



Published in final edited form as:

Infect Control Hosp Epidemiol. 2017 September ; 38(9): 1110–1113. doi:10.1017/ice.2017.133.

Patient Hand Colonization with MDROs Is Associated with Environmental Contamination in Post-acute Care

Payal K. Patel, MD MPH^{1,2}, Julia Mantey, MPH, MUP¹, and Lona Mody, MD, MSc^{1,2}

¹University of Michigan Medical School, Ann Arbor, MI, USA

²Ann Arbor Veterans Affairs Healthcare System, Ann Arbor, MI, USA

Abstract

We assessed MDRO patient hand colonization in relation to the environment in post-acute care and described risk factors for MDRO hand colonization. We showed that patient hand colonization was significantly associated with environmental contamination. Risk factors for hand colonization included disability, urinary catheter, recent antibiotic use, and prolonged hospital stay.

Keywords

Infection Control; Hand Hygiene; Drug Resistance; Microbial; Risk Factors

Introduction

Evidence that healthcare personnel serve as vectors for MDRO transmission is extensive.¹ Patients in modern healthcare systems are especially mobile, encouraged to be independent, and frequently visit common areas. We performed this study to further understand the role of patient hand colonization in transmission and spread of MDROs within post-acute care (PAC) facilities.

Methods

As described in previous work,² a prospective microbial surveillance study was conducted at six PAC facilities in Southeast Michigan. Facilities were for-profit and ranged in size from 74 to 143 beds. 41–51% of eligible patients were enrolled at each facility (Supplemental Table 1). On each visit, swabs were collected from patients' hands, other anatomic sites, and from high-touch surfaces in the environment.² MRSA, VRE and RGNB were identified using standard microbiological methods. Study personnel also collected information on patient characteristics and medical history.³

Corresponding Author: Payal K. Patel MD, MPH, University of Michigan, Infectious Disease Clinic, Taubman Center Floor 3 Reception D, 1500 E. Medical Center Dr. SPC 5352, Ann Arbor, MI 48109, Office: 734-845-5695, Fax: 734-845-3290, payalkp@umich.edu. Alternate Corresponding Author: Lona Mody, MD, M.Sc, University of Michigan Medical School, Division of Geriatric and Palliative Care Medicine, 300 N. Ingalls Rd., Rm. 905, Ann Arbor, MI 48109, Tel: 734-764-8942, Fax: 734-936-2116, lonamody@umich.edu.

Potential Conflicts of Interest:

All authors report no conflicts of interest.

We used multinomial logistic regression to compare the relative risk of MDRO hand colonization, as well as colonization at any site (other than hands), versus no colonization at any body site, clustering by facility. First, we conducted univariate analyses. We conducted a multivariate analysis including factors found to be significant at P -value $.05$ in the univariate analyses.

To evaluate whether hand colonization with MDROs was associated with environmental contamination with the same MDRO, we evaluated all visit samples and used Pearson's chi-squared test to assess the independence of patient hand and room colonization for each MDRO.

Results

Bacterial swabs were obtained from 650 patients and rooms over 1,607 study visits (18,689 patient-days), including 14,869 environmental samples. Most patients (94.9%) were admitted to a PAC following an acute care hospital stay. The average time to enrollment was 5.6 days. Mean age was 74.7 years (SD 12.2). Average Physical Self-Maintenance Scale (PSMS)⁴ score at baseline was 14.5 (SD 4.6), and average Charlson Comorbidity Score⁵ was 2.6 (SD 2.1). The mean study follow-up time was 29 days (SD 44.1 days), 2.5 visits (SD 1.7) per patient. At enrollment, 54 (8.4%) patients had an indwelling urinary catheter, 17 (2.6%) had a feeding tube, and 80 (12.4%) had a peripherally-inserted central catheter.

A total of 164 (25.4%) patients were colonized with an MDRO on their hands at baseline. To assess risk factors, we compared the relative risk of hand colonization with any MDRO as well as colonization of other body sites (but not hands) versus no colonization at baseline. Significant multivariate predictors of hand colonization included male sex (RR 1.62 [95% CI, 1.30–2.01]), PSMS score (RR 1.10 [1.08–1.12]), urinary catheter (RR 1.79 [1.13–2.86]), antibiotic use in prior 30 days (RR 2.24 [1.78–2.80]), and recent prolonged (>2 weeks) hospital stay (RR 5.01 [2.71–9.27]) (Table 1). Disabilities in bathing (RR 2.22 [1.66–2.97]), ambulation (RR 2.66 [2.05–3.44]), toileting (RR 2.44 [2.09–2.85]), dressing (RR 2.19 [1.40–3.43]), and grooming (RR 1.79 [1.30–2.46]) were independent predictors of MDRO hand colonization.

In a sensitivity analysis of 175 patients enrolled within 3 days of PAC admission, male sex, PSMS score, and antibiotic use in prior 30 days remained significant predictors (Supplemental Table 2). Very few patients in this subpopulation had urinary catheters or prolonged hospitalizations, limiting the strength of significance testing.

Association between Patient Hand Colonization and Environmental Contamination

Patients' hands were colonized with MRSA at 174 visits (10.8% of 1,605 visits); VRE on 218 visits (13.6% of 1,607 visits); and RGNB on 91 visits (5.7% of 1,607 visits). Patient rooms were contaminated with MRSA on 429 visits (26.7% of 1,605 visits); VRE on 725 visits (45.1% of 1,607 visits); and RGNB on 502 visits (31.2% of 1,607 visits). Patients' hands and their environment were positive for the same organism in 21.9% of visits (352 of

1,607 visits). Hand colonization with MRSA, VRE, and RGNB were associated with analogous environmental contamination (Table 2). Examining hand colonization among patients followed for at least 60 days (4 visits), we found MRSA and VRE hand colonization to be more persistent than RGNB (Supplemental Table 3).

Discussion

In our study, patient hand colonization with an MDRO was pervasive. Functional disability, indwelling medical devices, and recent antibiotic use were predictive of an MDRO on patients' hands at baseline. When patients' hands were found to be colonized with an MDRO, their environment was often contaminated with the same MDRO. Our findings suggest that environmental contamination is significantly associated with patient hand colonization.

Our results support other work that has shown MDRO colonization in PAC is widespread and that patient disability increases the risk of acquiring an MDRO.^{3, 6} In acute care, contaminated environment has been shown to contribute to MDRO transmission and interventions targeting improved environmental cleaning can decrease the risk of patients becoming infected.⁷ We further this work by assessing the role patient hands may play in MDRO colonization and transmission. The connection between disability and risk of MDRO colonization is important because when patients are unable to independently move around or use the bathroom, they are less likely to have direct access to a sink or alcohol-based hand rub, increasing the risk of transmission. Some patients had hand colonization but negative environmental contamination, suggesting they may have acquired the MDRO from another source (healthcare worker or common area).

Evidence correlating environmental contamination to patient colonization with MDROs in the PAC setting is scarce; most studies are based in acute care.⁸ Building on patient hand hygiene as a concept for infection control, future studies should focus on well-designed trials with patient hand hygiene interventions, measures of pathogen colonization and infection, and what role patient hands may have in self-inoculation.

The strengths of this study are its prospective design, unique population and ample environmental and anatomic site sampling. This study has several limitations. First, we focused on newly admitted PAC patients; a similar study should be done that focuses on institutionalized patients who are in long-term care. Second, conducting molecular typing is critical to understand transmission dynamics and should be addressed in future studies, but was beyond the scope of this study. Third, patient microbiological data previous to arrival and history of prior room occupants was not known. Fourth, swabs for environmental culture may not be the most sensitive method for detecting contamination and may underestimate our findings. Finally, we sampled for-profit PAC facilities in Southeast Michigan; thus, results may not be generalizable nationwide. However, epidemiological investigations in nursing homes across the nation have also shown high prevalence and new acquisition of MDROs.⁹

Targeting patient hand hygiene in the PAC setting is practical. Simplicity in innovation is important to uptake of practice, especially in healthcare settings. One of the most successful interventions for hand hygiene has been the implementation of alcohol-based hand rub practices.¹⁰ The act of having patients wash their hands also incorporates emerging concepts of active patient engagement and shared responsibility in patient safety.

Further investigation of patient hands as a target of enhanced infection prevention in those with known pathogen colonization may be of high yield. If hand colonization with pathogens can be decreased, there may be an associated decrease in environmental colonization and possibly infection.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Funding/ Support

This work was supported by the National Institute on Aging [RO1 AG041780 and K24 AG050685 to LM] and the Centers for Disease Control and Prevention [BAA 200-2016-91954 to LM and PKP].

We thank Marco Cassone, Sara McNamara, Bonnie Lansing, and Kristen Gibson for their efforts in data collection and laboratory testing. We thank all facilities, personnel, and patients for their participation.

References

1. Haun N, Hooper-Lane C, Safdar N. Healthcare personnel attire and devices as fomites: a systematic review. *Infect Control Hosp Epidemiol*. 2016; 37:1367–1373. [PubMed: 27609491]
2. Cao J, Min L, Lansing B, Foxman B, Mody L. Multidrug-resistant organisms on patients' hands: a missed opportunity. *JAMA Intern Med*. 2016; 176:705–706. [PubMed: 26974592]
3. Mody L, Krein SL, Saint S, et al. A targeted infection prevention intervention in nursing home residents with indwelling devices: a randomized clinical trial. *JAMA Intern Med*. 2015; 175(5):714–23. [PubMed: 25775048]
4. Lawton MP, Brody EM. Assessment of older people: self-maintaining and instrumental activities of daily living. *Gerontologist*. 1969; 9:179–186. [PubMed: 5349366]
5. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis*. 1987; 40:373–383. [PubMed: 3558716]
6. Min L, Galecki A, Mody L. Functional disability and nursing resource use are predictive of antimicrobial resistance in nursing homes. *J Am Geriatr Soc*. 2015; 63:659–666. [PubMed: 25857440]
7. Otter JA, Yezli S, Salkeld JA, French GL. Evidence that contaminated surfaces contribute to the transmission of hospital pathogens and an overview of strategies to address contaminated surfaces in hospital settings. *Am J Infect Control*. 2013; 41:S6–11. [PubMed: 23622751]
8. Srigley JA, Furness CD, Gardam M. Interventions to improve patient hand hygiene: a systematic review. *J Hosp Infect*. 2016; 94:23–29. [PubMed: 27262906]
9. McKinnell JA, Miller LG, Singh R, et al. Prevalence of and factors associated with multidrug resistant organism (MDRO) colonization in 3 nursing homes. *Infect Control Hosp Epidemiol*. 2016:1–4. [PubMed: 26633292]
10. Mody L, McNeil SA, Sun R, Bradley SE, Kauffman CA. Introduction of a waterless alcohol-based hand rub in a long-term-care facility. *Infect Control Hosp Epidemiol*. 2003; 24:165–171. [PubMed: 12683506]

Article Summary Line

Patient hand colonization with MDROs is common, particularly in patients with functional disability, devices and recent antibiotic use. Environmental contamination with MDROs strongly correlates with patient hand MDRO colonization.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Table 1

Predictors of Patient Hand Colonization with Multi-drug Resistant Organisms

Characteristic	No Colonization [n=277]			Patient Colonization ^d			Hands Colonized [n=164] (%)		
	n (%)	No Hand Colonization, Other Body Site(s) Colonized [n=204]	Multivariate RR (95% CI)	n (%)	Multivariate RR (95% CI)	n (%)	Multivariate RR (95% CI)		
Age, mean (SD)	74.6 (12.8)	74.6 (11.6)	1.00 (0.98–1.02)	74.8 (12.0)	1.01 (0.99–1.03)	74.8 (12.0)	1.01 (0.99–1.03)		
Male	110 (39.7)	82 (40.2)	1.09 (0.83–1.43)	81 (49.4) *	1.62 (1.30–2.01) **	81 (49.4) *	1.62 (1.30–2.01) **		
Charlson Comorbidity Score, mean(SD)	2.5 (2.1)	2.4 (2.0)	0.95 (0.86–1.05)	2.9 (2.0) *	1.01 (0.92–1.10)	2.9 (2.0) *	1.01 (0.92–1.10)		
Cognitive Sum Score, mean(SD), ^{b,d}	12.8 (3.5)	13.1 (3.2)	NA	12.7 (3.6)	NA	12.7 (3.6)	NA		
Physical Self Maintenance Score, mean (SD) ^c	13.6 (4.3)	14.4 (4.7)	1.05 (0.99–1.11)	15.8 (4.6) *	1.10 (1.08–1.12) **	15.8 (4.6) *	1.10 (1.08–1.12) **		
Feeding Disability	13 (4.7)	20 (9.8) *	2.18 (1.16–4.08) **	10 (6.1)	0.94 (0.47–1.87)	10 (6.1)	0.94 (0.47–1.87)		
Bathing Disability	126 (45.5)	106 (52.0)	1.30 (0.94–1.80)	108 (65.9) *	2.22 (1.66–2.97) **	108 (65.9) *	2.22 (1.66–2.97) **		
Ambulation Disability	161 (58.1)	121 (59.3)	1.08 (0.71–1.65)	126 (76.8) *	2.66 (2.05–3.44) **	126 (76.8) *	2.66 (2.05–3.44) **		
Toileting Disability	69 (24.9)	64 (31.4) *	1.37 (1.04–1.82) **	78 (47.6) *	2.44 (2.09–2.85) **	78 (47.6) *	2.44 (2.09–2.85) **		
Dressing Disability	151 (54.5)	119 (58.3)	1.19 (0.84–1.68)	118 (72.0) *	2.19 (1.40–3.43) **	118 (72.0) *	2.19 (1.40–3.43) **		
Grooming Disability	64 (23.1)	55 (27.0)	1.24 (0.78–1.97)	61 (37.2) *	1.79 (1.30–2.46) **	61 (37.2) *	1.79 (1.30–2.46) **		
Urinary Catheter	14 (5.1)	15 (7.4) *	1.14 (0.79–1.63)	25 (15.2) *	1.79 (1.13–2.86) **	25 (15.2) *	1.79 (1.13–2.86) **		
Feeding Tube	3 (1.1)	8 (3.9)	NA	6 (3.7)	NA	6 (3.7)	NA		
Peripherally-inserted central venous catheter	26 (9.4)	24 (11.8)	1.13 (0.51–2.48)	30 (18.3) *	1.54 (0.85–2.79)	30 (18.3) *	1.54 (0.85–2.79)		
Antibiotic Use in previous 30 days ^d	142 (53.0)	127 (63.5) *	1.50 (1.09–2.07) **	120 (74.5) *	2.24 (1.78–2.80) **	120 (74.5) *	2.24 (1.78–2.80) **		
Diabetes	107 (38.6)	89 (43.6)	1.31 (0.89–1.92)	78 (47.6) *	1.34 (0.99–1.82)	78 (47.6) *	1.34 (0.99–1.82)		
Dementia ^d	46 (16.7)	34 (16.7)	NA	29 (17.7)	NA	29 (17.7)	NA		
Prolonged Hospital Stay (>2 weeks)	11 (4.0)	16 (7.8) *	1.84 (1.07–3.16) **	33 (20.1) *	5.01 (2.71–9.27) **	33 (20.1) *	5.01 (2.71–9.27) **		

^a N=645; 5 patients were not cultured on hands at baseline.

^b Possible Cognitive Sum Score range, 0 to 15; higher scores indicating higher cognitive function.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

^cPossible Physical Self Maintenance Score range, 6 to 30, higher scores indicating more functional disability.

^dThese variables had missing data. The totals for each are: cognitive sum score, $n=627$; antibiotic use, $n=644$. For multivariate analyses, missing values were assigned as zero, and a missing control was added.

* These variables were significant at $P < .05$ in clustered univariate analysis and included in the adjusted model. Disability variables are collinear; adjusted RRRs for these do not include other disability variables.

** These variables were significant at $P < .05$ in clustered multivariate analysis.

Table 2

Association between Patient Hand Colonization and Environmental Contamination with MDROs (all visits)

	Patient Environment			
	Positive (%)	Negative (%)	Total	
MRSA Colonization				
Positive	145 (83.3)	29 (16.7)	174	
Negative	284 (19.9)	1147 (80.2)	1431	<.001
Total	429	1176	1605 ^a	
VRE Colonization				
Positive	202 (92.7)	16 (7.3)	218	
Negative	523 (37.7)	866 (62.4)	1389	<.001
Total	725	882	1607	
RGNB Colonization				
Positive	57 (62.6)	34 (37.4)	91	
Negative	445 (29.4)	1071 (70.7)	1516	.01
Total	502	1105	1607	

^aResults were inconclusive for MRSA colonization in two hand samples.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript