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ORIGINAL ARTICLE

Contact Precautions: More Is Not Necessarily Better

Sorabh Dhar, MD;^{1,2} Dror Marchaim, MD;³ Ryan Tansak, MD;⁴ Teena Chopra, MD;¹ Adnan Yousuf, MD;⁵ Ashish Bhargava, MD;¹ Emily T. Martin, MPH, PhD;¹ Thomas R. Talbot, MD, MPH;⁶ Laura E. Johnson, MD;⁷ Ameet Hingwe, MD;⁸ Jerry M. Zuckerman, MD;⁹ Bartholomew R. Bono, MD;¹⁰ Emily K. Shuman, MD;¹¹ Jose Poblete, MD;¹² MaryAnn Tran, MD;¹³ Grace Kulhanek, MD;¹³ Rama Thyagarajan, MD;¹⁴ Vijayalakshmi Nagappan, MD;¹⁴ Carrie Herzke, MD;¹⁵ Trish M. Perl, MD, MSc;¹⁵ Keith S. Kaye, MD, MPH¹

(See the commentary by Anderson et al, on pages 222–224.)

OBJECTIVE. To determine whether increases in contact isolation precautions are associated with decreased adherence to isolation practices among healthcare workers (HCWs).

DESIGN. Prospective cohort study from February 2009 to October 2009.

SETTING. Eleven teaching hospitals.

PARTICIPANTS. HCWs.

METHODS. One thousand thirteen observations conducted on HCWs. Additional data included the number of persons in isolation, types of HCWs, and hospital-specific contact precaution practices. Main outcome measures included compliance with individual components of contact isolation precautions (hand hygiene before and after patient encounter, donning of gown and glove upon entering a patient room, and doffing upon exiting) and overall compliance (all 5 measures together) during varying burdens of isolation.

RESULTS. Compliance with hand hygiene was as follows: prior to donning gowns/gloves, 37.2%; gowning, 74.3%; gloving, 80.1%; doffing of gowns/gloves, 80.1%; after gown/glove removal, 61%. Compliance with all components was 28.9%. As the burden of isolation increased (20% or less to greater than 60%), a decrease in compliance with hand hygiene (43.6%–4.9%) and with all 5 components (31.5%–6.5%) was observed. In multivariable analysis, there was an increase in noncompliance with all 5 components of the contact isolation precautions bundle (odds ratio [OR], 6.6 [95% confidence interval (CI), 1.15–37.44]; $P = .03$) and in noncompliance with hand hygiene prior to donning gowns and gloves (OR, 10.1 [95% CI, 1.84–55.54]; $P = .008$) associated with increasing burden of isolation.

CONCLUSIONS. As the proportion of patients in contact isolation increases, compliance with contact isolation precautions decreases. Placing 40% of patients under contact precautions represents a tipping point for noncompliance with contact isolation precautions measures.

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In 2002, an estimated 1.7 million healthcare-associated infections occurred and resulted in approximately 100,000 deaths in the United States.¹ Multidrug-resistant organisms (MDROs) comprise a significant portion of these infections and pose a unique challenge in both treatment and prevention.^{2–4} When compared with infections resulting from susceptible organisms, MDROs are associated with additional increases in mortality, hospital duration, and costs.⁵ Multiple methods to prevent MDRO transmission have been proposed; the majority focus on timely identification of patients colo-

nized or infected with MDROs, implementation of barrier precautions (gowns and gloves), and strict adherence to hand hygiene. These methods are collectively referred to as contact isolation precautions.

Contact isolation precautions require healthcare workers (HCWs) to adhere to the following steps: hand hygiene upon entering and leaving the patient room, donning unused gloves and gowns prior to entering, and doffing these items when leaving the room. Additional precautions to prevent transmission include the use of designated equipment (ie, steth-

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oscopes, blood pressure cuffs) or the cleaning of these devices after patient contact. Studies have shown that gloves and gowns become contaminated in up to 69% of interactions with patients colonized or infected with MDROs, and environmental contamination in these rooms can be as high as 73%.⁶ While guidelines have been published regarding which MDROs merit contact isolation precautions,⁶⁻⁸ application of these guidelines is not universally required, resulting in variations of practice.

Several studies have attempted to show benefits of contact isolation precautions in preventing transmissions and infections but have provided disparate results.⁹⁻¹⁹ Reasons for these varied findings may relate to differences in isolation protocols and poor compliance with contact isolation precautions. Studies observing the rates of compliance have consistently shown that HCWs perform below expectations.^{14,20-22} Compliance rates for glove/gown use have ranged from 22% to 79%, and associated handwashing rates often do not exceed 50%.^{13,22-24} Often, compliance varies as a function of location (such as intensive care unit [ICU]) and among different types of HCW.^{20,21,24} Barriers to achieving compliance include time constraints, conflicting data demonstrating direct benefits of contact isolation precautions, perceptions of decreased time spent with patients, and beliefs of psychological harm and decreased quality of care.^{19,25-29}

A question that has not previously been studied in a rigorous fashion and that may help to explain the disparate results is whether the proportion of patients in isolation is a determinant of compliance by HCW with contact isolation precautions. Contact isolation requires resources—both materials (gowns, gloves) and time for donning and doffing—that may become burdensome during times of high isolation. Understanding whether there is an inverse relationship between the proportions of patients in a given unit in contact isolation precautions (referred to as the burden of isolation) and the ability to maintain compliance may help in future efforts to reduce MDRO transmissions and infections.

METHODS

A multicenter, prospective cohort study was conducted from February 2009 through October 2009 in 11 hospitals after obtaining institutional review board approval: Detroit Receiving Hospital (Detroit, MI), Harper University Hospital (Detroit, MI), John D. Dingell Veteran's Affairs Medical Center (Detroit, MI), Henry Ford Hospital (Detroit, MI), Einstein Medical Center (Philadelphia, PA), Oakwood Hospital (Dearborn, MI), Sparrow Hospital (East Lansing, MI), Summa Akron City Hospital (Akron, OH), University of Michigan Health System (Ann Arbor, MI), Johns Hopkins Hospital (Baltimore MD), and Vanderbilt University Medical Center (Nashville, TN). Anonymous undercover observers (medical students, residents, infection control preventionists, and infectious disease physicians) were trained through conference calls to conduct observations and capture compliance data

for contact isolation precautions on acute care floors and in ICUs, using uniform definitions and data collection forms. Observations were conducted by observers situated outside of the patient rooms, where HCW practice could be directly visualized. The burden of isolation was defined as the percentage of patients in contact isolation precautions in the unit at the time of the observation (number of patients in contact isolation precautions/total number of patients in the unit) and documented by the observer at that time. If a team of multiple HCWs were observed entering a room, compliance was based on the actions of the person interacting with and/or examining the patient.

The components of contact isolation precautions compliance were categorized as (1) hand hygiene before donning gown and gloves, (2) gowning upon entering the patient's room, (3) gloving upon entering the patient's room, (4) doffing gown and glove upon leaving the patient's room, and (5) hand hygiene after doffing gown and gloves. Additional precautions if used (such as a dedicated stethoscope) were also recorded. Other data points captured included job category of the person observed (including student learners), presence of a team, and additional infection control precautions in place along with contact isolation precautions (eg, airborne or droplet).⁸ Along with the observation, the number of patients in contact isolation precautions and the total number of patients in that unit were counted and recorded by the observer to calculate the burden of isolation. If any variable were not observed (ie, unknown), it was marked and excluded in the final analysis.

A standardized survey was also completed by each hospital's infection control department detailing isolation practices at their institution. Information included the types of MDROs for which patients were isolated and local contact isolation precautions practices. Active surveillance was defined as the use of screening cultures to detect asymptomatic colonization with an MDRO and presumptive isolation as implementation of contact isolation precautions while awaiting the results of the screening cultures.

STATISTICAL ANALYSIS

All analyses utilized SAS software (ver. 9.2). The primary association analyzed was between contact isolation precautions compliance and burden of isolation. Overall compliance was defined as full compliance with all 5 components of the contact isolation precautions bundle. If any of the components had an unknown value, the observation was excluded during the analysis of the individual component and the 4 associated components were excluded in the calculation of the overall compliance rate. A χ^2 test was used for categorical variables and Wilcoxon rank sum test for continuous variables. To further test the assumption of a percentage of isolation at which compliance significantly decreases, the burden of isolation was analyzed in a logistic regression model with a categorical variable for burden of isolation. Also, a gener-

alized estimating equation model was generated to estimate the effect of each additional 10% increase in burden on the primary outcome (full compliance), controlling for correlation by study site. Burden of isolation in the 60%–100% range was collapsed into a single category because of low numbers of observations. Positive and negative imputations were done to understand the effects of unknown values. All *P* values were 2 sided.

RESULTS

Contact Isolation Practices at Study Hospitals

All sites defined contact isolation as the use of gowns and gloves (Table 1). Four sites also used masks as part of contact isolation. Contact isolation precautions were defined in this study as the use of gloves and gown only. Dedicated stethoscopes were available at the majority of sites ($n = 9$, 81.8%). Contact precautions were performed for a variety of pathogens. Contact precautions were implemented by all sites for carbapenem-resistant *Enterobacteriaceae*, 7 sites for methicillin-resistant *Staphylococcus aureus* (MRSA), 5 sites for extended-spectrum β -lactamase-producing enterobacteriaceae, and 5 sites for vancomycin-resistant enterococci. The mean number of different pathogens for which contact isolation

was performed in the non-ICU wards was 3.4 (median, 3.0; range, 1–6) and in the ICUs was 3.9 (median, 4.5; range, 2–6). Four sites utilized additional criteria based on the infectivity of an anatomic site (ie, a draining wound not adequately contained). Active surveillance for at least 1 MDRO was performed at 9 sites, with MRSA being the most common (6 sites). Four hospitals presumptively isolated patients while surveillance tests results were pending.

Compliance with Contact Isolation Precautions

A total of 1,013 observations were conducted, including 487 (48.2%) in ICUs and 524 (51.8%) in non-ICU wards. In 93 instances (9.2%), contact isolation precautions were conducted in conjunction with additional infection control precautions. The most common types of HCW observed included nurses ($n = 607$, 59.9%), attending physicians ($n = 133$, 13.1%), and trainees (ie, resident or fellows; $n = 101$, 10%). Most observations involved an individual provider rather than a group of HCWs ($n = 891$, 88%).

Compliance with the components of contact isolation precautions is detailed in Table 2. Compliance with hand hygiene was as follows: prior to donning gowns and gloves, 37.2%; gowning, 74.3%; gloving, 80.1%; doffing of gowns and gloves,

TABLE 1. Survey Results of Contact Isolation Practices at Study Sites ($n = 11$)

Variable	Acute care	Intensive care
Pathogens initiating contact isolation precautions		
CRE	11 (100)	11 (100)
CRAB	8 (73)	10 (91)
CSAB	1 (9)	2 (18)
ESBL	5 (45)	5 (45)
MRSA	7 (64)	8 (73)
VRE	5 (45)	5 (45)
Pathogens identified by active surveillance		
CRE	2 (18)	2 (18)
CRAB	1 (9)	1 (9)
CSAB	0 (0)	0 (0)
ESBL	0 (0)	0 (0)
MRSA	6 (55)	6 (55)
VRE	2 (18)	2 (18)
Infection site criteria ^a		
Contained	4 (36)	4 (36)
Noncontained	7 (64)	7 (64)
Protective equipment used in contact isolation precautions		
Gloves alone	0 (0)	0 (0)
Gloves + gowns	7 (64)	7 (64)
Gloves + gowns + masks	4 (36)	4 (36)
Presumptive isolation ^b	4 (44)	4 (44)
Use of dedicated equipment	9 (82)	9 (82)

NOTE. Data are no. (%) of study sites. CRAB, carbapenem-resistant *Acinetobacter baumannii*; CRE, carbapenem-resistant enterobacteriaceae; CSAB, carbapenem-sensitive *A. baumannii*; MRSA, methicillin-resistant *Staphylococcus aureus*; VRE, vancomycin-resistant enterococcus.

^a Clinical assessment of site of infections to determine whether contact isolation precautions are indicated. Contained: bacteremia, urinary tract infection; noncontained: purulent wounds.

^b In conjunction with active surveillance.

TABLE 2. Compliance with Contact Isolation Precautions

Variable	Hand hygiene			Gowning			Gloving			Doffing of gowns/gloves			Hand hygiene after removal			Overall (all 5 components)		
	n	Obs	Compliant P	Obs	Compliant P	Obs	Compliant P	Obs	Compliant P	Obs	Compliant P	Obs	Compliant P	Obs	Compliant P	Obs	Compliant P	
Total	1,013	933 (100)	347 (37.2)	...	1,000 (100)	743 (74.3)	...	996 (100)	798 (80.1)	964 (100)	772 (80.1)	...	956 (100)	583 (61.0)	...	848 (100)	245 (28.9)	...
HCW type																		
Attending	133	128 (13.7)	51 (39.8)	.55	131 (13.1)	96 (73.3)	.75	133 (13.5)	101 (75.9)	126 (13.1)	100 (79.4)	.81	127 (13.3)	79 (62.2)	.85	117 (13.8)	38 (32.5)	.40
Medical student	8	8 (0.9)	2 (25.0)	.72	8 (0.8)	8 (100)	.12	8 (0.8)	8 (100)	8 (0.8)	8 (100)	.37	8 (0.8)	5 (62.5)	1.0	8 (0.9)	2 (25.0)	1.0
Nursing staff	607	556 (59.6)	229 (41.2)	<.05	601 (60.1)	435 (43.5)	.09	592 (59.4)	472 (79.7)	578 (60.0)	461 (79.7)	.80	572 (59.8)	369 (64.5)	<.05	504 (59.4)	155 (30.8)	.16
OT/PRT	13	12 (1.3)	2 (16.7)	.23	13 (1.3)	12 (92.3)	.20	13 (1.3)	12 (92.3)	13 (1.4)	12 (92.3)	.48	13 (1.4)	10 (76.9)	.27	12 (1.4)	2 (16.7)	.53
Other/unknown	77	59 (6.3)	10 (17)	<.05	75 (7.5)	54 (5.4)	.68	75 (7.5)	57 (76)	67 (7.0)	46 (68.7)	.03	68 (7.1)	24 (35.3)	<.05	47 (5.5)	8 (17)	.07
Phlebotomist	14	14 (1.5)	5 (35.7)	1.0	14 (1.4)	13 (92.9)	.13	14 (1.4)	14 (100)	14 (1.5)	13 (92.9)	.32	14 (1.5)	9 (64.3)	1.0	14 (1.7)	4 (28.6)	1.0
Radiology tech	12	12 (1.3)	2 (16.7)	.12	12 (1.2)	11 (97.7)	.32	12 (1.2)	12 (100)	12 (1.2)	12 (100)	.14	11 (1.15)	6 (54.6)	.76	11 (1.3)	2 (18.2)	.74
Resident/fellow	101	98 (10.5)	30 (30.6)	.18	98 (9.8)	77 (78.6)	.33	101 (10.1)	85 (84.2)	99 (10.3)	83 (83.8)	.36	97 (10.2)	56 (57.7)	.51	92 (10.9)	22 (23.9)	.33
RT	48	46 (4.9)	16 (34.8)	.88	48 (4.8)	37 (77.1)	.74	48 (4.8)	37 (77.1)	47 (4.9)	37 (78.7)	.85	46 (4.8)	25 (54.4)	.36	43 (5.1)	12 (27.9)	1.0
Location																		
ICU	487	424 (45.5)	113 (26.7)	<.001	480 (48.1)	373 (77.7)	.02	473 (47.6)	383 (81)	465 (48.3)	368 (79.1)	.51	444 (46.5)	269 (60.6)	.89	379 (44.8)	84 (22.2)	<.001
Acute care floors	524	507 (54.5)	232 (45.7)		518 (51.9)	368 (71.1)		521 (52.4)	413 (79.3)	497 (51.7)	402 (80.9)		510 (53.5)	312 (61.2)		467 (55.2)	159 (34.1)	
Surveillance MRSA																		
Active	591	574 (58.6)	189 (34.5)	.054	585 (58.5)	431 (73.7)	.61	575 (57.7)	442 (76.9)	571 (59.2)	425 (74.4)	<.001	543 (56.8)	329 (60.6)	.80	495 (58.4)	150 (30.3)	.32
Passive	422	389 (41.4)	158 (40.9)		415 (41.5)	312 (75.2)		421 (42.3)	356 (84.6)	393 (40.8)	347 (88.3)		413 (43.2)	254 (61.5)		353 (41.6)	95 (26.9)	
Team compliance																		
No team	891	819 (87.7)	317 (38.7)	<.05	879 (87.9)	644 (73.3)	.06	874 (87.4)	695 (79.5)	848 (88.1)	672 (79.3)	.11	841 (88.1)	516 (61.4)	.48	744 (87.7)	219 (29.4)	.42
Team	121	114 (12.2)	30 (26.3)		120 (12.0)	98 (81.7)		121 (12.2)	102 (84.3)	115 (11.9)	99 (86.1)		114 (11.9)	66 (57.9)		104 (12.3)	26 (25.0)	

NOTE. Data are no. (%), unless otherwise indicated. Unknown observations (Obs) excluded. Comparator arms are specific healthcare worker (HCW) type versus all others. ICU, intensive care unit; MRSA, methicillin-resistant *Staphylococcus aureus*; OT/PRT, occupational therapy/physical therapy; RT, respiratory therapist.

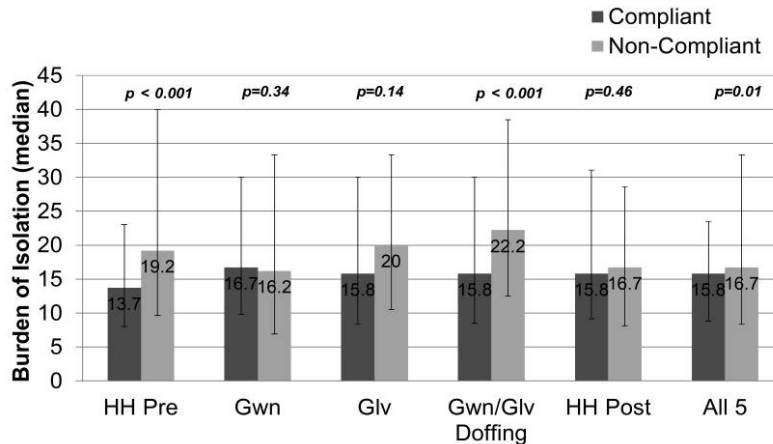


FIGURE 1. Median burden of isolation and compliance with contact isolation precautions. Comparison of compliant and noncompliant observations for each parameter of contact isolation precautions and contact isolation precautions bundle to the median number of patients placed in contact precautions for each component, respectively. HH Pre, hand hygiene prior to or shortly after entering room; Gwn, donning of gown at the time of or shortly after entering room; Glv, donning of gloves at the time of or shortly after entering room; Gwn/Glv Doffing, removal of glove and gown when leaving patient room; HH Post, hand hygiene when leaving patient room; All 5, 5 components of contact isolations precautions. Burden of isolation was defined as the proportion of patients on a given floor who were in contact isolation precautions at the time that the observation was conducted. Error bars display interquartile range for each component.

80.1%; and hand hygiene after doffing, 61%. Compliance with all 5 components of contact isolation precautions (ie, the contact isolation precautions bundle) was 28.9%. When comparing the ICU wards with non-ICU wards, compliance with hand hygiene prior to donning (26.7% vs 45.7%; $P < .001$) and with the contact isolation precautions bundle (22.2% vs 34.1%; $P < .001$) was significantly lower in ICUs. Compliance with use of gowns in ICUs was significantly higher (77.7% vs 71.1%; $P = .02$), and there were no significant differences in the other components. Sites conducting surveillance for MRSA were less likely to comply with hand hygiene (34.5% vs 40.9%; $P = .054$) and were significantly less likely to appropriately don gloves (76.9% vs 84.6%; $P = .003$) or doff gown and gloves (74.4% vs 88.3%; $P < .001$). Observations of teams revealed that the compliance with hand hygiene by the lead provider upon entry was significantly lower compared with a provider entering alone (26.3% vs 38.7%; $P < .05$).

The median percentage of patients in contact isolation where observations were conducted (median burden of isolation) was 16.7% (interquartile range, 9.1–31.0). The median burden of isolation was significantly greater among noncompliant encounters compared with compliant encounters for hand hygiene prior to room entry (13.7% vs 19.2%; $P < .01$), gown and glove doffing (15.8% vs 22.2%; $P < .001$), and overall compliance with the contact isolation precautions bundle (15.8% vs 16.7%; $P = .01$; Figure 1). To further evaluate the effect of increasing isolation on adherence, compliance was analyzed comparing intervals of increasing isolation (Figure 2). As the burden of isolation increased, there was a stepwise decrease in hand hygiene compliance upon room entry from 43.6% (when the burden of isolation was

less than 20%) to 4.9% (when the burden exceeded 60%). A similar reduction was noted for compliance with the contact isolation precautions bundle, from 31.5% (when the burden of isolation was less than 20%) to 6.5% (when the burden exceeded 60%). In multivariable analysis controlling for confounding effects of individual hospitals, compared with a burden of isolation of less than 20%, there was a significant increase in noncompliance with all 5 components (odds ratio [OR], 6.6 [95% confidence interval (CI), 1.15–37.44]; $P = .03$) and in noncompliance with hand hygiene prior to donning (OR, 10.1 [95% CI, 1.84–55.54]; $P < .008$; Figure 3). After controlling for the effect of correlation by study site (generalized estimating equation model), noncompliance for completing all 5 components significantly increased for each additional 10% of burden up to the highest category (60%–100%); OR, 1.19 [95% CI, 1.03–1.38]; $P = .02$) and in noncompliance with hand hygiene prior to donning of gowns or gloves (OR, 1.2 [95% CI, 1.07–1.38]; $P = .002$). All other individual contact isolation precautions components were nonsignificant. Of the 1,013 HCW observations for all 5 contact isolation precautions variables, 4.9% of the individual data points were unknown (248 out of 5,065). Positive and negative imputation had no meaningful impact on the results, with the exception of the fully compliant end point, for which negative imputation resulted in a loss of significance (OR, 1.03 [95% CI, 0.92–1.16]; $P = .56$).

DISCUSSION

Overall, compliance with contact isolation precautions was unacceptably low (28.9% for all 5 components and ranging

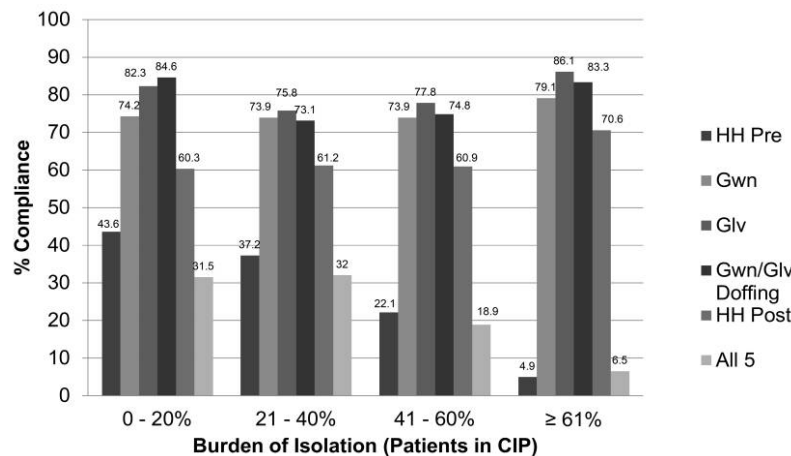


FIGURE 2. Impact of burden of isolation on contact isolation precautions (CIP) compliance. Comparison of the compliance with components of contact isolation precautions and contact isolation precautions bundle with increasing burdens of isolation. HH Pre, hand hygiene prior to or shortly after entering room; Gwn, donning of gown at the time of or shortly after entering room; Glv, donning of gloves at the time of or shortly after entering room; Gwn/Glv Doffing, removal of glove and gown when leaving patient room; HH Post, hand hygiene when leaving patient room; All 5, 5 components of contact isolations precautions. Burden of isolation was defined as the proportion of patients on a given floor who were in contact isolation precautions at the time that the observation was conducted.

from 37.2% to 80.1% for any individual component; Table 2). The component of contact isolation precautions most frequently not complied with was hand hygiene prior to donning gloves and gown. Although gloves decrease risk for spread of pathogens from HCWs, performing hand hygiene prior to gloving decreases the risk for contamination of gloves.³⁰ Conversely, gloves do not guarantee protection for the hands, as bacterial pathogens have been isolated from the hands of hospital personnel after the removal of contaminated gloves.³¹ There is an 8-fold reduction in bacteria on HCWs hands as a result of the use of gloves, but it does not completely eliminate hand contamination.³² The lack of handwashing with or without the use of gloves likely increases the risk of transmission of pathogens to patients or to the environment (doorknobs, papers, pens, medical equipment). Recognition of the importance of hand hygiene prior to donning gloves might be improved through education and feedback to providers.

This study demonstrates a negative impact on compliance with contact isolation precautions associated with an increasing proportion of patients in contact isolation. The effect of burden of isolation on noncompliance increased in a stepwise fashion as the burden of isolation of patients increased, and when the numbers in isolation exceeded 60%, compliance with all 5 components of the contact isolation precautions bundle decreased by more than 6-fold. This finding has profound implications for infection control policy and hospital practice. For contact isolation precautions, the 40% burden represented a tipping point for HCW compliance. At this point, compliance fatigue may set in, leading to breaks in the contact isolation precautions process and potentially the spread of MDROs.

Placing patients in contact precautions must be weighed against the likelihood that providers will comply with these precautions. Hospitals and policy makers should consider prioritizing the types of pathogens that should be targeted for contact isolation in order to optimize compliance with contact isolation precautions. If the burden of isolation exceeds 40% in a given unit, then direct measures of compliance, enhanced reinforcement of contact isolation precautions practices, and educational efforts regarding the rationale and importance of contact isolation precautions are warranted.

One finding unique to our study was that when a team entered a patient room, compliance with hand hygiene by the lead provider was significantly lower as opposed to when the provider was entering the room alone (26.3% vs 38.7%; $P < .05$). This finding is particularly concerning, since team leaders are important in shaping the behaviors of other HCWs.^{33,34} Also surprising was a significantly lower rate of overall contact isolation precautions compliance in ICUs compared with non-ICU wards (22.2% vs 34.1%; $P < .001$), as well as lower rates of hand hygiene prior to donning gloves (26.7% vs 45.7%; $P < .001$). Findings from this study are in contrast to prior studies that have reported improved compliance in the ICU compared with non-ICU acute care floors.^{20,21} The poor compliance in ICUs was likely due in part to the greater burden of isolation in ICUs compared with non-ICU wards (median burden of isolation, 25% vs 11%; $P < .001$). Other potential explanations include an increased workload in the ICU and the perception that the use of gowns and gloves obviates the need for handwashing.

Previous studies have reported that comprehensive active surveillance (with or without decolonization protocols to carriers) and contact isolation programs—through an aggressive

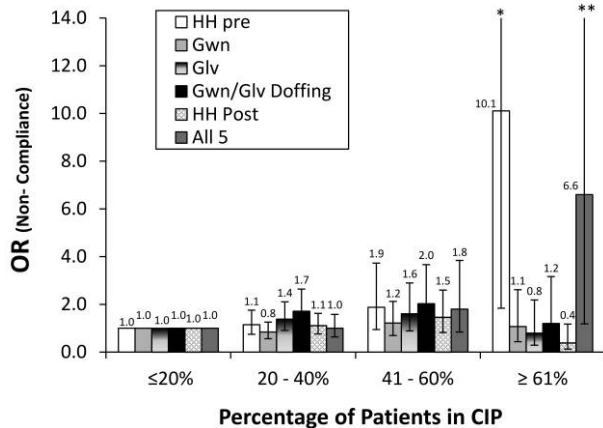


FIGURE 3. Adjusted impact of burden of isolation on contact isolation precautions (CIP) compliance. Likelihood of noncompliance with hand hygiene (HH) and all components of contact isolation adjusted for clustering by hospitals. Reference group is 20% or less. Burden of isolation was defined as the proportion of patients on a given floor who were in contact isolation precautions at the time that the observation was conducted. HH Pre, hand hygiene prior to or shortly after entering room; Gwn, donning of gown at the time of or shortly after entering room; Glv, donning of gloves at the time of or shortly after entering room; Gwn/Glv Doffing, removal of glove and gown when leaving patient room; HH Post, hand hygiene when leaving patient room; All 5, 5 components of contact isolations precautions. Asterisk: odds ratio (OR), 10.1 (95% confidence interval [CI], 1.84–55.54); $P = .008$. Two asterisks: OR, 6.6 (95% CI, 1.15–37.44); $P = .03$. All other P values nonsignificant.

screening and containment process—can reduce transmissions and infections with MDROs.^{9,11} In this study, however, among sites that conducted active surveillance for MRSA, the rate of compliance with hand hygiene, donning of gloves, and doffing of gowns/gloves was lower than among sites that did not conduct surveillance. Not surprisingly, the median burden of isolation at the sites conducting active surveillance was higher (25% vs 9.52%; $P < .001$). This observation does not imply direct causality for noncompliance, since the burden of isolation for these sites was also significantly higher and supports the notion of isolation fatigue. It is important that sites that conduct active surveillance closely monitor compliance with contact isolation precautions, and this parameter should be factored in future analyses testing the potential benefits of implementing screening policy.

Major strengths of the study included its prospective design; observations conducted in multiple, diverse centers; inclusion of both acute care floors and ICUs; and utilization of anonymous study observers who thus were not readily identified as observing contact isolation precautions nor subject to observer bias.³⁵ Limitations of this study include the relatively few observations conducted involving HCWs who were not nurses or physicians. Thus, this study was under-

powered to determine the associations between burden of isolation and compliance with contact isolation precautions for some types of support healthcare personnel or trainees. Documentation of the time of day the observations were done and whether the secret observers were identified were not recorded and may have potentially biased the results. Unknown observation components were excluded; however, a negative imputation resulted in a loss of significance for the fully compliant end point. In addition, the burden of isolation rarely exceeded more than 60%, limiting the analysis and associations of compliance during times of universal (ie, 100%) isolation. Compliance with hand hygiene was found to be low; however, it is not known what the corresponding compliance with hand hygiene was in patients who were not in contact isolation to assess the effect of contact isolation precautions specifically on this measure. HCWs were not formally interviewed during the study, which may have helped to clarify the reasons for noncompliance with certain measures. Additionally, the number of entries into a patient room during the course of a day was not assessed, since this may also affect compliance.

CONCLUSION

The data regarding use of routine contact precautions to reduce the spread of MDROs in endemic, nonoutbreak settings are conflicting.^{9,10,13-15,19} Several studies have reported that in some instances, contact isolation may be detrimental to the care of patients because of decreased number of visits and time spent with patients by healthcare providers and the increased psychological stress experienced by these patients.^{19,25-29,36} Providers and hospital administrators have to weigh these adverse effects of contact precautions against the potential for reducing the spread of MDROs in the hospital. On the basis of the results from this study, providers and infection control programs should consider the negative impact of the burden of isolation on compliance with contact isolation precautions when developing infection control policies and practices. Indiscriminately placing patients in contact precautions might have the adverse effect of decreasing the efficacy of contact isolation precautions in controlling the spread of MDROs. A burden of isolation of 40% may represent a tipping point, above which compliance with contact isolation precautions drops significantly.

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APPENDIX

TABLE A1. Hospital Compliance with Contact Isolation Precautions

	1	2 ^a	3	4 ^a	5 ^a	6	7 ^a	8	9 ^a	10	11 ^a
Observations											
Overall ^b	100 (9.9)	100 (9.9)	101 (10.0)	100 (9.9)	91 (9.0)	100 (9.9)	100 (9.9)	102 (10.1)	100 (9.9)	19 (1.9)	100 (9.9)
Acute care floor	42 (59.1)	86 (86.0)	50 (49.5)	50 (50.0)	51 (56.0)	50 (50.0)	81 (81.0)	50 (50.0)	4 (4.0)	2 (10.5)	50 (50.0)
ICU	29 (40.8)	13 (13.0)	51 (50.5)	50 (50.0)	40 (44.0)	50 (50.0)	18 (18.0)	52 (52.0)	96 (96.0)	17 (89.5)	50 (50.0)
Patients in isolation, average, %	15.7	28.0	13.5	20.5	38.0	9.8	12.2	11.1	54.7	12.6	26.5
Observations of											
Attending	3 (3.0)	23 (23.0)	19 (18.8)	12 (12.0)	2 (2.2)	5 (5.0)	22 (22.0)	8 (7.8)	21 (21.0)	2 (19.1)	16 (16.0)
Medical students	...	...	2 (2.0)	...	1 (1.1)	2 (2.0)	1 (1.0)	...	1 (1.0)	...	1 (1.0)
Nursing	64 (64.0)	71 (71.0)	48 (47.5)	59 (59.0)	63 (69.2)	73 (73.0)	42 (42.0)	69 (67.6)	55 (55.0)	7 (36.8)	56 (56.0)
OT/PT	3 (3.0)	...	...	2 (2.0)	4 (4.4)	1 (1.0)	1 (1.0)	...	2 (2.0)	...	...
Other/unknown	22 (22.0)	...	17 (16.8)	11 (11.0)	3 (3.3)	5 (5.0)	4 (4.0)	3 (2.9)	3 (3.0)	2 (19.1)	7 (7.0)
Phlebotomist	...	...	2 (2.0)	...	1 (1.1)	1 (1.0)	9 (9.0)	...	1 (1.0)	...	...
Radiology tech	...	...	...	3 (3.0)	3 (3.3)	1 (1.0)	...	5 (4.9)	...	...	...
Resident/fellow	6 (6.0)	4 (4.0)	12 (11.9)	9 (9.0)	13 (14.3)	5 (5.0)	13 (13.0)	10 (9.8)	9 (9.0)	3 (15.8)	17 (17.0)
RT	2 (2.0)	2 (2.0)	1 (1.0)	4 (4.0)	1 (1.1)	7 (7.0)	8 (8.0)	7 (6.9)	8 (8.0)	5 (26.3)	3 (3.0)
Team upon entering	9 (9.0)	7 (7.0)	15 (14.9)	6 (6.0)	11 (12.1)	6 (6.0)	20 (20.0)	4 (3.9)	22 (22.0)	2 (19.1)	19 (19.0)
Compliance											
Hand hygiene pre ^c	18 (24.0)	79 (79.8)	21 (23.9)	50 (53.8)	9 (12.3)	36 (36.0)	41 (42.3)	67 (65.7)	8 (8.7)	11 (64.7)	2 (2.3)
Gowning ^c	75 (75.8)	86 (86.0)	73 (74.5)	80 (84.2)	50 (54.9)	90 (91.8)	63 (63.0)	53 (55.2)	84 (84.0)	18 (94.7)	68 (68.0)
Gloving ^c	70 (70.7)	87 (87.0)	83 (83.8)	82 (82.0)	63 (69.2)	90 (91.8)	69 (69.7)	89 (87.3)	86 (86.0)	18 (94.7)	56 (65.1)
Removal of gown/gloves ^c	67 (73.6)	85 (85.0)	80 (88.9)	75 (78.9)	53 (59.6)	94 (94.0)	68 (68.0)	88 (95.7)	84 (84.0)	14 (87.5)	60 (69.0)
Hand hygiene post ^c	39 (41.4)	86 (86.9)	55 (56.1)	59 (60.2)	58 (68.2)	67 (67.0)	63 (64.3)	72 (72.7)	58 (69.9)	14 (87.5)	8 (9.6)
Overall ^c	12 (16.9)	74 (75.5)	15 (18.5)	37 (43.5)	2 (2.9)	33 (33.7)	30 (31.9)	26 (29.2)	6 (8.0)	9 (64.3)	1 (1.3)

NOTE. Data are no. (%), unless otherwise indicated. ICU, intensive care unit; OT/PT, occupational therapy/physical therapy; RT, respiratory therapist.

^a Hospitals that conduct active surveillance for methicillin-resistant *Staphylococcus aureus*.

^b Percentage for overall observations comparator is all other hospitals. For all other percentages, comparator is the individual hospital.

^c Missing values excluded from analysis.

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