or Antimicrobial Soap vs Alcohol-Based Antiseptics in Reducing Counts on Hands

- Alcohol more effective than plain soap (17 studies)
- In all but two trials (15/17), alcohol-based solutions reduced bacterial counts on hands to a greater extent than washing with soaps or detergents containing povidone-iodine, 4% CHG, or triclosan

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Hand Hygiene Technique

- Apply alcohol-based handrub to one hand and rub hands together, covering all surfaces. Follow manufacturer's recommendation on volume. IB
- Soap and water-wet hands, apply amount of product recommended, rub hands together for 15 sec, covering all surfaces. Rinse with water and dry with disposal towel. IB

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Infection Prevention in LTC Facilities

- Surface contamination with MDROs is common in rooms for nursing home patients
- Nursing home patients have a high prevalence of colonization with MDROs (~35%); VRE (33%); MDR-GNR (20%); and *C. difficile* (4-30%).
- Role of nursing home environment in MDRO transmission

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Environmental Contamination Leads to HAIs

Weber, Kanamori, Rutala. Curr Op Infect Dis .2016.

Evidence environment contributes

- Role-MRSA, VRE, *C. difficile*
- Surfaces are contaminated-~25%
- EIP survive days, weeks, months
- Contact with surfaces results in hand contamination; contaminated hands transmit EIP to patients
- Disinfection reduces contamination
- Disinfection (daily) reduces HAIs
- Rooms not adequately cleaned

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Admission to Room Previously Occupied by Patient C/I with Epidemiologically Important Pathogen

- Results in the newly admitted patient having an increased risk of acquiring that previous patient's pathogen by 39-353%
- For example, increased risk for *C. difficile* is 235% (11.0% vs 4.6%) Shaughnessy et al. ICHE
- Exposure to contaminated rooms confers a 5-6 fold increase in odds of infection, hospitals must adopt proven methods for reducing environmental contamination (Cohen et al. ICHE. 2018;39:541-546)

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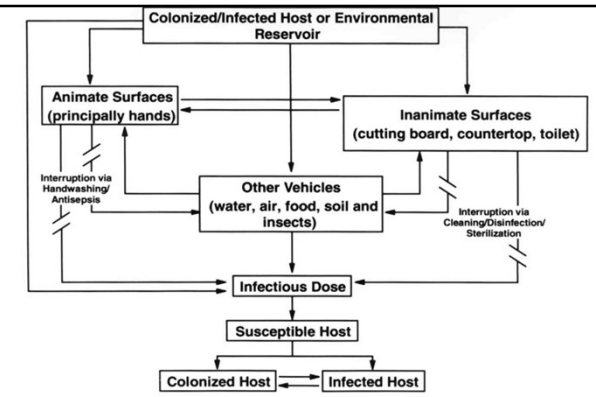

Transmission of infectious agents via animate and inanimate surfaces

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Infection Prevention In Long Term Care Facilities

- Housekeeping in the facility should be performed on a routine and consistent basis to provide for a safe and sanitary environment (IC)
- Measures should be instituted to correct unsafe and unsanitary practices (e.g., environmental cleanliness may be monitored by walking rounds with a checklist)

Elements	Examples
Infection control activities	
Establish and implement routine infection control policies and procedures	Hand hygiene Standard precautions Organism-specific isolation Employee education
Infection identification	Develop case definitions Establish endemic rates Establish outbreak thresholds
Identification, investigation, and control of outbreaks	
Organism-specific infection control policies and procedures	Influenza TB Scabies MDROs (eg, MRSA)
Disease reporting	Public health authorities Receiving institutions LTCF staff
Antibiotic stewardship	Review of antimicrobial use
Monitoring of patient care practices	Aspiration precautions Pressure ulcer prevention Invasive device care and use
Facility management issues	General maintenance Plumbing/ventilation Food preparation/storage Laundry collection/cleaning Infectious waste collection/disposal Environment Housekeeping/cleaning Disinfection/sanitation Equipment cleaning
Product evaluation	Single use devices
Resident health program	TB screening Immunization program
Employee health program TB screening	TB screening Immunizations Occupational exposures
Other program elements	
Performance improvement	Serve on PI committee
Resident safety	Study preventable adverse events
Preparedness planning	Develop pandemic influenza preparedness plan

Smith PW, et al.
ICHE 2008;29:785-814

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MRSA PREVALENCE IN NURSING HOME RESIDENTS

- **Study design: Multicenter, prospective study of residents of 26 nursing homes in Orange County, CA, from 2009-2011**
- **Methods: Only nares cultured**
- **Results:**
  - **Admission prevalence = 16%**
  - **Point prevalence = 26%**
  - **Dominant clones = USA300 (ST8/t008), USA100 (ST5/t002) and USA100 variant (ST5/t242)**

Hudson LO, et al. J Clin Microbiol 2013 (Epub)

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CONTAMINATION OF THE ENVIRONMENT WITH MRSA

- **Study design: Assessment of environment for MDROs in an occupied and newly built replacement nursing home (samples 11 weeks before and after transfer to new building)**
- **Results: MRSA commonly isolated; ESBL producing *E. coli* isolated once**

Detection of meticillin-resistant *Staphylococcus aureus* (MRSA) in old and new nursing homes

Environmental sites	Old occupied nursing home		New unoccupied nursing home		New occupied nursing home	
	No. of tests	No. with MRSA	No. of tests	No. with MRSA	No. of tests	No. with MRSA
Door handles ($N = 92$)	18	1	18	0	56	13
Floor surfaces ($N = 26$)	6	4	6	1	14	11
Tables ($N = 23$)	6	2	3	1	14	5
Bedside lockers ($N = 26$)	6	4	6	0	14	10
Bed frames ($N = 26$)	6	2	6	0	14	11
Toilet seats ($N = 36$)	6	1	9	0	21	7
Arm chairs ($N = 23$)	6	3	3	0	14	6

Ludden C, et al. J Hosp Infect 2013;83:327-9

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Prevalence of MDROs in LTC

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Environmental MDRO Contamination from High-Touch Objects

McKinnell et al. JAMDA 2020

Environmental MDRO contamination was found in 74% of resident rooms and 93% of common areas.

	n	Any MDRO, %	MRSA, %	VRE, %	ESBL, %	CRE, %
Resident room: high-touch objects						
Bedside table and bedrail	84	55	31	29	5	0
Call button, TV remote, phone	84	35	23	15	1	0
Door knobs	84	33	24	12	1	0
Light switch	84	26	18	8	1	0
Bathroom rail, sink, flush handle	84	38	23	20	5	1
Any object	420	37	24	17	3	0.2
Common room: high-touch objects						
Nursing station counter or cart	28	57	43	32	0	0
Table	28	54	39	29	4	0
Chair	28	46	29	18	0	0
Hand rail (hallway)	28	61	32	32	4	0
Drinking fountain or drinking station	28	32	25	11	0	0
Any object	140	50	34	24	1	0
Contamination by room type						
Common room	28	93	89	61	7	0
Resident room	84	74	55	38	11	1
Ambulatory short stay	28	79	46	46	7	0
Ambulatory ADRD	28	71	61	36	18	4
Total care	28	71	57	32	7	0
Any room	112	79	63	44	10	0.9

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Quantitative Analysis of Microbial Burden on Long-Term Care Facilities Environmental Surfaces

Rutala et al. ICHE. 2024

- Microbiological samples were collected using Rodac plates from resident rooms and common areas in 5 local LTCFs
- 5 samples from up to 10 environmental surfaces were collected
- Epidemiologically-important pathogens (EIPs) were defined as MRSA, VRE, *C. difficile* and MDR GNR

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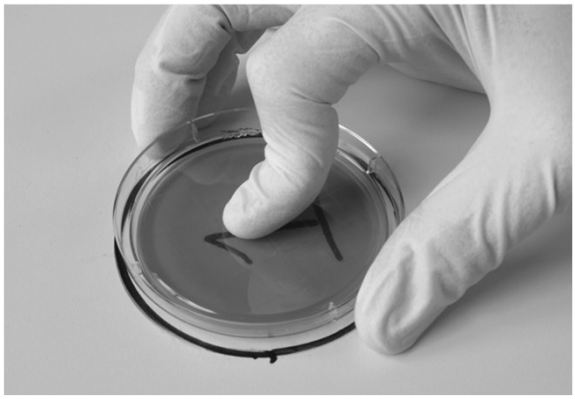

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	Number of Rodac Sampling	Total CFU by Site	Mean CFU per Rodac	Total EIP by Site	Mean EIP Counts per Rodac	Number of Rodac Sampling	Total CFU by Site	Mean CFU per Rodac	Total EIP by Site	Mean EIP Counts per Rodac
Sampling Site	Non-Colonized Resident Rooms					Colonized Resident Rooms				
Bathroom Floor	54	8175	151.39	35	0.65	55	8227	149.58	1820	33.09
Bed Rail	48	5020	104.58	20	0.42	45	7176	159.47	614	13.64
Over Bed Table	48	5953	124.02	24	0.50	55	5123	93.15	123	2.24
Nightstand	55	4934	89.71	1	0.02	49	6081	124.10	223	4.55
Sink	55	5078	92.33	251	4.56	49	2684	54.78	371	7.57
Side Table	45	2477	55.04	4	0.09	34	3023	88.91	3	0.09
Chair	35	2008	57.37	1	0.03	44	2945	66.93	361	8.20
Head of Bed	15	799	53.27	0	0.00	20	1211	60.55	3	0.15
Window Sill	5	175	35.00	0	0.00	5	361	72.20	0	0.00
Foot of Bed	35	779	22.26	1	0.03	45	1127	25.04	20	0.44
Bed Remote Control	3	56	18.67	0	0.00	3	64	21.33	0	0.00
Door	25	157	6.28	0	0.00	14	98	7.00	16	1.14
Closet Door	10	65	6.50	0	0.00	10	55	5.50	7	0.70
Resident Room Total	433	35676	82.39	337	0.78	428	38175	89.19	3561	8.32

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Quantitative Analysis of Microbial Burden on Long-Term Care Facilities Environmental Surfaces

Rutala et al. ICHE. 2024

	Resident Rooms			*Community Rooms*			*Overall Total*		
Pathogen Identified	Number of Positive Rodac with EIP	EIP Total Counts on Positive Rodacs	EIP Counts per Positive Rodac	Number of Positive Rodac with EIP	EIP Total Counts on Positive Rodacs	EIP Counts per Positive Rodac	Number of Positive Rodac with EIP	EIP Total Counts on Positive Rodacs	EIP Counts per Positive Rodac
C. difficile	34	856	25.18	5	7	1.40	39	863	22.13
MRSA	51	2998	58.78	15	101	6.73	66	3099	46.95
VRE	1	1	1.00	1	7	7.00	2	8	4.00
MDR GNR	10	43	4.30	7	144	20.57	17	187	11.00

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Quantitative Analysis of Microbial Burden on Long-Term Care Facilities Environmental Surfaces

Rutala et al. ICHE. 2024

- Varying levels of CFU and EIP on environmental sites at LTCFs were found
- Colonization status of a resident was a strong predictor of higher levels of EIP being recovered from his/her room
- MRSA was the most common EIP recovered from Rodac plates, followed by *C. difficile*
- Infection prevention strategies (e.g., hand hygiene, high-fidelity disinfection, etc) should be performed in the LTCF setting on a routine and consistent basis

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journal homepage: www.ajicjournal.org

Major Article

Evaluation of daily environmental cleaning and disinfection practices in veterans affairs acute and long-term care facilities: A mixed methods study

L. McKinley RN, PhD [a,*], C.C. Goedken MPH [b], E. Balkenende MPH [b,c], G. Clore MPH [b,c], Sherlock S. Hockett MAA [b,c], R. Bartel MA [d], S. Bradley MD [e,f], J. Judd MBA [g,h], Goedken Lyons BHS, MPH [e,f], C. Rock MD, MS [i], M. Rubin MD, PhD [g,h], C. Shaughnessy BS [a], H.S. Reisinger PhD [b,c], E. Perencevich MD, MS [b,c], N. Safdar MD, PhD [a,j]

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Descriptive Characteristics of Environmental CD by 62 Room Observations

McKinley et al. AJIC.2023;51:205-213

- Semiprivate patient rooms and surfaces close to patient barriers to cleaning/disinfection
  Acute Care=35 LTC=27 Total=62

Disinfectant application method			
• Spray bottle	4 (11%)	8 (30%)	12 (19%)
• Wet cloth	29 (83%)	18 (67%)	47 (76%)
Number of cleaning wipes used			
• >3	5 (14%)	5 (19%)	10 (16%)
• 2-3	18 (51%)	7 (26%)	25 (40%)
• 0-1	10 (29%)	14 (52%)	24 (39%)
Mop method			
• Dry	1 (3%)	2 (7%)	3 (5%)
• Wet	30 (86%)	24 (89%)	54 (87%)
Mop material			
• Reusable cotton	23 (66%)	0 (0%)	23 (37%)
• Microfiber	10 (29%)	27 (100%)	37 (60%)
• Disposable synthetic	0 (0%)	0 (0%)	0 (0%)
Cleaning wipe material			
• Reusable cotton	0 (0%)	0 (0%)	0 (0%)
• Microfiber	10 (29%)	27 (100%)	37 (60%)
• Disposable synthetic	0 (0%)	0 (0%)	0 (0%)
Bedroom disinfectant			
• Quaternary ammonium	33 (94%)	27 (100%)	60 (97%)
• Sodium hypochlorite	0 (0%)	0 (0%)	0 (0%)
Bathroom disinfectant			
• Quaternary ammonium	29 (83%)	21 (78%)	50 (81%)
• Sodium hypochlorite	1 (3%)	0 (0%)	1 (2%)
• Quaternary plus Bleach	3 (9%)	6 (22%)	9 (15%)
Hand Hygiene upon room entry			
• Yes	14 (20%)	12 (44%)	26 (42%)
• No	21 (80%)	15 (56%)	36 (58%)

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Observed Environmental Surface Cleaning and Disinfection (CD) in AC and LTC

McKinley et al. AJIC.2023;51:205-213

Observed surface CD was 33.6% for all environmental surfaces and 60% for high-touch surfaces. Must improve CD compliance by standardized CD/monitoring

Table 2
Frequency of observed environmental surface cleaning rates by surface observation (N = 3602)

	ACMean (SD)	LTCMean (SD)	TotalMean (SD)
Cleaning rates – all surfaces	0.27 (0.09)	0.42 (0.11)	33.69 (1.26)
Cleaning rates – HTSs	0.69 (0.12)	0.49 (0.14)	60.17 (1.63)

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Environmental Cleaning and Disinfection

AHRQ.gov

- Cleaning refers to physically removing soil and dirt.
- Disinfecting is removing and killing the pathogens that can cause disease.
- Surfaces in a room or equipment can harbor these pathogens.
- All touchable surfaces and equipment must be routinely cleaned and disinfected, including between use of each resident, to prevent the spread of pathogens and diseases.

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Environmental Cleaning and Disinfection

AHRQ.gov

- All staff have a role in keeping the facility and equipment clean and disinfected
- The best cleaning/disinfecting products
  - Clean and disinfect at the same time
  - Are safe on surfaces
- Hospital-approved cleaning/disinfecting products are adequate for most situations in LTC facilities
- All staff at the LTC facility should receive training before using cleaning/disinfecting products

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Blood Pressure Cuff
Non-Critical Patient Care Item

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Surface Disinfection

Noncritical Patient Care
Rutala, Weber. www.cdc.gov

- Disinfecting Noncritical Patient-Care Items
  - Process noncritical patient-care equipment with an EPA-registered disinfectant at the proper use dilution and a contact time of at least 1 min. *Category IB*
  - Ensure that the frequency for disinfecting noncritical patient-care surfaces be done minimally when visibly soiled and on a regular basis (such as after each patient use or once daily or once weekly). *Category IB*

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Surface Disinfection

Environmental Surfaces

Rutala, Weber. www.cdc.gov

- Disinfecting Environmental Surfaces in HCF
  - Disinfect (or clean) housekeeping surfaces (e.g., floors, tabletops) on a regular basis (e.g., daily, three times per week), when spills occur, and when these surfaces are visibly soiled. *Category IB*
  - Use disinfectant for housekeeping purposes where: uncertainty exists as to the nature of the soil on the surfaces (blood vs dirt); or where uncertainty exists regarding the presence of multi-drug resistant organisms on such surfaces. *Category II*

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LOW-LEVEL DISINFECTION FOR NONCRITICAL EQUIPMENT AND SURFACES

Rutala, Weber. Infect Control Hosp Epidemiol. 2014;35:855-865; Rutala, Weber. AJIC 2019;47:A3-A9

Exposure time ≥ 1 min

Germicide	Use Concentration
Ethyl or isopropyl alcohol	70-90%
Chlorine	100ppm (1:500 dilution)
Phenolic	UD
Iodophor	UD
Quaternary ammonium (QUAT)	UD
Quat With Alcohol	RTU
Improved hydrogen peroxide (HP)	0.5%, 1.4%
PA with HP, 4% HP, chlorine (*C. difficile*)	UD

UD=Manufacturer's recommended use dilution; others in development/testing-electrolyzed water; polymeric guanidine; cold-air atmospheric pressure plasma (Boyce Antimicrob Res IC 2016. 5:10)

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Improved cleaning and disinfection of the contaminated environmental surface is necessary to reduce risk through sharing common areas (e.g., activity rooms, dining areas)

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Environmental Issues

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- Nutrition and Food Services
- Disinfection and Sterilization

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North Carolina Medical Waste Rules

Regulated Medical Waste Definitions

Microbiological - cultures and stocks of infectious agents

Pathological - human tissues, organs and body parts; carcasses and body parts of animals exposed to pathogens

Blood - liquid blood, serum, plasma, other blood products, emulsified human tissue, spinal fluids, and pleural and peritoneal fluids; in individual containers in volumes greater than 20 ml (bloody gauze, used gloves, tubing and dressings are not regulated medical waste).

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North Carolina Medical Waste Rules

Regulated Medical Waste Treatment*

Microbiological - incineration, steam sterilization or chemical treatment

Pathological - incineration

Blood and body fluids in individual containers in volumes greater than 20 ml - incineration or sanitary sewage systems, provided the sewage treatment authority is notified.

*Other methods of treatment shall require approval by the Division of Solid Waste Management

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North Carolina Medical Waste Rules

- Definition - “sharps” means and includes needles, syringes with attached needles, capillary tubes, slides, cover slips and scalpel blades.
- Requirement - sharps will be placed in a container which is rigid, leakproof when in an upright position and puncture-resistant. Contained sharps shall not be compacted prior to off-site transportation.
- Treatment - none required. The package may be disposed with general solid waste.

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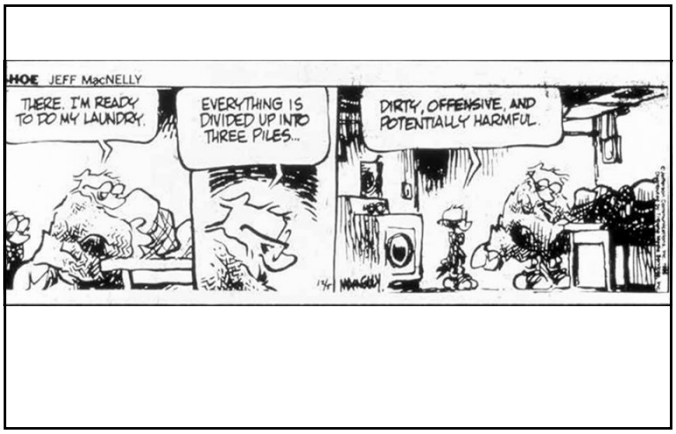

66

Routine Handling of Soiled Linen

- Soiled linen should be handled as little as possible.
- Soiled linen should be bagged or put into carts at the location where used. It should not be sorted or rinsed in patient care areas.
- Wet linen should be placed and transported in bags that prevent leakage.

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Transportation of Linen

- All soiled linen should be transported in well covered and clearly identified carts used exclusively for linen.
- If laundry chutes are used, all linens should be bagged.
- All laundry chute doors should be kept closed, be tight-fitting and should be located in well-ventilated rooms, not in corridors in patient care areas.

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Linen

- Soiled linens can be a source of large amounts of microbial contamination, although the risk of disease transmission appears to be negligible.

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Processing Linen

- All soiled linen will be treated as potentially infectious. White linen bags will be used for soiled linen from all patient care areas.
- Gloves and waterproof aprons should be worn when processing soiled linen. Handwashing facilities should be made available to personnel who sort linen.
- In the laundry, soiled linen should move from the dirtiest to the cleanest areas as it is being processed. The flow of ventilation air in the laundry should be from the cleanest to the dirtiest area.

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Processing Linen (cont)

- Linen should be washed with a detergent in water hotter than 160^{o}F for 25 minutes or if low-temperature laundry cycles are used, the wash formula must be controlled especially the amount of bleach.
- Heavily soiled items (e.g., floor mops, door mats) should be laundered separately from linens.

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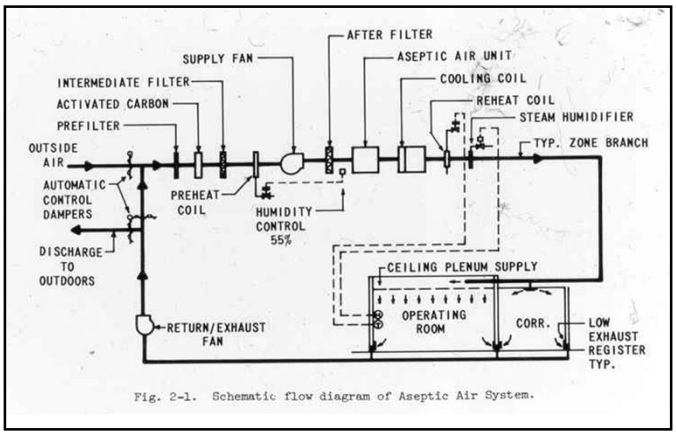

Fig. 2-1. Schematic flow diagram of Aseptic Air System.

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SPECIAL HEALTHCARE SETTINGS
(Airborne Infection Isolation-AII)

- Planning new or renovating AII units
  - **Directed airflow:** exhaust air to the outside, away from air-intake and populated areas (IC)
  - **Well-sealed room** (IB)
  - **Room-air pressure:** Maintain continuous negative room with respect to corridor; monitor air pressure periodically (IB).; install self-closing doors (IC)
  - **Room-air changes:** Maintain at ≥12 per hour (IB)

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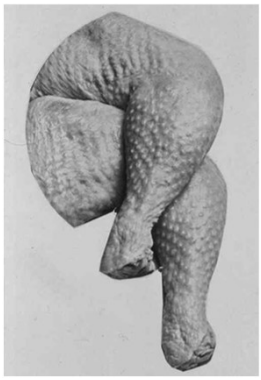
Environmental Issues

- Environmental Sampling
- Hand Hygiene
- Surface Contamination
- Medical Waste
- Linen
- Plant Engineering
- Nutrition and Food Services
- Disinfection and Sterilization

80



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Nutrition and Food Services

- Why? Job of providing food for residents that is wholesome, appetizing, economical and safe to eat.
- What? General principles of protection, equipment, storage, preparation, service.
- How? Rounding

82

Factors that Contributed to 725 Reported Foodborne Disease Outbreaks, 1961-72

Factor	Frequency % (No)
Inadequate refrigeration	336 (46)
Preparing food far in advance of planned service	156 (22)
Infected persons practicing poor personal hygiene	151 (21)
Inadequate cooking or heat processing	140 (19)
Holding food in warming devices at bacteria-incubating temperatures	114 (16)
Contaminated raw ingredient in uncooked food	84 (12)

83

Factors that Contributed to 725 Reported Foodborne Disease Outbreaks, 1961-72 (cont)

Factor	Frequency % (No)
Inadequate reheating	66 (9)
Cross-contamination	58 (8)
Inadequate cleaning of equipment	57 (7)
Obtaining foods from unsafe sources	44 (6)
Using leftovers	23 (3)
Storing acid foods in toxic containers	19 (3)
Intentional additives	17 (2)
Incidental additives	8 (1)

Bryan, FL J. Environ Health 38:74, 1975.

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Institutional Foodservice – NURSING HOMES: Percent of Observations Found Out of Compliance for Each RISK FACTOR

Foodborne Illness Risk Factor	Total Observations	Observations out of compliance	% observations out of compliance
Improper Holding/Time & Temperature	483	141	29.2%
Contaminated Equipment/Protection from Contamination	459	77	16.8%
Poor Personal Hygiene	455	73	16.0%
Other/Chemical	96	12	12.5%
Inadequate Cooking	166	16	9.6%
Food From Unsafe Sources	192	4	2.1%

FDA Report on the Occurrence of Foodborne Illness Risk Factors in Selected Institutional Foodservice, Restaurants and Retail Food Facility Types (2009) p.54.

85

Institutional Foodservice – HOSPITALS: Percent of Observations Found Out of Compliance for Each RISK FACTOR

Foodborne Illness Risk Factor	Total Observations	Observations out of compliance	% observations out of compliance
Improper Holding/Time & Temperature	483	175	36.2%
Contaminated Equipment/Protection from Contamination	443	78	17.6%
Poor Personal Hygiene	77	73	17.1%
Other/Chemical	14	96	14.6%
Inadequate Cooking	193	9	4.7%
Food From Unsafe Sources	222	5	2.3%

FDA Report on the Occurrence of Foodborne Illness Risk Factors in Selected Institutional Foodservice, Restaurants and Retail Food Facility Types (2009) p.42.

86

Nutrition and Food Services Staff

- Exclude employees with communicable diseases (skin, respiratory, gastrointestinal) from contact with food products or utensils in accordance with the occupational health policy
- Routine culturing of food service personnel for enteric pathogens has not been shown to be cost-effective

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Nutrition and Food Services Staff

- Wash hands after: using toilet, handling raw food, contact with unclean equipment and work surfaces, soiled clothing; wash rags and touching the mouth, nose, ears, eyes and hair.

88

Nutrition and Food Services

89

Nutrition and Food Services

- Amount of hand contact
- Cleanliness of equipment
- Length of time foods are held at bacteria-incubating temperatures (<45^{o}F or >140^{o}F)

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Nutrition and Food Services

No Hand Contact

91

Nutrition and Food Services

No Hand Contact, Serving Utensils

92

Nutrition and Food Services

Food Preparation

93

Nutrition and Food Services

Cooked Foods Reach Appropriate Temperature (145-165ºF)

94

Nutrition and Food Services

Cooked Foods Reach Appropriate Temperatures (145-165ºF)

Cook all food to these minimum internal temperatures as measured with a food thermometer before removing food from the heat source. For reasons of personal preference, consumers may choose to cook food to higher temperatures.

Product	Minimum Internal Temperature & Rest Time
Beef, Pork, Veal & Lamb Steaks, chops, roasts	145 °F (62.8 °C) and allow to rest for at least 3 minutes
Ground meats	160 °F (71.1 °C)
Ham, fresh or smoked (uncooked)	145 °F (62.8 °C) and allow to rest for at least 3 minutes
Fully Cooked Ham (to reheat)	Reheat cooked hams packaged in USDA-inspected plants to 140 °F (60 °C) and all others to 165 °F (73.9 °C).

Product	Minimum Internal Temperature
All Poultry (breasts, whole bird, legs, thighs, wings, ground poultry, giblets, and stuffing)	165 °F (73.9 °C)
Eggs	160 °F (71.1 °C)
Fish & Shellfish	145 °F (62.8 °C)
Leftovers	165 °F (73.9 °C)
Casseroles	165 °F (73.9 °C)

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Nutrition and Food Services

Food Preparation

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Nutrition and Food Services

Cleanliness of Cutting Boards

97

Nutrition and Food Services

Food Storage (First in, First Out)

98

6" off the floor

99

Nutrition and Food Services

- Fruits, vegetables
- Dairy products
- Meat, poultry

$33^{o}F – 45^{o}F$

CMS guidance: Cold - 41°F and below

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Nutrition and Food Services

Monitoring Temperatures

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Nutrition and Food Services

Monitoring Temperatures

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Nutrition and Food Services

Monitoring Temperatures

103

Nutrition and Food Services

Monitoring Temperatures Electronically

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Nutrition and Food Services

- Steam Tables
  - Maintain hot foods at 140ºF or above.
  - Should not be used to warm foods.
- Cold Tables
  - Maintain cold foods at 45ºF or lower.
  - Should not be used to refrigerate foods.

CMS guidance: Hot – 135 °F and above, Cold - 41°F and below

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Nutrition and Food Services

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Nutrition and Food Services

Steam Tables at 140ºF (CMS 135ºF or greater)

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Nutrition and Food Services

Automatic Washer-140°F wash for 20s, 180°F rinse for 10s

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Nutrition and Food Services

Pot Cleanup (manual temp 110-120°F; sanitized for 30s 170°F or 50ppm chlorine at 75°F)

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Environmental Issues

- Environmental Sampling
- Hand Hygiene
- Surface Contamination
- Medical Waste
- Linen
- Plant Engineering
- Nutrition and Food Services
- Disinfection and Sterilization

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Disinfection and Sterilization

WA Rutala, DJ Weber, and HICPAC, www.cdc.gov

EH Spaulding believed that how an object will be disinfected depended on the object's intended use.

CRITICAL - objects which enter normally sterile tissue or the vascular system or through which blood flows should be **sterile.**

SEMICRITICAL - objects that touch mucous membranes or skin that is not intact require a disinfection process (**high-level disinfection [HLD]**) that kills all microorganisms but high numbers of bacterial spores.

NONCRITICAL -objects that touch only intact skin require **low-level disinfection** (or non-germicidal detergent).

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Critical Medical/Surgical Devices

Rutala et al. ICHE 2014;35:883; Rutala et al. ICHE 2014;35:1068; Rutala et al. AJIC 2016;44:e47

- Critical
  - Transmission: direct contact
  - Control measure: sterilization
  - Surgical instruments
    - Enormous margin of safety, rare outbreaks
    - ~85% of surgical instruments <100 microbes
    - Washer/disinfector removes or inactivates 10-100 million
    - Sterilization kills 1 trillion spores

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Semicritical Medical Devices

Rutala et al. AJIC 2016;44:e47

- Semicritical
  - Transmission: direct contact
  - Control measure: high-level disinfection
  - Endoscopes top ECRI list of 10 technology hazards, >150 outbreaks (GI, bronchoscopes)
    - 0 margin of safety
      - Microbial load, 10^7-10^{10}
      - Complexity
      - Biofilm
  - Other semicritical devices, rare outbreaks
    - ENT scopes, endocavitary probes (prostate, vaginal, TEE), laryngoscopes, cystoscopes
    - Reduced microbial load, less complex

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High-Level Disinfection of "Semicritical Objects"

Rutala, Weber. AJIC 2019;47:A3-A9

Germicide	Exposure Time ≥ 8m-45m (US), 20°C Concentration
Glutaraldehyde	≥ 2.0%
Ortho-phthalaldehyde	0.55%
Hydrogen peroxide*	7.5%
Hydrogen peroxide and peracetic acid*	1.0%/0.08%
Hydrogen peroxide and peracetic acid*	7.5%/0.23%
Hypochlorite (free chlorine)*	650-675 ppm
Accelerated hydrogen peroxide	2.0%
Peracetic acid	0.2%
Glut and isopropanol	3.4%/26%
Glut and phenol/phenate**	1.21%/1.93%

*May cause cosmetic and functional damage; **efficacy not verified

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Noncritical Medical Devices

Rutala et al. AJIC 2016;44:e1; Rutala, Weber. Env Issues NI, Farber 1987

- Noncritical medical devices
- Transmission: secondary transmission by contaminating hands/gloves via contact with the environment and transfer to patient
- Control measures: hand hygiene and low-level disinfection
- Noncritical devices (stethoscopes, blood pressure cuffs, wound vacuum), rare outbreaks

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LOW-LEVEL DISINFECTION FOR NONCRITICAL EQUIPMENT AND SURFACES

Rutala, Weber. Infect Control Hosp Epidemiol. 2014;35:855-865; Rutala, Weber. AJIC 2019;47:A3-A9

Germicide	Exposure time ≥ 1 min Use Concentration
Ethyl or isopropyl alcohol	70-90%
Chlorine	100ppm (1:500 dilution)
Phenolic	UD
Iodophor	UD
Quaternary ammonium (QUAT)	UD
QUAT with alcohol	RTU
Improved hydrogen peroxide (HP)	0.5%, 1.4%
PA with HP, 4% HP, chlorine (*C. difficile*)	UD

UD=Manufacturer's recommended use dilution; others in development/testing-electrolyzed water; polymeric guanidine; cold-air atmospheric pressure plasma (Boyce Antimicrob Res IC 2016. 5:10)

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Effective Surface Decontamination

Product and Practice = Perfection

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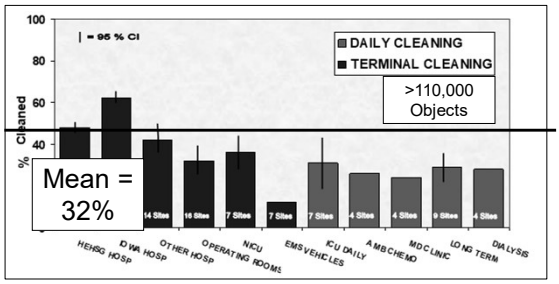
Thoroughness of Environmental Cleaning

Carling et al. ECCMID, Milan, Italy, May 2011



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Daily Environmental Cleaning and Disinfection in Acute and LTCF

McKinley et al. AJIC 2023;51:205-211

- Average observed surface cleaning rate during daily cleaning in patient rooms was 33.6% for all environmental surfaces and 60% for high-touch surfaces.
- Higher cleaning rates when patient not present in room
- Lower cleaning rates in semiprivate rooms
- Bedroom disinfectant in LTC was Quat (100%)
- Bathroom disinfectant in LTC was Quat (78%) and Quat plus bleach (22%)
- Disinfectant application method: spray bottle (78%) and wipe (67%)

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Clean/disinfect at least daily (one-step cleaning and disinfection)

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CANDIDA AURIS: AN OVERVIEW, CDC

- *Candida auris* is an emerging fungus that presents a serious global health threat for the following reasons:
  - *C. auris* is spreading geographically and increasing in incidence.
  - From 2019 to 2021, 17 states reported their first *C. auris* case and cases resistant to antifungal drugs tripled…now 35 states
  - *C. auris* may colonize patients for months to years (no method of decolonization). Infection (usually candidemia) has a high mortality (~60%).
  - It is often multidrug-resistant (e.g., echinocandins, triazoles, polyene [amphotericin B]). Some strains are resistant to all three available classes of antifungals.
  - It is difficult to identify with standard laboratory methods, and it can be misidentified in labs without specific technology. Misidentification may lead to inappropriate management.
  - It has caused multiple outbreaks in healthcare settings. For this reason, it is important to quickly identify *C. auris* in a hospitalized patient so that healthcare facilities can take special precautions to stop its spread.
- May 11, 2021: Updated tracking *C. auris* to include historical and current U.S. interactive maps and downloadable datasets
- July 19, 2021: Environmental Protection Agency (EPA) has created List P, a list of EPA-registered disinfectants effective against *C. auris*
- Current needs: (1) rapid diagnostics; (2) new drugs; (3) decolonization methods; (4) registered, easy to use and effective disinfectants; (5) other tools or protocols for treatment and prevention

https://www.cdc.gov/fungal/candida-auris/index.html
https://www.cdc.gov/fungal/candida-auris/researchers-and-industry-professionals.html

UNC SCHOOL OF MEDICINE

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Susceptibility of *C. auris* and *C. albicans* to 21 germicides used in healthcare facilities

- Goal: Assess susceptibility of *C. auris* to germicides
- Methods: Disc-based quantitative carrier testing
- Results: All of the FDA-cleared high-level disinfectants have a registration claim >1 minute (e.g., 8–45 minutes). In summary, with the exception of a water-based QAC and a 1:50 dilution of sodium hypochlorite, our data demonstrate that most disinfectants (10 of 13, 77%) used in healthcare facilities are effective (>3-$\log_{10}$ reduction) against *C. auris*.

Rutala WA, et al. ICHE 2019;40:380-382

Germicide name	Manufacturer, Location	Active ingredient	Formulation Tested	Classification	*C. auris*[a]	*C. albicans*[a]
Purell Advanced instant hand sanitizer	GOJO, Akron, OH	70% ethanol	Undiluted	Antiseptic	4.0	2.5
Betadine solution	Purdue Products, Stamford, CT	10% povidone-iodine/1% iodine	Undiluted	Antiseptic	2.5	2.3
Medicated Soft 'N Sure	Steris, St. Louis, MO	0.5% triclosan	Undiluted	Antiseptic/Handwash	1.4	1.7
Soft Care Defend	Diversey, Charlotte, NC	2% chloroxylenol	Undiluted	Antiseptic/Handwash	2.8	3.9
Avagard	3M, St Paul, MN	1% chlorhexidine gluconate solution, 61% ethyl alcohol	Undiluted	Antiseptic/Surgical hand scrub	2.0	1.9
Scrub-Stat 2%	Ecolab, St Paul, MN	2% chlorhexidine gluconate solution	Undiluted	Antiseptic/Surgical hand scrub/handwash	1.6	2.8
Scrub-Stat 4%	Ecolab, St Paul, MN	4% chlorhexidine gluconate solution	Undiluted	Antiseptic/Surgical hand scrub/handwash	1.9	3.5
Isopropyl rubbing alcohol 70% USP	Medichoice, Mechanicsville, VA	70% isopropyl alcohol	Undiluted	Antiseptic/Disinfectant	3.8	4.1
Solution of hydrogen peroxide 3% USP	Medichoice, Mechanicsville, VA	3% hydrogen peroxide	Undiluted	Antiseptic	1.4	1.8
Austin's A-1 bleach 1:10	James Austin Co, Mars, PA	5.25% sodium hypochlorite (~4,200–4,700 ppm)	1:10 dilution	Disinfectant	4.1	4.0
Austin's A-1 bleach 1:50	James Austin Co, Mars, PA	5.25% sodium hypochlorite (~1,040 ppm)	1:50 dilution	Disinfectant	1.6	1.5
Vesphene IIse	Steris, St Louis, MO	9.039% o-phenylphenol, 7.68% p-tertiary amylphenol	1:128 dilution	Disinfectant	4.1	3.6
Hydrogen peroxide cleaner disinfectant	Clorox, Oakland, CA	1.4% hydrogen peroxide	Undiluted	Disinfectant	4.1	4.1
Lysol disinfectant spray	Reckitt Benckiser, Parsippany, NJ	58% ethanol, 0.1% QAC[b]	Undiluted	Disinfectant	3.8	4.1
A-456 II disinfectant cleaner	Ecolab, St Paul, MN	21.7% QAC[c]	1:256 dilution	Disinfectant	1.7	1.5
Super Sani-Cloth wipe	PDI, Orangeburg, NY	55% isopropyl alcohol, 0.5% QAC[b]	Undiluted[d]	Disinfectant	3.9	4.1
Prime Sani-Cloth wipe	PDI, Orangeburg, NY	28.7% isopropyl alcohol, 17.9% ethyl alcohol, 0.61% QAC[c]	Undiluted[d]	Disinfectant	4.1	4.1

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List P: Antimicrobial Products Registered with EPA for Claims Against *Candida auris* (contact times, product dependent)

- Sodium Hypochlorite (1-3 min)
- Hydrogen peroxide and peracetic acid (1-3 min)
- Hydrogen Peroxide, Peracetic Acid and Octoanoic Acid (4 min)
- Dodecylbenzenesulfonic acid (1-1.25 min)
- Isopropyl Alcohol and Quaternary Ammonium Compound (1 min)
- Isopropyl Alcohol, DDAC and ADBAC (2 min)
- Hydrogen Peroxide (1-5 min)
- Quaternary Ammonium Compounds (10 min)
- Sodium dichloro-s-triazinetrione (2 min)
- Ethanol, Isopropyl Alcohol and DDAC (1 min)
- Isopropyl Alcohol and Quaternary Ammonium Compounds (2 min)

Caveats

- List P displays 30 approved products
- All products are ONLY approved for "hard non-porous surfaces"
- Contact times vary by class and specific product
- Products include sprays, wipes and liquids
- Some products are ready to use; others may require dilution
- Per CDC, if products on List P are not accessible or otherwise suitable, interim guidance permits use of an EPA-registered disinfectant active against *C. difficile* (List K)
- Follow manufacturer's use recommendations

https://www.epa.gov/pesticide-registration/list-p-antimicrobial-products-registered-epa-claims-against-candida-auris
https://www.cdc.gov/fungal/candida-auris/c-auris-infection-control.html

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Infection Prevention and Control for *Candida auris*

- Hand Hygiene: HCP should follow standard hand hygiene practices. Alcohol-based hand sanitizer (ABHS) is the preferred hand hygiene method for *C. auris* when hands are not visibly soiled. If hands are visibly soiled, wash with soap and water.
- Transmission Based Precautions: Private room with bathroom, contact isolation (gloves & gown)
  - Duration of precautions: Patients often remain colonized with *C. auris* for many months, perhaps indefinitely, even after an acute infection (if present) has been treated and resolves. Continue precautions for entire duration of stay.
  - CDC does not recommend routine reassessments for *C. auris* colonization. At this time, no specific intervention is known to reduce or eliminate *C. auris* colonization.
- Disinfection: *C. auris* can persist on surfaces in healthcare environments for days to months.
  - Perform thorough routine (at least daily) and terminal cleaning and disinfection of patients' rooms and other areas where patients receive care (e.g., radiology, physical therapy) using an appropriate disinfectant. Clean and disinfect shared or reusable equipment (e.g., ventilators, physical therapy equipment) after each use. Label cleaned and disinfected equipment as such and store it away from dirty equipment. Data indicate that products solely dependent on quaternary ammonia compounds (QACs) are NOT effective. Use an EPA–registered hospital-grade disinfectant effective against *C. auris* (List P). Consider a "no touch" method (e.g., UV-C) as a supplement to standard disinfection.
- Other: 1) Educate HCP about appropriate precautions; 2) Ensure adequate supplies are available; 3) Monitor compliance with HH & disinfection (provide feedback); 4) Ensure proper signage on door; 5) Flag the patient's record; 6) Consider patient screening and lab surveillance.

https://www.cdc.gov/fungal/candida-auris/c-auris-infection-control.html

UNC

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UNC Medical Center strategy for control:

- Patient's chart flagged before arrival to UNC Medical Center.
- Service lines caring for the patient have been communicated with directly.
- Infection Prevention has partnered with nursing staff, environmental services, patient transport, ICU transport, house supervisors, patient logistics center and ancillary areas the patient may visit.
- Patient placed on Enteric Precautions to ensure proper room cleaning daily with bleach and bleach + UV upon discharge.
- Alcohol based hand rubs are effective.
- Microbiology lab has been notified and has developed algorithm for identification.

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Role of Healthcare Surface Environment in SARS-CoV-2 Transmission

Kanamori, Weber, Rutala, Clin Infect Dis, , https://doi.org/10.1093/cid/ciaa1467, 28 September 2020

Surface disinfection effective provided thorough cleaning/disinfection and effective product used as recommended

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COVID:19: Overview of Contamination of the Healthcare Environment and Effective Surface Disinfection Technologies

The healthcare environment can be contaminated with SARS-CoV-2 and serve as a fomite, leading to possible transmission to personnel and patients

Role of environment in SARS-CoV-2 transmission and environmental disinfection

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Microbiological Disinfectant Hierarchy

Rutala WA, Weber DJ, HICPAC. www.cdc.gov

Most Resistant

Spores (*C. difficile*)

Mycobacteria (*M. tuberculosis*)

Non-Enveloped Viruses (norovirus, HAV, polio)

Fungi (Candida, *Trichophyton*)

Bacteria (MRSA, VRE, *Acinetobacter*)

Enveloped Viruses (HIV, HSV, Flu, SARS-CoV-2)

LLD

Most Susceptible

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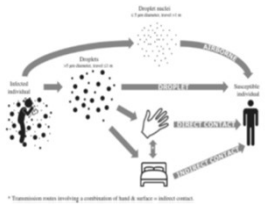
Transmission of SARS-CoV-2



- Droplet (< 6 feet)
- Direct-person-to-person via respiratory aerosols
- Indirect (via the contaminated environment); not main route
- Asymptomatic (infection transmission demonstrated)
- Pre-symptomatic-highly likely

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Role of Healthcare Surface Environment in SARS-CoV-2 Transmission

Kanamori, Weber, Rutala, Clin Infect Dis, https://doi.org/10.1093/cid/ciaa1467, 28 September 2020

- Survival on environmental surfaces
  - Hours to days (SARS-CoV-2)
  - Depends on experimental conditions such as viral titer (10^7 higher than real life) and volume of virus applied to surface, suspending medium, temperature, relative humidity and surface substrates
  - Human coronavirus 229E persist on surface materials at RT for at least 5 days
  - SARS-CoV-2 can be viable on surfaces for 3 days (plastic, stainless steel ~2-3 days, cardboard ~24h)
  - Suggest transmission of SARS-CoV-2 may occur

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Role of Healthcare Surface Environment in SARS-CoV-2 Transmission

Kanamori, Weber, Rutala, Clin Infect Dis, https://doi.org/10.1093/cid/ciaa1467, 28 September 2020

Centers for Disease Control & Prevention says the virus spreads from person to person mainly through respiratory droplets from coughing, sneezing or talking in close proximity to each other, but the CDC has also said it may be possible for a person to get COVID-19 by touching a surface or object that has the virus on it and then touching their own mouth, nose or possibly their eyes. CDC clarified while it is still possible that a person can catch it from touching a contaminated surface, it's "not thought to be the main way the virus spreads."

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Role of Healthcare Surface Environment in SARS-CoV-2 Transmission

Kanamori, Weber, Rutala, Clin Infect Dis, , https://doi.org/10.1093/cid/ciaa1467, 28 September 2020

- Evidence suggests:
  - The healthcare environment contaminated with SARS-CoV-2 may play a role in transmission of SARS-CoV-2
  - Medical devices commonly used in daily practice also can be contaminated
  - Environmental surfaces in rooms occupied by patients with SARS-CoV-2 RNA and shared patient care items should be regularly and rigorously cleaned/disinfected by well-trained healthcare providers using appropriate disinfectant with an emerging viral pathogen claim.

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Role of Healthcare Surface Environment in SARS-CoV-2 Transmission

Kanamori, Weber, Rutala, Clin Infect Dis, https://doi.org/10.1093/cid/ciaa1467, 28 September 2020

SARS-CoV-2 RNA				
Bed rail	Sink	BP monitor	Infusion pump	Keyboard
Bedside table	Floor	ECG monitor	Fluid stand	Phone
Chair	Toilet seat	Oxygen regulator	Hand sanitizer	Computer mouse
Doorknob	Toilet bowl	Oxygen mask	Trash can	Door
Light switches	Stethoscope	CT scanner	Self-service printer	Glass window
Call button	Pulse oximetry	Ventilator	Desktop	PPE storage area
Centrifuge	Biosafety cabinet	Infant bed	Air outlet	Ambu bag
TV remote	Bed sheet	Urinary catheters	TV	Beepers
Elevator buttons	Ventilator tubing	Glove boxes	Touch screen	All surfaces in nurse's station

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Role of Healthcare Surface Environment in SARS-CoV-2 Transmission

Kanamori, Weber, Rutala, Clin Infect Dis, https://doi.org/10.1093/cid/ciaa1467, 28 September 2020

- CDC recommends that an EPA-registered disinfectant on the EPA's List N that has qualified under the emerging pathogen program for use against SARS-CoV-2 be chosen for the COVID-19 patient care.
- List N has >450 entries and 32 different active ingredients

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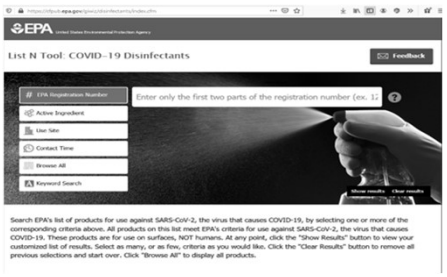
List N Tool: COVID-19 Disinfectants

https://cfpub.epa.gov/giwiz/disinfectants/index.cfm



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List N Tool: COVID-19 Disinfectants
32 Active Ingredients

- Ethyl alcohol
- Hydrogen peroxide
- Hypochlorous acid
- Isopropyl alcohol
- Peracetic acid
- Phenolic
- Quaternary ammonium

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Inactivation of Coronavirus
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Table 8. Inactivation of coronaviruses by different types of biocidal agents in suspension tests.

Biocidal agent	Concentration	Virus	Strain / Isolate	Exposure time	Reduction of viral infectivity (log_{10})	Reference
Ethanol	95%	SARS-CoV	Isolate FFM-1	30 s	≥ 5.5	[29]
	85%	SARS-CoV	Isolate FFM-1	30 s	≥ 5.5	[29]
	80%	SARS-CoV	Isolate FFM-1	30 s	≥ 4.3	[29]
	80%	MERS-CoV	Strain EMC	30 s	> 4.0	[14]
	78%	SARS-CoV	Isolate FFM-1	30 s	≥ 5.0	[28]
	70%	MHV	Strains MHV-2 and MHV-N	10 min	> 3.9	[30]
	70%	CCV	Strain I-71	10 min	> 3.3	[30]
	70%	SARS-CoV	Isolate FFM-1	30 s	≥ 5.5	[29]
2-Propanol	75%	SARS-CoV	Isolate FFM-1	30 s	≥ 4.0	[14]
	75%	MERS-CoV	Strain EMC	30 s	≥ 4.0	[14]
	70%	SARS-CoV	Isolate FFM-1	30 s	≥ 3.3	[28]
	50%	MHV	Strains MHV-2 and MHV-N	10 min	> 3.7	[30]
	50%	CCV	Strain I-71	10 min	> 3.7	[30]
2-Propanol and 1-propanol	45% and 30%	SARS-CoV	Isolate FFM-1	30 s	≥ 4.3	[29]
		SARS-CoV	Isolate FFM-1	30 s	≥ 2.8	[28]
Benzalkonium chloride	0.2%	HCoV	ATCC VR-759 (strain OC43)	10 min	0.0	[31]
	0.05%	MHV	Strains MHV-2 and MHV-N	10 min	> 3.7	[30]
	0.05%	CCV	Strain I-71	10 min	> 3.7	[30]
	0.00175%	CCV	Strain S378	3 d	3.0	[32]
Didecyldimethyl ammonium chloride	0.0025%	CCV	Strain S378	3 d	> 4.0	[32]
Chlorhexidine digluconate	0.02%	MHV	Strains MHV-2 and MHV-N	10 min	0.7 – 0.8	[30]
	0.02%	CCV	Strain I-71	10 min	0.3	[30]
Sodium hypochlorite	0.21%	MHV	Strain MHV-1	30 s	≥ 4.0	[33]
	0.01%	MHV	Strains MHV-2 and MHV-N	10 min	2.3 – 2.8	[30]
	0.01%	CCV	Strain I-71	10 min	1.1	[30]
	0.001%	MHV	Strains MHV-2 and MHV-N	10 min	0.3 – 0.6	[30]
	0.001%	CCV	Strain I-71	10 min	0.9	[30]
Hydrogen peroxide	0.5%	HCoV	Strain 229E	1 min	> 4.0	[34]
Formaldehyde	1%	SARS-CoV	Isolate FFM-1	2 min	> 3.0	[28]

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Inactivation of Coronavirus
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	0.7%	SARS-CoV	Isolate FFM-1	2 min	> 3.0	[28]
	0.7%	MHV		10 min	> 3.5	[30]
	0.7%	CCV	Strain I-71	10 min	> 3.7	[30]
	0.009%	CCV		24 h	> 4.0	[35]
Glutaraldehyde	2.5%	SARS-CoV	Hanoi strain	5 min	> 4.0	[36]
	0.5%	SARS-CoV	Isolate FFM-1	2 min	> 4.0	[28]
	7.5%	MERS-CoV	Isolate HCoV-EMC/2012	15 s	4.6	[37]
	4%	MERS-CoV	Isolate HCoV-EMC/2012	15 s	5.0	[37]
	1%	SARS-CoV	Hanoi strain	1 min	> 4.0	[36]
	1%	MERS-CoV	Isolate HCoV-EMC/2012	15 s	4.3	[37]
Povidone iodine	0.47%	SARS-CoV	Hanoi strain	1 min	3.8	[36]
	0.25%	SARS-CoV	Hanoi strain	1 min	> 4.0	[36]
	0.23%	SARS-CoV	Hanoi strain	1 min	> 4.0	[36]
	0.23%	SARS-CoV	Isolate FFM-1	15 s	≥ 4.4	[38]
	0.23%	MERS-CoV	Isolate HCoV-EMC/2012	15 s	≥ 4.4	[38]

SARS = Severe Acute Respiratory Syndrome; MERS = Middle East Respiratory Syndrome; MHV = mouse hepatitis virus; CCV = canine coronavirus; HCoV = human coronavirus.

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Recommendations for Cleaning and Disinfecting of Noncritical Surfaces and Medical Devices in COVID-19 Patient Care
Kanamori, Weber, Rutala, Clin Infect Dis, https://doi.org/10.1093/cid/ciaa1467, 28 September 2020

- Standardize cleaning/disinfection of environmental surfaces and medical devices in rooms occupied by COVID-19 patients.
- Follow CDC recommendation for letting room remain empty (or wearing PPE required for COVID-19 patient care) after discharge for the specified time period.
- Provide education and training for cleaning/disinfecting staff on proper donning and doffing of PPE as recommended by CDC.

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Air changes/hour (ACH) and time required for airborne-contaminant removal by efficiency *

ACH § ¶	Time (mins.) required for removal 99% efficiency	Time (mins.) required for removal 99.9% efficiency
2	138	207
4	69	104
6**	46	69
8	35	52
10**	28	41
12**	23	35
15**	18	28
20	14	21
50	6	8

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Health Care Providers (HCP) Fighting COVID-19
HCP, including EVS, worked heroically to fight transmission-Lompoc Valley

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Environmental Issues

- Environmental Sampling
- Hand Hygiene
- Surface Contamination
- Medical Waste
- Linen
- Plant Engineering
- Nutrition and Food Services
- Disinfection and Sterilization

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THANK YOU!

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