262

Microbial Load on Environmental Surfaces: The Relationship Between Reduced Environmental Contamination and Reduction of Healthcare-Associated Infections

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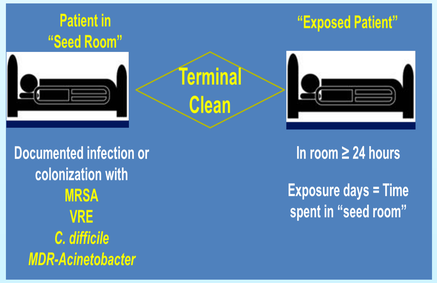
Background

- Disinfection of noncritical environmental surfaces in patient room and shared equipment is an essential component of an infection prevention program.
- Noncritical environmental surfaces and noncritical medical equipment surfaces may become contaminated with infectious agents and may contribute to cross-transmission directly or by leading to acquisition of transient hand carriage by healthcare personnel.
- Disinfection should render surfaces and equipment free of pathogens in sufficient numbers that cause human disease (i.e., hygienically clean).
- We sought to characterize the level of microbial contamination of environmental surfaces as well as the level of microbial contamination needed that is sufficient to put the next patient at risk of acquiring the previous patient's pathogen at two hospitals.
- We monitored four "marker" MDROs (i.e., methicillin-resistant *Staphylococcus aureus* [MRSA], vancomycin-resistant enterococci [VRE], *Clostridium difficile* and multidrug-resistant [MDR] *Acinetobacter baumannii* complex.
- These organisms were chosen due to their importance as pathogens in HAIs, and propensity to contaminate and persist on hospital room surfaces, making them ideal markers by which to study bacterial transmission in the hospital setting.
- The current study was performed in selected hospitals contemporaneously with the BETR-Disinfection study (NCT01579370), a multicenter cross-over study comparing the feasibility and effectiveness of three enhanced disinfection strategies for terminal room disinfection against standard practice.
- The overlap of the current study with the BETR-Disinfection study allowed us to evaluate risk of bacterial transmission occurring during implementations of best-known strategies to disinfect environmental surfaces.

Methods



- Rooms of patients on contact precautions decontaminated with standard or enhanced methods and "exposed" patient monitored for target MDROs.
- At each study visit, microbiological samples were also collected from eight previously-identified high-frequency-touch surfaces in the hospital room of the study subject; these surfaces included the bed rail, over-bed table, top of the nearest bedside table, arm rest of chair, sink, toilet seat, shower floor, and bathroom floor.
- Each surface was sampled repeatedly using ten individual Rodac plates (five for aerobic and the remaining five for anaerobic culture) to enhance microbiological yield and to reduce sampling error.
- Each Rodac plate samples 25cm^2 so 5 Rodac plates sample 125cm^2.
- Overall the number of rooms sampled was Quat, 21; Quat/UV, 28; Bleach, 23; and, Bleach/UV, 20.

Results

Table 1. Epidemiologically-Important Pathogens (EIP) by Intervention and Contamination in Patient Rooms

		Treatment (mean CFUs per room)				P-value		
Room type	Pathogen	Quat (N=21)	Quat/UV (N=28)	Bleach (N=23)	Bleach/UV (N=20)	Quat vs Quat/UV	Quat vs Bleach	Quat vs Bleach/UV
Patient room only	MDR-*Acinetobacter*	8.76	0.18	0.39	0.25			
	C. difficile	0	0.07	0.04	0			
	MRSA	2.33	0.11	2.13	0.05			
	VRE	8.62	0.07	0.78	0.35	0.029		
	EIP	19.71	0.43	3.35	0.65	0.003	0.013	0.006
Bathroom only	MDR-*Acinetobacter*	0.19	0	0	0	0.0009	0.001	0.002
	C. difficile	3.76	2.79	4.43	3.25			
	MRSA	6.19	0	2.26	0.80			
	VRE	30.95	0.14	1.65	1.55			
	EIP	41.10	2.93	8.35	5.60	0.033		
Patient room and bathroom	MDR-*Acinetobacter*	8.95	0.18	0.39	0.25			
	C. difficile	3.76	2.86	4.48	3.25			
	MRSA	8.52	0.11	4.39	0.85			
	VRE	39.57	0.21	2.43	1.90	0.028	0.047	
	EIP	60.81	3.36	11.70	6.25	0.013	0.041	0.028

P-values are shown only when P < 0.05.

Table 2. Relationship between microbial reduction of epidemiologically-important pathogens (EIP) and colonization/infection in a patient subsequently admitted to a room of a patient colonized/infected with an EIP by decontamination method.

	Standard Method	Enhanced method		
	Quat	Quat/UV	Bleach	Bleach/UV
EIP (mean CFUs per room)	60.81	3.36	11.70	6.25
Reduction (%)		94	81	90
Colonization/Infection (rate)	2.3	1.5	1.9	2.2
Reduction (%)		35	17	4

Reduction in an enhanced method is calculated compared to standard method.

Results Summary

- Our data demonstrated that the number of epidemiologically-important pathogens following disinfection was highest with use of a Quat and lowest with the use of Quat/UV.
- All enhanced disinfection interventions (i.e., Quat/UV, Bleach, Bleach/UV) were significantly superior to a Quat alone (standard method) in reducing epidemiologically-important pathogens in the patient's room and patient's room plus bathroom.
- However, only Quat/UV achieved a significant reduction for the bathroom alone.
- There were no statistical differences between any of the three enhanced methods (i.e., Quat/UV, Bleach, and Beach/UV) in reducing epidemiologically-important pathogens for any surfaces (i.e., patient room only, bathroom only, patient's room plus bathroom).
- The BETR-Disinfection study demonstrated the rate of colonization/infection in a patient subsequently admitted to a room with of a patient colonized/infected with an epidemiologically-important pathogen as Quat, 2.3%; Quat/UV, 1.5%; Bleach, 1.9%, and Bleach/UV, 2.2%.
- Comparing the best strategy with the worst strategy (i.e., Quat vs Quat/UV) revealed that a reduction of 94% in epidemiologically-important pathogens (i.e., 60.8 vs 3.36) lead to a 35% decrease in colonization/infection (i.e., 2.3% vs 1.5%).

Conclusions

- Our data demonstrated that a decrease in room contamination is associated with a decrease in subsequent patient colonization/infection.
- The fact that this decrease did not entirely eliminate colonization/infection may have been due to other transmission mechanisms or that further reduction of epidemiologically-important pathogens is required to reduce subsequent colonization/infection.
- We showed that an enhanced method of room decontamination is superior to a standard method.
- Hospitals should consider the use of an enhanced method of room decontamination for terminal disinfection.

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