American Journal of Infection Control 50 (2022) 336–341

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major Article

# Long-term impact of contact precautions cessation for Methicillin-Resistant *Staphylococcus Aureus* (MRSA)

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*Key words:*
Healthcare associated infections
Contact precautions
Personal protective equipment
Central Line Associated Bloodstream Infections
MRSA bacteremia LabID events

***Background:*** Methicillin-Resistant *Staphylococcus aureus* (MRSA) is a major cause of healthcare-associated infections (HAI). Contact isolation has been traditionally implemented to stop transmission but its impact is increasingly questioned.

***Methods:*** A single center, retrospective, nonrandomized, observational, quasi-experimental study compared MRSA HAI rates between pre-/postdiscontinuation of MRSA contact isolation in a tertiary university hospital over 68 months. Data on primary outcomes, Central line-associated bloodstream infections and MRSA LabID bacteremia events, were analyzed by interrupted time series design using segmented Poisson regression modeling. As secondary outcomes catheter-associated urinary tract infections , ventilator-associated pneumonia , surgical site infections and hospital-associated pneumonia were compared using Fisher's exact tests. Current savings due to discontinuation were calculated based on gown use.

***Results:*** Two hundred and ninty-five patients developed 399 HAIs. Infection rates between pre- and postinterventions were as follows: Central line-associated bloodstream infections: (0.02% vs 0.02%; *P*-value = .64), MRSA LabID events: (0.01% vs 0.02%; *P*-value = .32), hospital-associated pneumonia: (0.01% vs 0.01%; *P*-value = .64), catheter-associated urinary tract infections: (0% vs 0.01%; *P*-value = .56), ventilator-associated pneumonia: (0.01% vs 0.01%; *P*-value = .32), surgical site infections (0.55% vs 0.15%; *P*-value = .03). Savings amount to $139,228 annually.

***Conclusions:*** Discontinuing CP did not negatively impact endemic MRSA HAI rates between pre-postdiscontinuation periods and saved costs for isolation materials.



Health care-associated infections (HAI) affect 1 out of 31 hospitalized patients in the United States.[1] As one of the prominent pathogens causing HAI Methicillin-Resistant *Staphylococcus aureus* (MRSA) are associated with high morbidity and mortality rates especially in patients with immunocompromising conditions.[2,3] The Centers for Disease Control and Prevention (CDC) recommends the implementation of Contact Precautions (CP) to control and prevent cross-transmission between patients with MRSA.[4] However, this costly and time-consuming practice lags strong evidence.[5-12]

There is a wide variation of using CP for MRSA among healthcare facilities.[10] Concerns have been raised regarding the impact on patients such as reduced care activities, decrease in patient satisfaction, and adverse outcomes such as falls, anxiety and depression.[11-13] Several retrospective and prospective studies were published debating CP effectiveness and supporting the discontinuation of CP for MRSA.[8,14-16] Some United States hospitals have discontinued the use of CP for MRSA in their facilities.[5,6] The primary objective of our study was to assess the impact of discontinuation of CP for MRSA on MRSA associated infection rates over an extended time period in a tertiary care university hospital. Furthermore, we determined the impact of CP discontinuation on current costs for isolation material such as gowns.

## METHODS

### *Setting*

The study was conducted at Wake Forest Baptist Medical Center (WFBMC), an 885-bed tertiary care teaching hospital with >40,000

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Funding/support: None.
Conflict of Interest: None of the authors has a conflict of interest to report.

https://doi.org/10.1016/j.ajic.2021.10.044

inpatients admissions and >89,000 ED visits annually (pediatric and adult patients).

*Study design and data collection*

This is a retrospective, observational, nonrandomized, quasi-experimental pre-postintervention research design comparing MRSA HAI rates before and after discontinuation of CP isolation. The study includes all patients hospitalized from January 2013 to September 2018. CP was defined as wearing a gown and gloves before entering a patient room on MRSA isolation. All employees were asked to perform hand hygiene (handrub solution or soap and water) at least at room entry and exit. Routine CP isolation for patients with MRSA was discontinued in September 2015. Data from September 2015 was excluded as this was considered a wash in period. In total, the study period was 68 months with 32 months being pre-intervention and 35 months being postintervention. MRSA surveillance at patient admission to critical care units was stopped and daily bathing with 2% Chlorhexidine Gluconate (CHG) was introduced at the same time of CP discontinuation. Adherence to the bathing protocol was assessed by weekly audits. Infection preventionists observed hand hygiene and isolation compliance. At least 40 hand hygiene opportunities were collected per month. Patients with other significant pathogens remained in appropriate isolation (e.g., ESBL, MDROs).

Infection Preventionists identified HAI associated with MRSA as part of the CDC's National Healthcare Safety Network HAI surveillance.[17] These included Central line-associated bloodstream infections (CLABSI), and MRSA LabID bacteremia events (MRSA LabID) as primary outcome variables. Data on Catheter-Associated Urinary Tract Infections (CAUTI), Ventilator-Associated Pneumonia (VAP), Surgical Site Infections (SSI) and Hospital-Acquired Pneumonia (HAP) were analyzed as secondary outcomes. Denominators were calculated as the number of device days (CLABSI, CAUTI, VAP), patient days (MRSA LabID, HAP) or procedure counts (SSI) during the study period. Patient information including clinical characteristics, device and patient day counts, and surgical procedures were extracted from the WFBMC Electronic Medical Record (EMR; EPIC, Verona, WI).

Current costs savings due to CP discontinuation were estimated by multiplying the total number of MRSA patient days with the number of room entries by staff with the costs for gowns adjusted by the average adherence to direct observed isolation precautions. Cost estimates were based on purchasing data as of 01/2020 pre-COVID-19 pandemic. Room entry data were derived from current estimates using an electronic staff monitoring system (Infinite Leap Inc., Fargo, ND), and monthly adherence data were collected by Infection Preventionists as part of their weekly surveillance rounds.

The institutional review board (IRB) approved the study protocol and a waiver of written informed consent was obtained.

*Data analysis*

HAI rates were compared between the pre- and postintervention periods using Fisher's exact tests. For the primary HAIs of interest (CLABSI and MRSA LabID events), an interrupted time series design using segmented Poisson regression models was used.[18]

The appropriate denominators (central line days for CLABSI and patient days for MRSA LabID) were included in the Poisson model as an offset term to allow analysis of the rate of HAIs. Level change models (models including time as well as an indicator of pre- versus postintervention period) are presented. Relative Risks (RR) are reported comparing post- and preintervention rates along with corresponding *P*-values and 95% confidence intervals (CI).

Patient demographics were summarized for the entire study and by pre- and postintervention periods. Length of stay (LOS) and time from admission to MRSA sample collection were calculated for all MRSA admissions. Fisher's exact tests or t-tests were used as appropriate to compare demographics and mortality by MRSA HAI types between the pre- and postinterventions. All tests were 2-tailed, with $P < .05$ considered statistically significant.

## RESULTS

From January 2013 to September 2018, 222,526 patients were admitted to WFBMC (mean LOS: 7.38 days, female: 47.03%). The overall mortality for patients admitted to the hospital was 2.96% + 0.36% with no differences between the intervention periods (3.01%; 2.92%; *P*-value = .22). Two hundred ninety-five patients (0.13%) developed 399 MRSA associated infections including 50 CLABSI, 204 MRSA LabID events, 3 CAUTI, 14 SSI, 9 VAP, and 119 HAP infections. Table 1 summarizes the MRSA patient demographics.

**Table 1**
MRSA patient characteristics

| | All patients (N = 295) | Preintervention (N = 120) | Postintervention (N = 175) | *P* value |
|---|---|---|---|---|
| Age, years | | | | .70 |
| Mean (SD) | 53.98 (21.86) | 53 (20.45) | 54.29 (22.82) | |
| Sex | | | | .55 |
| Female (%) | 128 (43.39) | 55 (45.83) | 73 (41.71) | |
| Male (%) | 167 (56.61) | 65 (54.17) | 102 (58.29) | |
| Race/Ethnicity | | | | .18 |
| Non-Hispanic White (%) | 224 (75.93) | 98 (81.67) | 126 (72.00) | |
| Non-Hispanic Black (%) | 61 (20.68) | 19 (15.83) | 42 (24.00) | |
| Hispanic (%) | 4 (1.36) | 2 (1.67) | 2 (1.14) | |
| Other (%) | 6 (2.03) | 1 (0.83) | 5 (2.86) | |
| Mortality | | | | .76 |
| No (%) | 235 (79.66) | 97 (80.83) | 138 (78.86) | |
| Yes (%) | 60 (20.34) | 23 (19.17) | 37 (21.14) | |
| LOS, days* | | | | .0021 |
| Mean (SD) | 36.73 (39.03) | 29.27 (22.50) | 41.93 (46.61) | |
| Time from Admission to MRSA Sample Collection * | | | | .042 |
| Mean (SD) | 13.56 (22.49) | 10.77 (10.81) | 15.51 (27.74) | |

*Calculated with re-admission (total of all admissions=305).
Data are presented as n (%) unless otherwise indicated. LOS, length of stay in days; SD, Standard deviation. *P*-value was tested by T-Test or Fisher exact test.

**Table 2**
Mortality by MRSA HAI/event type

| | All patients death/total (%) | Preintervention death/total (%) | Postintervention death/total (%) | *P* value* |
|---|---|---|---|---|
| CLABSI | 11/50(22) | 3/16(19) | 8/34(24) | 1.00 |
| CAUTI | 0/3 (0) | 0/0 (0) | 0/3 (0) | 1.00 |
| SSI | 0/14 (0) | 0/10 (0) | 0/4 (0) | 1.00 |
| HAP | 17/119(14) | 6/49(12) | 11/70(16) | .79 |
| VAP | 0/9 (0) | 0/2 (0) | 0/7 (0) | 1.00 |
| LABID event | 45/204(22) | 15/82(18) | 30/122(25) | .31 |

*Fisher's Exact test.

*Demographic comparisons — total patient population versus MRSA HAI patients*

No differences were detected between all patients admitted and those with MRSA HAI for gender (*P*-value = .43) or race/ethnicity (*P*-value = .29). MRSA HAI patients were older than non-MRSA patients (53.98 vs 52.20; *P*-value = .02) and stayed longer in the hospital (37.73 vs 7.38; *P*-value < .001). CLABSI rates not associated with MRSA declined from 0.237% to 0.129% (*P* < .001). The overall mortality for patients admitted to the hospital was 2.96% ± 0.36% with no differences between the intervention periods (3.01%; 2.92%; *P*-value = .22). Mortality rates due to MRSA HAI are displayed in Table 2.

Adherence to the simultaneously introduced daily bathing with CHG was low (<10%) throughout the hospital. LOS (pre and post *P*-value < .001) was significantly longer and mortality rate (pre and post *P*-value < .001) was significantly higher when comparing MRSA HAI patients and non-MRSA patients in both the pre and postinterventions. Direct observation of hand hygiene adherence was overall high but slightly lower during the postintervention (preintervention: 97.1%; post-intervention: 93.0%; *P*-value < .001). Compliance with isolation precautions including CP increased from pre- to postintervention (83.5% to 88.2%; *P*-value < .001).

*Patients clinical characteristics*

Respiratory specimens (46.44%) and blood cultures (38.64%) were the most common sample collection sites. Patients' exposure to medical devices during their hospital stay were not significantly different between pre-postinterventions (97.29% vs 97.50%; *P*-value = 1). Mean ventilator days were higher in the postcompared to the preintervention (3.64 ± 6.64 vs 6.23 ± 13.07; *P*-value = .04), while average Foley days were lower in the postintervention (0.36 ± 0.68 vs 0.17 ± 0.39; *P*-value = .002).

*Length of stay and time from admission to MRSA sample collection*

The mean LOS for all inpatients was 7.38 ± 0.34 days (preintervention: 7.25 ± 0.36, postintervention: 7.50 ± 0.28). For patients affected by HAIs LOS was higher in the postcompared to preintervention (41.93 ± 46.61 vs 29.27 + 22.50); *P*-value = .0021; Table 1). Patients with CLABSI stayed the longest (41.78 ± 42.37 days) followed by HAP (40.75 ± 39.53 days), MRSA LabID events (37.63 ± 37.73 days), VAP (25.83 ± 14.59 days), CAUTI (24.67 ± 24.95 days) and SSI (17.36 ± 12.97 days). Burn and neonate patients (n = 58) had higher LOS compared to other patients (59.22 ± 48.36 and 124.00 ± 82.71; *P*-value < .0001).

The time from admission to MRSA sample collection for all MRSA positive patients was 13.56 ± 22.49 days with 15.93 ± 27.74 days and 10.77 ± 10.81 days for the pre- and postinterventions, respectively (p-value=0.042). Identification of MRSA was shortest for VAP (1.17 ± 3.87 days) followed by CAUTI (6.00 ± 8.19 days), SSI (7.14 ± 7.44 days), MRSA LabID events (13.00 ± 24.00 days), CLABSI (14.16 ± 11.07 days), and HAP (17.18 ± 27.57 days). Of note, the longest sample collection timing was observed in neonates with 59.88 ± 56.13 days after admission.

*Impact on infections*

*Primary outcomes*

MRSA CLABSI. No significant difference in the incident rates for MRSA CLABSI was detected between the pre-/postinterventions (0.0179% vs 0.0157%; *P*-value = .64). Fitting a segmented model (Fig 1), we found: (1) no significant level change and time trend in the postsegment with (2) overall estimated Relative Risk (RR) = 1.801 (95% CI = 0.649-4.994; *P*-value= .25).

MRSA LabID events. The incident rates for MRSA LabID events increased by 15.4% from pre- to postintervention without reaching significance (pre: 0.0130% vs post: 0.0150%; *P*-value = .32). Fitting a segmented model (Fig 2), we found: (1) no significant level change and time trend in the postintervention with (2) overall estimated RR = 1.028 (95% CI = 0.591-1.788; *P*-value = .92).

*Secondary outcomes*

Non-significant increases from the pre to postintervention period was found for HAP, CAUTI and VAP as summarized in Table 3. SSIs associated with MRSA significantly decreased by 72%.

*Cost savings estimate based on current data*

From 09/2019 to 08/2020 a total of 295 admitted patients tested positive for MRSA with an average time on isolation of 19 days. Rooms of patients on contact isolation for pathogens other than MRSA were entered by staff on average 122 times during a 24 hour period. Isolation adherence for the pre and poststudy periods was 83.5% and 88.2%, respectively. This resulted in 102 staff/patient/day (pre) and 108 staff/patient/day (post) interactions with appropriate PPE. Taking into account the pre-COVID-19 pandemic costs for gowns ($0.23 each) the estimated cost savings due to isolation discontinuation were $139,228 per year.

*Other infection prevention interventions and initiatives during the study period*

The following interventions and initiatives were introduced during the latter part of the study period. In 2015, we discontinued MRSA contact isolation and also introduced new, similarly effective surface disinfection wipes and initiated a high level disinfection campaign. In 2016, a colon surgical site infection bundle was introduced, and central line dressings were standardized. In 2017, a daily and terminal room cleaning initiative was started. In 2018, we initiated a "Don't Wait — Isolate" early patient isolation campaign, and sent out a *S. aureus* bacteremia treatment advisory.

## DISCUSSION

More evidence is emerging that CP do not decrease MRSA associated HAIs.[5] After discontinuing CP for MRSA in 09/2015 we used an interrupted time series analysis approach to evaluate the impact of this intervention on MRSA associated HAI over close to three years. No significant change in the overall rate and trend over time of MRSA associated HAI and LabID events was detected during the intervention period without CP. This included our primary outcomes, MRSA CLABSI and MRSA LabID events. Secondary outcomes such as MRSA-HAP, CAUTI, and VAP also did not change. Only SSIs showed a significant decrease most likely caused by the introduction of a surgical

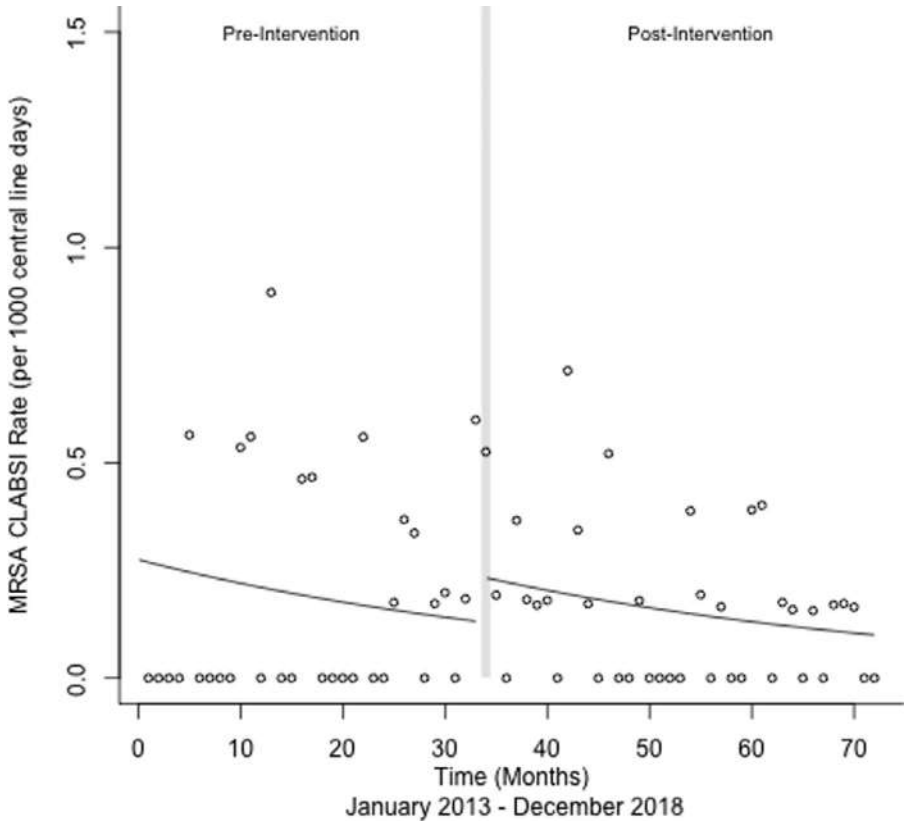


**Fig 1.** MRSA CLABSI burden changes*.
*Interrupted time series design using segmented Poisson regression models.

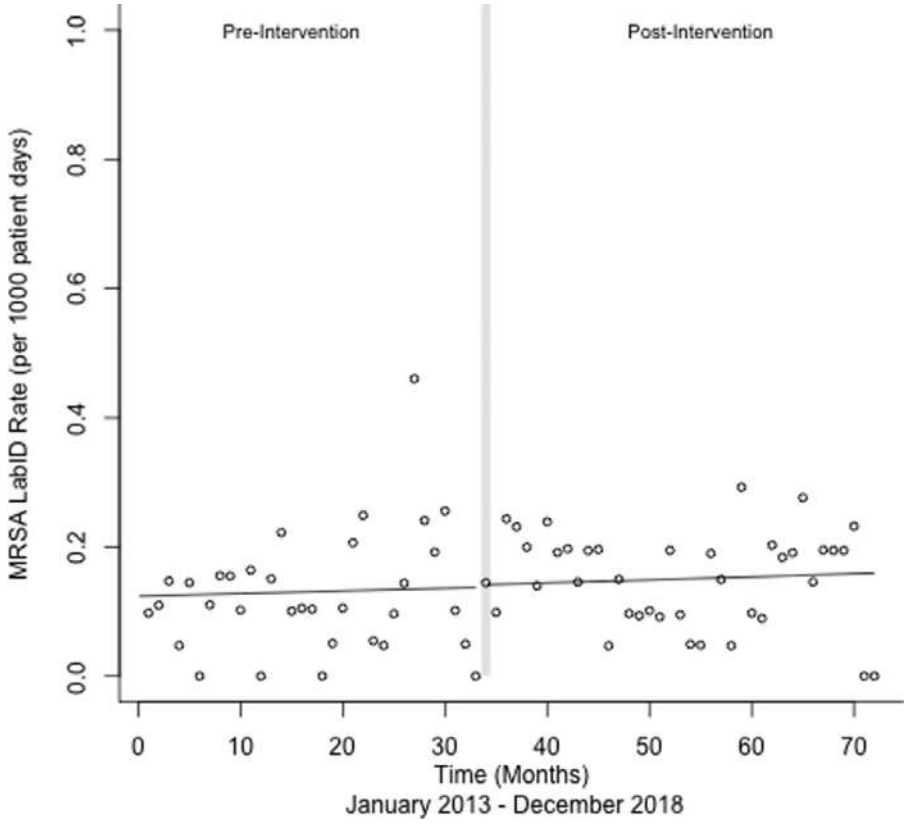


**Fig 2.** MRSA LabID events burden changes*.
*Interrupted time series design using segmented Poisson regression models.

**Table 3**
HAIs MRSA rates comparison between pre-postintervention periods

| | Preintervention | | Postintervention | | |
|---|---|---|---|---|---|
| HAI type | Events (Denom) | Rate | Events (Denom) | Rate | *P* value* |
| CLABSI | 16 (89,137) | 0.02% | 34 (216,743) | 0.02% | .64 |
| CAUTI | 0 (103,965) | 0% | 3 (189,152) | 0.01% | .56 |
| SSI | 10(1,826) | 0.55% | 4(2,605) | 0.15% | .03 |
| HAP | 49 (628,536) | 0.01% | 70 (811,401) | 0.01% | .64 |
| VAP | 2 (41,032) | 0.01% | 7 (52,700) | 0.01% | .32 |
| LabID | 82 (628,536) | 0.01% | 122 (811,401) | 0.02% | .32 |

*Fisher's Exact test.

bundle during the intervention period. The patient characteristics revealed long hospitalizations and high mortality rates for patients affected with MRSA compared to non-MRSA patients. Cost savings amounted to close to $140,000 per year for gowns alone.

Recently published studies support that discontinuation of CP does not affect MRSA transmission.[9,16,18-30] Our data confirm the lag of a significant impact of CP on MRSA CLABSI and LabID events over an extended study period of several years. Kullar et al. concluded that CP alone is not associated with a reduction in MRSA transmission but that there is a need for additional interventions to decrease MRSA infection.[31] We introduced daily CHG bathing at the same time of the CP discontinuation to maximize horizontal infection prevention measures.[32] However, adherence to bathing was very low indicating that bathing did not contribute to the results. Other studies did not detect a difference using CHG bathing either.[9,25-28,32] Adherence to hand hygiene and isolation as essential drivers were high even with a decrease noted during the postintervention period. However, this did not appear to affect MRSA associated HAIs. Our own investigation provides further evidence that CP does not change MRSA transmission rates even over several years.

Our secondary objective included the impact of CP discontinuation on other MRSA associated HAI such as CAUTI, HAP, VAP, and SSI. With the exception of SSI all other HAI remained at a similar level compared to the baseline period. The majority of these events have rather low counts requiring prolonged data collection for the impact analysis of the intervention. However, the longer timeframe increases the chance of other interventions to interfere with the CP discontinuations, which are discussed below. The decrease detected in SSI during the intervention period was most likely due to the introduction of an SSI bundle.

Hospitalized patients may also encounter harmful consequences of CP due to stigmatization, and reduced frequency and length of care activities. Several studies have demonstrated the negative impact of CP on patients.[11-13,33] A systematic review indicated high risk adverse outcomes related to placing patients on CP including reduced contact with healthcare providers, delay in transferring to other healthcare facilities, increase in depression and anxiety and lower patient satisfaction scores.[11] While we did not study the impact of CP on the psychological wellbeing and provision of care of patients the need of placing patients in isolation dissolves with the failure to reduce nosocomial MRSA transmission.

The analysis of patient characteristics revealed significantly longer hospitalization times for patients affected with MRSA compared to the general inpatient population (36.73 vs 7.38 days; $P < .0001$). Extended length of stay has been reported as risk factor for MRSA acquisition.[34] Loke at al. found a dose-response relationship between LOS three weeks or more and MRSA acquisition.[35] Even higher LOS times were detected in patients requiring burn care and neonates (level 4). The latter tend to have prolonged LOS which increases the potential of exposure to MRSA infection during their stay. It should be noted that only 8 neonates were affected (2 – preintervention; 6 – postintervention).[36] However, the time from admission to MRSA sample collection also increased significantly during the intervention period. This indicates that the discontinuation of MRSA isolation did not lead to earlier exposures during hospitalization. In addition, no clusters of MRSA infections were detected during the study periods.

HAI mortality did not increase due to the intervention.[37] The most fatalities were observed in patients with CLABSI, and LabID events. This matches fatality rates of 10-30% reported for bacteremias by Van Hal et al.[3]

Our estimate of the cost savings was based on the frequency of patient contact with healthcare workers using an electronic tracking system and the sole costs of gowns. We did not account for visitors, glove usage or the use of gowns for blood and body exposures. Patient contact data (n = 122/day) were slightly lower compared to the daily room entries of 132 provided by Cohen et al.[38] We estimated an overall annual cost savings of $139,228. Carey et al. extrapolated cost saving of $130,000 per year including staff time and PPE use from a 3 month pilot study for MRSA and VRE CP discontinuation in a 400 bed and a 81 bed hospital.[39] Cost for a gown was higher than in our study but patient contact was estimated to be much lower with 15/day compared to our electronically registered tracking data. The variation of the different elements used for cost estimates reflects the individual settings and makes it at least difficult to transfer to other settings. A more standardized approach might be helpful to derive comparable estimates.

Limitations of the study include the retrospective, nonrandomized, single-center study design that may limit the applicability to other healthcare settings. The low baseline rates of some HAI resulted in small effect sizes leading to the potential of over- or underestimations. Having only single occupancy patient rooms may have influenced the outcome by making MRSA transmission more difficult. Other interventions that were introduced during the study period may have affected the outcome variables. Based on the timing the most likely candidates include the change to new disinfectant wipes (same activity profile as replaced wipes), central line dressing standardization, the colon surgical site bundle, and a daily and terminal room cleaning initiative. The overall postintervention trend for the main outcome variables did not show significant changes after the introduction of the above interventions with the exception of colon SSI rates. However, the impact on MRSA cannot be fully ruled out and should be noted. We also assessed the trend of non-MRSA CLABSI showing a significant decrease after the intervention. However, the focus of this study was on the impact of discontinuing MRSA isolation. Other communicable or multidrug resistant pathogens currently triggering isolation may change due to re-emergence, community pressure, novel devices, or new therapy and treatment regimens etc. It remains unclear if there are associations between the MRSA targeting intervention and HAI caused by other pathogens.

The rationale for implementing CP is based on the expected reduction of patient risk to acquire MRSA within a healthcare setting. This study offers a long-term insight on discontinuing CP for MRSA infection. Our findings suggest that taking away CP for MRSA will not negatively impact HAI and LabID event rates and will subsequently lead to cost savings. Of note, simultaneous introduction of CHG bathing as an additional horizontal infection prevention measure did not change the findings due to low adherence. Further studies on the long-term impact of current and future infection prevention practices are warranted to gain a better understanding of their efficacy.[8]

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