TABLE 1. Incidence Rate of *Clostridium difficile* Infections and Amount of Cefazolin Dispensed before and after Protocol Modification

	Neurosurgical intensive care unit				Neurosurgery service			
	2011	2012	Differences (95% CI)	*P*	2011	2012	Differences (95% CI)	*P*
Patient-days	9,669	9,725			16,951	18,177		
C. difficile cases	19	5			20	10		
Incidence rate/1,000 pt-days	1.97	0.51	1.45 (0.46, 2.44)	.0036	1.18	0.55	0.63 (0.010, 1.25)	.0459
Cefazolin doses dispensed	7,104	2,603			9,625	4,896		
Cefazolin doses/1,000 pt-days	735	268	467 (447, 487)	<.0001	568	269	298 (285, 312)	<.0001

NOTE. CI, confidence interval; pt-days, patient-days.

population notable for trauma and intracranial hemorrhage. Although we did not audit antimicrobial usage in every patient with an EVD, a 20% sampling of patients after protocol implementation did demonstrate greater than 90% adherence to discontinuing systemic antimicrobial prophylaxis, which is supported by the significant reduction in cefazolin usage. In addition, we continued to use antimicrobial-impregnated EVD catheters during both time periods, so we cannot comment on the use of systemic antimicrobial prophylaxis in the absence of the impregnated catheters.

Our study suggests that limiting systemic antimicrobial prophylaxis to the first 24 hours of EVD placement in neurosurgical patients in whom an antimicrobial-impregnated catheter is used may decrease the risk for CDI and should lead to more formal investigation.

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Correlation between Methicillin-Resistant *Staphylococcus aureus* Nasal Sampling and *S. aureus* Pneumonia in the Medical Intensive Care Unit

In the medical intensive care unit (MICU), 19% of patients with methicillin-resistant *Staphylococcus aureus* (MRSA) colonization will develop MRSA disease.[1] In addition to a con-

stellation of clinical features and demonstrable infiltrate, the presence of gram-positive cocci in clusters on a Gram stain is the best indicator of *S. aureus* pneumonia.[2] The enduring problem is that antibiotic susceptibility results are not available when the Gram stain is reported, leaving providers irresolute as to whether anti-MRSA therapy is warranted. We hereby investigate the data on MRSA pneumonia in MICU patients with MRSA nasal colonization.

The University and Medical Center Institutional Review Board approved this retrospective chart review. MRSA nasal screening via BD GeneOhm real-time polymerase chain reaction (PCR; Becton Dickinson)[3] is performed on all patients admitted at Vidant Medical Center, a 900-bed tertiary care hospital in North Carolina. Patients with *S. aureus* respiratory cultures were identified via MedMined (CareFusion) audit and feedback software.

Data from March 2010 through March 2013 were reviewed for demographics, laboratory values, clinical and radiologic findings, and MRSA nasal colonization results. Respiratory cultures included sputum samples, endotracheal aspirates, and bronchoalveolar lavages. A true infection was based on Infectious Diseases Society of America community-acquired pneumonia (CAP), ventilator-associated pneumonia (VAP), and healthcare-associated pneumonia (HCAP) criteria.[2,4]

Excluded patients were those lacking diagnostic criteria and those in non-MICU wards. As all colonized patients are placed under contact precautions and decolonized with mupirocin, patients previously treated with mupirocin were excluded. Categorical values were compared using χ^2 analysis, and continuous values were compared by *t* test. A 2-sided *P* value less than or equal to .05 was considered statistically significant.

Over the 3-year period, 387 respiratory cultures grew *S. aureus*, of which 115 were excluded for not meeting pneumonia criteria. Of the 275 remaining patients, 165 (60%) had MRSA pneumonia and 110 (40%) had methicillin-susceptible *S. aureus* (MSSA) pneumonia. Of the 165 patients with MRSA pneumonia, 91 (55%) had a negative nasal screen. The positive predictive value and negative predictive value (NPV) of nasal screening in patients with *S. aureus* pneumonia were 97.4% (95% confidence interval, 90.8%–99.6%) and 54.3% (95% confidence interval, 47.1%–61.3%), respectively. Of the 110 patients with MSSA pneumonia, 108 (98%) had a negative screen ($P < .0001$). While there were more females among the MRSA pneumonia patients ($P = .02$), there were no other significant differences between the groups (Table 1). Other organisms were isolated in 24 (9%) of our patients with *S. aureus* pneumonia, including *Acinetobacter* (20%), *Pseudomonas* (14%), and *Stenotrophamonas* (8%).

HCAP and CAP are the 2 most common infections treated

TABLE 1. Data Collected during the Medical Intensive Care Unit *Staphylococcus aureus* Pneumonia Retrospective Chart Review

Category	MSSA ($n = 110$)	MRSA ($n = 165$)	*P*
Age, mean, years	54.8	56.7	NS (.34)
Sex			.02
Male	64 (58)	71 (43)	
Female	46 (42)	94 (57)	
Race			
White	46 (42)	71 (43)	
Black	63 (57)	92 (56)	
Hispanic	1 (1)	2 (1)	
Mean APACHE II score	18.0	19.2	NS (.17)
Respiratory specimen			NS
Endotracheal aspirate	67 (61)	100 (61)	
Bronchoalveolar lavage	31 (28)	43 (26)	
Sputum sample	12 (11)	22 (13)	
S. aureus semiquantitative culture results			NS
1+ (rare)	12 (11)	18 (11)	
2+ (few)	8 (7)	20 (12)	
3+ (moderate)	33 (30)	66 (40)	
4+ (many)	57 (52)	61 (37)	
Pneumonia type			NS
Healthcare-associated pneumonia	94 (85)	142 (86)	
Community-acquired pneumonia	16 (15)	23 (14)	
MRSA nasal screen			<.0001
Positive	2 (2)	74 (45)	
Negative	108 (98)	91 (55)	

NOTE. Data are no. (%), unless otherwise indicated. APACHE, Acute Physiology and Chronic Health Evaluation; MRSA, methicillin-resistant *S. aureus*; MSSA, methicillin-sensitive *S. aureus*; NS, not significant.

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in our 24-bed MICU, of which MRSA accounts for 18% of our HCAPs and 17% of our CAPs.[5] We focused our attention on HCAP and CAP, where anti-MRSA therapy is used in 86% of all MICU pneumonias, regardless of Gram stain result. Akin to previous studies, we demonstrate a strong prediction of MRSA disease in MRSA-colonized patients with *S. aureus* pneumonia.[1,6] While MRSA nasal screening can offer earlier diagnosis of MRSA pneumonia and guide empiric therapy if a pneumonia arises with clusters of gram-positive cocci on Gram stain, it should not be used to discontinue anti-MRSA therapy. The NPV of 54.3% is lower than the NPV described by Chan et al[7] (97%) and Lampti et al[8] (89%). Although they suggested that a negative surveillance culture can accurately exclude MRSA as the cause of VAP, 55% of our MRSA pneumonia patients would have lacked MRSA therapy on the basis of a negative surveillance screen.

Twenty-three of our 39 colonized patients with CAP had MRSA. Given the rapid turnaround time of MRSA nasal screening via PCR, it may be beneficial to perform nasal sampling on all CAP patients with MRSA risk factors. Rather than differences in the sampling type or frequency, the higher prevalence of MRSA pneumonia may help explain the discrepancy between our study and other studies that have evaluated surveillance cultures and the development of infection.

There are some limitations that should be considered. First, we assessed only nasal screening in patients with *S. aureus* pneumonia. Although nasal screening alone may miss cases of oropharyngeal-positive results, this is the MRSA screening method implemented by a number of institutions.[9,10] We also chose to utilize data from PCR-based methods because of their higher sensitivity (100%) than culture and rapid turnaround time.[10] Our single-site results may not be generalizable to all ICUs. Since our study was retrospective, there is no direct evidence to show that nasal MRSA actually definitively caused the pneumonia. Achieving this would have required accurate molecular typing of nasal and lung MRSA isolates from individual patients. As studies have illustrated improved predictive values when the interval between surveillance sampling and development of infection is reduced, MRSA nasal screening only at admission may be a limitation if the time interval was too long.

In conclusion, there is a strong relationship between MRSA nasal colonization and MRSA pneumonia in MICU patients with *S. aureus* pneumonia. A positive MRSA screen may be a great strategy to guide empiric anti-MRSA therapy in MICU patients with pneumonia, especially when the Gram stain is showing clusters of gram-positive cocci. A positive MRSA nasal screen in MICU patients with a clinical diagnosis of pneumonia should be a recognized risk factor for MRSA CAP or HCAP. However, it may not be appropriate to base the need for empiric anti-MRSA therapy on a nasal screen or the need to de-escalate therapy on a negative result.

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Improving Hand Hygiene Compliance with Point-of-Use Reminder Signs Designed Using Theoretically Grounded Messages

Signs are a common strategy for promoting hand hygiene (HH) compliance, and many multifaceted interventions include signs as one component of their bundles.[1,2] However, little is known about their independent effectiveness, and insufficient attention has been given to the characteristics of signs associated with the greatest impact. Recent studies from the psychology literature found signs grounded in health behavior theories to have the greatest potential to improve HH compliance.[3,4] We tested theoretically derived signs in acute care settings at 3 hospitals in general medical wards and intensive care units (ICUs) to determine whether signs—and variations in their messages—can independently affect healthcare worker (HCW) HH compliance.

Four distinct messages were designed using constructs from health behavior theories: personal (HCW) versus patient consequences,[3] gain versus loss framing,[5] and social norms/appeal to professional role.[6] Personal versus patient consequences and gain-framed versus loss-framed messages were combined in 2 of the signs. Signs were placed at the point of use near hand sanitizer dispensers in the wards/units to increase their potential as cues to action at the point of care.[7]

A small, 5-month, cluster-randomized trial of the signs was embedded in a prospective cohort study of HCW HH behavior. The cohort study began in March 2011 in 11 wards and ICUs in 3 geographically distinct hospitals. In February 2012, the signs were placed in 5 randomly chosen wards/ICUs. The remaining 6 control wards/ICUs did not receive signs. Randomization was conducted after matching the 11 wards on baseline HH compliance. A coin was flipped to determine the group assignment for each pair. The eleventh ward/unit was determined with a coin flip. The 6 signs with 4 different messages were displayed in each of the intervention wards/units. The 6 signs were dispersed evenly between the rooms (note that 2 of the messages were presented with alternative models and color schemes). Signs remained posted for 5 months. HH compliance was determined by direct covert observations at room entry and exit, as described elsewhere.[8] Observers also recorded which sign was displayed by the nearest hand sanitizer dispenser.

Entry and exit HH rates were calculated for each room during the baseline and intervention periods. Ward/unit-level changes in compliance rates were compared between wards/units assigned to signs versus no sign using a Wilcoxon rank-sum test to account for within-room correlation. A secondary individual-level analysis was performed using Poisson mixed-effects models with a random intercept. Last, we calculated entry and exit HH rates for each sign type during the intervention period. A Poisson mixed-effects model with a random intercept to account for within-room correlation was used to compare the signs.

In total, 13,195 HH opportunities were observed at baseline, and 3,517 opportunities were observed during the intervention period. Baseline entry and exit compliance was similar in control and intervention wards/units (see Table 1). After the intervention, intervention and control wards/units demonstrated similar improvements at entry (4.2% vs 7.5%; $P = .79$) and exit (5.1% vs 5.5%; $P = .54$). Findings using Poisson mixed-effects models were similar (results not shown).

Among specific HH signs, the patient consequence and gain-framed sign was associated with the highest absolute entry (51.2%) and exit (64.1%) compliance. However, in a Poisson mixed-effects model accounting for within-room correlation, no significant differences among signs was detected at entry ($P = .13$) or exit ($P = .61$).

Overall, in this 5-month, multicenter, cluster-randomized trial, point-of-use signs did not improve HH compliance compared with no signs. However, a sign using messages focused on patient consequences and gain-framed language demonstrated the greatest absolute compliance compared with other theoretically derived signs. This finding highlights

TABLE 1. Entry and Exit Hand Hygiene Compliance Data and Rate of Change between Baseline and Intervention Periods

	Entry compliance					Exit compliance				
	Baseline		Intervention period			Baseline		Intervention period		
	No. compliant/ no. observed	Rate (per 100)	No. compliant/ no. observed	Rate (per 100)	Change[a]	No. compliant/ no. observed	Rate (per 100)	No. compliant/ no. observed	Rate (per 100)	Change[a]
No signs	1,413/3,636	38.9	464/1,000	46.4	7.5	2,029/3,592	56.5	618/995	62.1	5.5
Signs	1,029/3,031	33.9	292/765	38.2	4.2	1,538/2,936	52.4	435/757	57.5	5.1

[a] Rate difference.

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