ORIGINAL ARTICLE

Elimination of Routine Contact Precautions for Endemic Methicillin-Resistant *Staphylococcus aureus* and Vancomycin-Resistant *Enterococcus*: A Retrospective Quasi-Experimental Study

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OBJECTIVE. To evaluate the impact of discontinuation of contact precautions (CP) for methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant *Enterococcus* (VRE) and expansion of chlorhexidine gluconate (CHG) use on the health system.

DESIGN. Retrospective, nonrandomized, observational, quasi-experimental study.

SETTING. Two California hospitals.

PARTICIPANTS. Inpatients.

METHODS. We compared hospital-wide laboratory-identified clinical culture rates (as a marker of healthcare-associated infections) 1 year before and after routine CP for endemic MRSA and VRE were discontinued and CHG bathing was expanded to all units. Culture data from patients and cost data on material utilization were collected. Nursing time spent donning personal protective equipment was assessed and quantified using time-driven activity-based costing.

RESULTS. Average positive culture rates before and after discontinuing CP were 0.40 and 0.32 cultures/100 admissions for MRSA ($P = .09$), and 0.48 and 0.40 cultures/100 admissions for VRE ($P = .14$). When combining isolation gown and CHG costs, the health system saved $643,776 in 1 year. Before the change, 28.5% intensive care unit and 19% medicine/surgery beds were on CP for MRSA/VRE. On the basis of average room entries and donning time, estimated nursing time spent donning personal protective equipment for MRSA/VRE before the change was 45,277 hours/year (estimated cost, $4.6 million).

CONCLUSION. Discontinuing routine CP for endemic MRSA and VRE did not result in increased rates of MRSA or VRE after 1 year. With cost savings on materials, decreased healthcare worker time, and no concomitant increase in possible infections, elimination of routine CP may add substantial value to inpatient care delivery.

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The Centers for Disease Control and Prevention and Society for Healthcare Epidemiology of America recommend contact precautions (CP) to decrease transmission of multidrug-resistant organisms (MDROs) in acute care hospitals, including methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant *Enterococcus* (VRE).[1,2] Although common practice, CP for endemic MRSA and VRE have become increasingly controversial given associations with patient harms.[3–5]

Data demonstrating that CP (gown and gloves) decrease transmission of endemic MRSA and VRE are limited.[3] Most studies on the effectiveness of CP include horizontal infection prevention strategies, including improved hand hygiene (HH), decolonization, and/or active surveillance cultures, not just organism-specific vertical prevention strategies.[3] Although combination strategies have shown decreases in MDRO acquisition, colonization, and invasive disease, there is no strong evidence supporting use of CP in the absence of additional strategies for endemic MRSA or VRE.[3,6–17]

CP have been associated with patient harms, including fewer healthcare worker (HCW) bedside visits, shorter HCW contact time, and less documentation compared with patients not on CP.[18–23] Patients experience delays in admission from the emergency room and discharge to skilled nursing facilities.[23–26]

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CP were also associated with increased preventable adverse events, including falls, pressure ulcers, and medication administration errors.[23,27] Patients on CP had increased anxiety and depression as well as lower satisfaction.[23,28–30] The results of newer studies, however, have conflicting findings and do not show increased adverse events.[31]

Of 87 hospitals recently surveyed, 92% still use CP for MRSA and VRE, but at least 30 US hospitals are no longer doing so and instead employ only horizontal infection prevention strategies.[3] One study showed no increase in device-associated healthcare-associated infection (HAI) rates after discontinuing CP for MRSA/VRE.[32]

The purpose of this study was to determine the impact of discontinuing routine CP for endemic MRSA and VRE on laboratory-identified (LabID) clinical culture rates (marker of HAI rates) in 2 California hospitals and overall health system costs.

METHODS

Hospital Setting

This study was conducted at Ronald Reagan UCLA Medical Center (hospital A), a 540-bed tertiary, academic hospital, with 154 intensive care unit (ICU) beds, large transplant population, and level 1 trauma center, and Santa Monica UCLA Medical Center (hospital B), a 265-bed community teaching hospital with 22 ICU beds. All beds at hospital A and the great majority at hospital B are single-occupant, private rooms. All rooms have alcohol-based hand rubs and sinks available for HH. CP rooms are equipped with signage, isolation gowns, and gloves.

Study Design and Policy Changes

We performed a retrospective, nonrandomized, observational, quasi-experimental study comparing clinical culture rates at both hospitals before and after the CP policy change and near-universal chlorhexidine gluconate (CHG) bathing. This study was exempt by the UCLA Institutional Review Board as nonhuman subjects research, given the policy was changed for quality improvement purposes.

Routine CP for endemic MRSA and VRE were discontinued on July 1, 2014, per the infection control committee recommendation after literature review and concern for harms associated with CP. Data were collected for 1 year before the change at hospital A and 6 months before at hospital B. Before July 1, 2014, all patients with active disease, history of, or positive surveillance screening for MRSA and/or VRE were placed in CP, requiring gown and glove use upon room entry. An alert flag was placed in the electronic health record, and patients were placed on CP for all subsequent hospitalizations. After July 1, 2014, CP were not required for MRSA or VRE, unless draining wounds were present. CP were still required for MDRO gram-negative infections and spore precautions for *Clostridium difficile*. Policies for droplet and airborne precautions were unchanged. Data were collected for 1 year after the policy change at both hospitals.

CHG bathing has been required in ICUs since 2012, except in neonatal. Starting in May 2014, daily 2% CHG bathing was implemented in all units. All patients older than 2 months undergo CHG bathing, except neonatal ICU, newborn nursery, and perinatal patients without a central line or cesarean delivery.

HAI Data Collection and Rate Calculations

Surveillance for MRSA, VRE, and *C. difficile* was performed monthly by infection preventionists using the National Healthcare Safety Network (NHSN) LabID Event method.[33] Hospital A reported all clinical specimens to NHSN and rate data for each culture is available for the entire study period. Hospital B reported only MRSA and VRE bloodstream infections to NHSN before January 2014, and all clinical specimens from January 2014 through June 2015. Hospital B collected *C. difficile* data for the entire study period. *C. difficile* rates were calculated monthly using the NHSN Facility *C. difficile* Infection Healthcare Facility-Onset Incidence Rate. *C. difficile* toxin B gene polymerase chain reaction assay was used for laboratory identification. MRSA and VRE rates were calculated monthly using the NHSN Overall MDRO Infection/Colonization Incidence Rate.

HH and Personal Protective Equipment (PPE) Compliance

Trained volunteers directly observed opportunities for HH and PPE and documented observed and correctly completed opportunities (see Appendix for details). PPE compliance requires gloves and a gown tied behind the head and back.

Change in Resistant Isolates

All *Staphylococcus aureus* and *Enterococcus* isolated from specimens submitted for culture (blood, respiratory, skin/soft tissue, wound, or other) were tested for susceptibility to oxacillin/cefoxitin and vancomycin using broth microdilution, if clinically warranted. Active surveillance tests were not included. The percentages of resistant isolates were compared before and after the intervention.

MRSA and VRE Screening

California law requires MRSA active surveillance culture via nasal swab testing on all high-risk patients.[34,35] High-risk patients include ICU admissions, transfers from outside hospitals or skilled nursing facilities, 30-day readmissions, orthopedic or spine surgery patients receiving prosthetic material, and hemodialysis patients. VRE surveillance testing by rectal swab was performed on patients deemed clinically high-risk by their treating physician's judgment. Testing was performed using chromogenic media.

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Hospital Outcomes

Before-and-after data on average length of stay, 30-day readmissions, and in-hospital mortality were collected. Analyses included all length of stay data and excluded hospice, readmissions for chemotherapy, radiation, rehabilitation, death on first admission, dialysis, delivery, birth, mental diseases, and drug/alcohol abuse treatment.

Cost Data

Gown and CHG costs were based on total purchasing of materials. UCLA began using washable gowns in some units in 2012 and house-wide in hospital A in August 2013. Washable gowns were phased in at hospital B throughout the study period.

HCW Time

To estimate HCW time spent donning PPE, donning time and average number of room entries were collected. HCW were randomly selected by unit and presence of CP rooms and were timed donning PPE during routine patient care on multiple units. Timing was started when they reached for PPE and stopped after gloves/gown were completely donned.

Randomly selected patient rooms were observed for 30 minutes to 1 hour (total of 26 hours) to assess nursing entries. The average number of entries per hour was calculated and broken down by ICU or medicine/surgery floor.

Time-driven activity-based costing was used to estimate costs associated with nursing time spent donning PPE (using average PPE donning time, average entries per hour, and nursing capacity time costs).[36,37] The capacity cost calculated using time-driven activity-based costing was $1.75 per minute for floor nurses and $1.66 per minute for ICU nurses (internal financial data).

Statistical Analysis

Before-and-after clinical culture rates were compared using Poisson regression models with monthly rates as the unit of analysis. To account for patient-days per month (*C. difficile*) or admissions per month (MRSA, VRE), all models included a (log) offset term. We assessed intervention effect 2 ways for each infection. The first set of models included a binary term for pre- versus postintervention period, with separate analyses for each hospital alone and both hospitals combined, producing 3 sets of results. On the basis of these models, we computed rate ratios and associated 95% confidence intervals. Next, we constructed a set of models with additional terms for hospital and intervention by hospital interaction. Statistical analyses for clinical culture rates were performed using SAS, version 9.4 (SAS Institute).

Pre- versus postintervention comparisons were made for resistant isolates, MRSA active surveillance cultures, VRE surveillance, HH compliance, PPE compliance, length of stay, 30-day readmissions, and in-hospital mortality using χ^2 tests for categorical variables and *t* tests for continuous variables. These analyses were performed using Stata, version 14.0 (StataCorp). $P < .05$ was considered statistically significant.

RESULTS

Impact on Infections

Throughout the study, admissions and patient-days were relatively constant (Supplementary Table 1).

There was no increase in LabID clinical culture rates for MRSA, VRE, or *C. difficile* at either hospital or in combined data after CP were discontinued for endemic MRSA and VRE (Table 1). There were monthly fluctuations in both the before-and-after periods (Figure 1). All rates were lower in the postperiod, except VRE in hospital B and *C. difficile* in hospital A, although not statistically significant. The rate ratios for the combined data trended toward favoring discontinuation of CP

TABLE 1. Mean Methicillin-Resistant *Staphylococcus aureus* (MRSA), Vancomycin-Resistant *Enterococcus* (VRE), and *Clostridium difficile* LabID Clinical Culture Rates (Marker of Healthcare-Associated Infections) Before and After Discontinuing Routine Contact Precautions for Endemic MRSA and VRE

Variable	Hospital	Rate before[a]	Rate after[a]	Rate ratio	*P* value
MRSA	A	0.43 (0.35–0.54)	0.38 (0.31–0.48)	0.88 (0.64–1.20)	.41
	B	0.33 (0.23–0.48)	0.25 (0.18–0.34)	0.74 (0.46–1.21)	.23
	Combined	0.40 (0.33–0.48)	0.32 (0.27–0.38)	0.80 (0.62–1.04)	.09
VRE	A	0.62 (0.52–0.74)	0.58 (0.48–0.69)	0.93 (0.72–1.20)	.58
	B	0.17 (0.10–0.28)	0.17 (0.12–0.25)	1.04 (0.55–1.98)	.90
	Combined	0.48 (0.40–0.57)	0.40 (0.34–0.47)	0.83 (0.66–1.06)	.14
C. difficile	A	11.53 (9.88–13.47)	11.83 (10.18–13.76)	1.03 (0.83–1.27)	.82
	B	10.87 (8.70–13.60)	9.51 (7.48–12.08)	0.87 (0.63–1.21)	.42
	Combined	11.31 (9.96–12.85)	11.06 (9.74–12.57)	0.98 (0.82–1.17)	.81

NOTE. Rates are displayed with 95% CIs. Hospital A, Ronald Reagan UCLA Medical Center; hospital B, Santa Monica UCLA Medical Center; Combined, Aggregated data from both locations.

[a]Rates for MRSA and VRE are LabID clinical cultures per 100 admissions. Rate for *C. difficile* is LabID clinical cultures per 10,000 patient-days.

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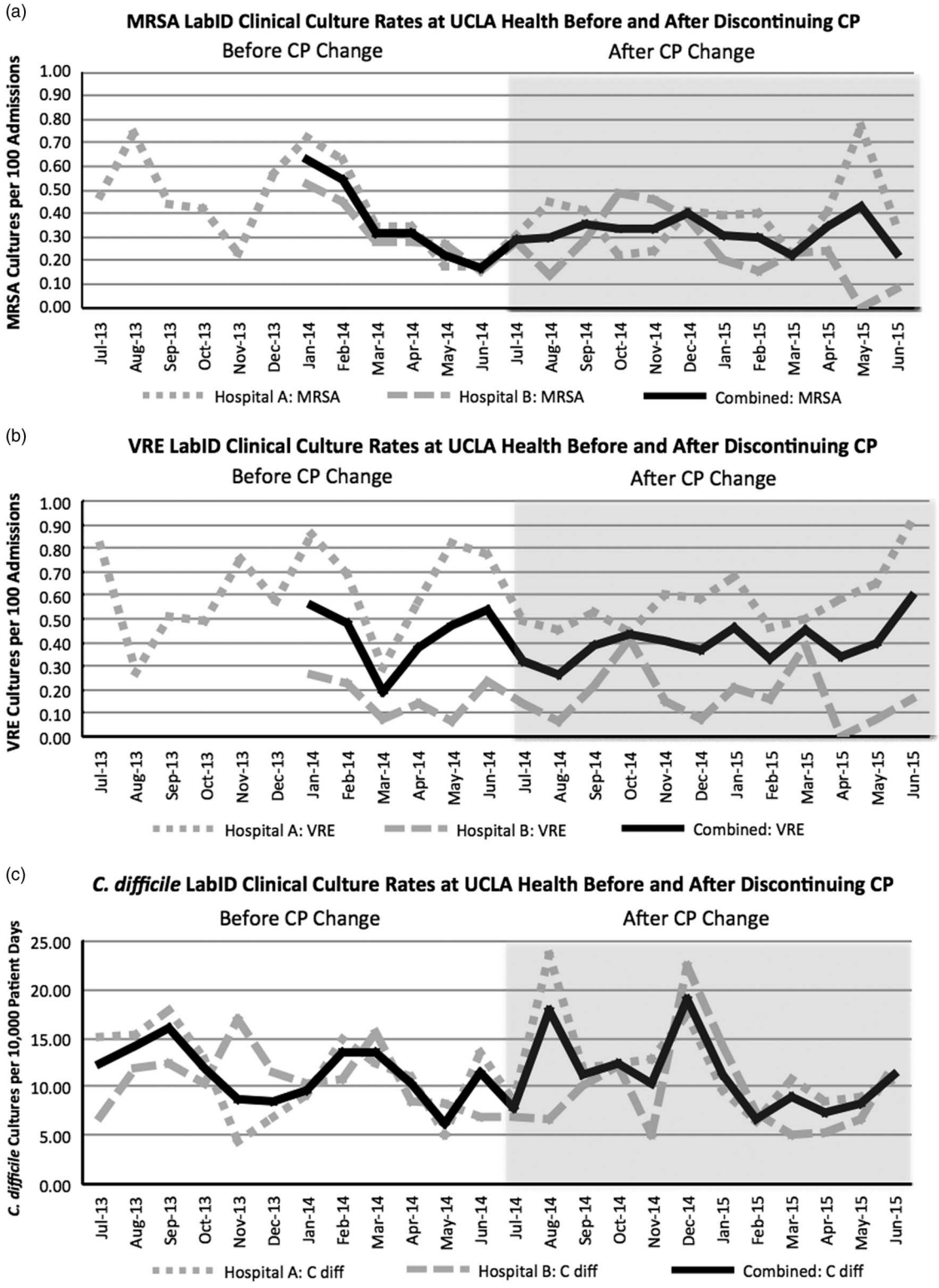

FIGURE 1. Graphs of the methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant *Enterococcus* (VRE), and *Clostridium difficile* LabID clinical culture rates (marker of healthcare-associated infections) before and after discontinuing routine contact precautions for endemic MRSA and VRE. Data were not available from July 2013 to December 2013 for hospital B for MRSA or VRE cultures. Hospital A, Ronald Reagan UCLA Medical Center; hospital B, Santa Monica UCLA Medical Center; Combined, Aggregated data from both locations.

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with rate ratios of 0.80 (95% CI, 0.62–1.04, $P = .09$) for MRSA and 0.83 (0.66–1.06, $P = .14$) for VRE.

There were higher overall rates in hospital A compared with B for both MRSA ($P = .015$) and VRE ($P < .0001$), but not *C. difficile* ($P = .17$). An evaluation for interaction between hospital and before/after period was performed and was not statistically significant for any culture (data not shown).

To evaluate the impact on microbial resistance, the percentage of *Staphylococcus aureus* clinical isolates resistant to methicillin (determined by oxacillin/cefoxitin resistance) and *Enterococcus* isolates resistant to vancomycin were compared from before and after CP was discontinued. There were no differences found (Table 2).

There was no change in percent positive MRSA screening in high-risk patients after CP were discontinued (Table 3). There was a trend toward fewer VRE-positive screening tests in the postperiod, but this was based on a small number of tests and not statistically significant.

There was a small increase in HH compliance in hospital A and decrease in HH compliance in hospital B after the policy change (Table 4). PPE compliance improved after CP were no longer required in hospital A from 64% to 74% ($P < .001$) but did not change in hospital B.

There was no change in 30-day readmissions or in-hospital mortality at either hospital (Supplementary Table 2). The combined length of stay was also unchanged, with an average of 5.71 days before and 5.85 days after ($P = .09$).

Impact on Costs

After MRSA/VRE CP were discontinued, isolation gown usage decreased, leading to cost savings of $729,572 (Table 5). CHG bathing was expanded to all units for additional cost of $85,796 per year. This led to overall cost savings of $643,776 per year.

In the ICU, nurses entered patient rooms on average 5.68 times per hour and on medicine/surgery floors 1.71 times per hour. Mean (SD) PPE donning time was 38 (11) seconds. Before the policy change, approximately 28.5% of ICU patients and 19% of medicine/surgery floor patients were on CP for MRSA and/or VRE (not including *C. difficile* or MDRO gram-negative infections).

Assuming a constant rate of room entries per hour by nurses and no difference in number of entries whether a patient is on CP or not, total nursing time spent in 1 year donning PPE for MRSA and VRE was more than 45,000 hours. Using time-driven activity-based costing, the capacity cost per minute of nursing time was calculated and used to estimate the value of time saved by reduction of nursing time donning PPE. This time was worth approximately $4.6 million (Table 6). Although this is a sunk cost, and a reduction of labor expenses is not actually recorded, nursing time is freed to focus that quantity of effort on direct patient care.

DISCUSSION

Although recent data suggest patient harms associated with CP, it remains common practice for MRSA and VRE.[3–5] Widespread elimination of CP for MRSA and VRE has been hampered by the absence of published data on the impact this has on HAI rates.

Our study shows that following discontinuation of routine CP for endemic MRSA and VRE and expansion of CHG bathing to nearly all patients, there was no change in the

TABLE 2. Comparison of Percentage of All Isolates Positive for Methicillin-Resistant *Staphylococcus aureus* (MRSA) and Vancomycin-Resistant *Enterococcus* (VRE) 1 Year Before and After the Contact Precautions (CP) Policy Change

Variable		Before CP were discontinued	After CP were discontinued	*P* value
Staphylococcus aureus	% MRSA[a]	37.0%	40.0%	.26
	n	699	672	
Enterococcus	% VRE[b]	37.7%	39.1%	.62
	n	596	567	

NOTE. Data above is combined from both hospitals.
[a]Percent of all *Staphylococcus aureus* clinical isolates found to be MRSA.
[b]Percent of all *Enterococcus* clinical isolates found to be VRE.

TABLE 3. Comparison of Percentages of Positive Surveillance Screening for Methicillin-Resistant *Staphylococcus aureus* (MRSA) and Vancomycin-Resistant *Enterococcus* (VRE) Before and After the Contact Precautions (CP) Policy Change

Variable		Before CP were discontinued	After CP were discontinued	*P* value
MRSA nasal swabs	% Positive	4.5%	4.9%	.255
	n	11,641	11,543	
VRE rectal swabs	% Positive	31.7%	22.6%	.084
	n	1,045	84	

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marker of HAIs (LabID clinical culture rates) for MRSA and VRE after 1 year. Further, the 95% confidence intervals for the rate ratios are narrow and, on the basis of the upper limit of the interval, it is unlikely that the true effects could be an increase of more than 4% and 6%, respectively.

One concern with our intervention is the impact on other HAIs that require CP to decrease transmission. Even though patients were still on spore precautions for *C. difficile*, there were overall fewer patients in the hospital on CP and a theoretical concern that this may lead to increases in *C. difficile*. This was not seen in our study.

TABLE 4. Hand Hygiene Rates Before and After Contact Precautions Policy Change

Variable	Compliance rate before	Compliance rate after	*P* value
Hand hygiene			
Hospital A	94% n = 22,890	96% n = 46,589	<.001
Hospital B	88% n = 1,772	84% n = 2,013	<.001
PPE			
Hospital A	64% n = 1,078	74% n = 1,540	<.001
Hospital B	56% n = 185	50% n = 151	.33

NOTE. Hospital A, Ronald Reagan UCLA Medical Center; Hospital B, Santa Monica UCLA Medical Center; PPE, personal protective equipment (gown and gloves).

There was also concern that not placing patients on CP for MRSA/VRE could lead to changes in resistance profiles of clinical isolates and higher percentages of MRSA and VRE relative to methicillin- and vancomycin-susceptible isolates. There was no change in percentages of resistant isolates after the policy change. Similarly, our study did not find a difference in MRSA colonization in high-risk patients, which is important given colonization is a risk factor for invasive MRSA infection.[38]

Although this study does not show an increase in possible HAI rates or surveillance cultures, it does not explain why, and it may be due to several factors. First, our MRSA and VRE rates are low and may have decreased the transmission risk. It is unclear if these results are reproducible in hospitals with higher rates. Additionally, UCLA has single-occupant patient rooms and near-universal CHG bathing. These factors may have also decreased transmission risk. Given the increase in CHG bathing shortly before discontinuing CP, it is not possible to separate the impact of these 2 interventions. Further data are needed to determine which, if any, of these additional factors are required for success.

Numerous studies have shown that HH is a key factor in decreasing transmission of MDROs and our documented HH compliance rates are relatively high.[39,40] Assuming the rates are accurate, the high compliance rates may have also decreased transmission risk and CP may not have provided any marginal benefit. Given that discontinuing CP has not been tested at a hospital with a lower HH rate, the critical rate of HH compliance required to prevent a rise in HAI is unknown and further research is necessary. It is also possible that these rates are falsely elevated given the HCW were being observed and

TABLE 5. Cost Analysis Before and After the Contact Precautions Policy Change

Cost savings	Monthly cost before	Monthly cost after	Monthly cost difference	Yearly cost difference
Gowns	$106,476	$45,679	$60,798	$729,572
Total savings				$729,572
Additional costs				
CHG bathing	$16,476	$23,626	$7,150	$85,796
Additional costs			$7,150	$85,796
			Total cost savings:	$643,776

NOTE. Costs have been rounded to the nearest dollar. CHG, chlorhexidine gluconate.

TABLE 6. Nursing Time Analysis Before and After Contact Precautions (CP) Policy Change

Variable	Total beds	% on CP before[a]	% on CP after[a]	Nursing room entries per hour	Average entry time, sec	Total hours per year	Nursing cost per hour	Total sunk cost
ICU	176	28.5%	0%	5.68	38	26,333	$99.60	$2,622,727
Med/surg floors	629	19%	0%	1.71	38	18,944	$105.00	$1,989,124
Total	805					45,277		$4,611,851

NOTE. ICU, intensive care unit.

[a]For methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant *Enterococcus* (VRE) only. Does not include *Clostridium difficile* or multidrug-resistant gram-negative organisms.

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the true rates may actually be lower. Although our data did not show a clear change in compliance, the new policy relies heavily on good HH and further data are necessary on whether compliance improves after HCW are not required to wear PPE for MRSA/VRE.

Another limitation of this study is that all of the analyses on impacts to cultures and burden of resistant organisms are at the population level. It was not possible to determine the impact on a single patient or hospital unit given that not all patients have specimens collected and cultured for resistant organisms.

Although these initial finding are encouraging, the data are limited to 2 institutions in a single health system and only 1 year of postdata. Follow-up data after 1 year and data from other hospitals are needed to ensure that MRSA and VRE rates do not creep up over time and to identify additional infection prevention strategies necessary for this to be successful and sustainable.

Another important impact of this policy change is on HCW time. Numerous studies have shown that HCW spend less time directly caring for patients on CP, likely due to the burden of donning PPE.[18–23] Although it took only 38 seconds to don PPE correctly, this adds up to a substantial amount of time given how often patients are visited by HCW each day in an 805-bed health system. We estimated nursing time donning PPE over 1 year in our health system at approximately 45,000 hours, time worth an estimated $4.6 million. This time is now freed to provide other services, including direct patient care.

There are limitations with the estimation for nursing time spent donning PPE. First, it assumes nurses are compliant with PPE every time, even though our PPE compliance rate was only 50%–74%. The total donning time also assumes nurses enter rooms at a constant rate. This seems less likely given data that HCW enter CP rooms less frequently and rates likely differ depending on time of day.[21] There may also be an observation bias. These factors could lead to an overestimation of the donning time. This number, however, does not reflect all of the other providers who spend time donning gowns, including, for example, physicians, allied health workers, and housekeeping. Although total donning time is only an estimate, it does highlight that a significant amount of time is spent donning PPE, time perhaps better spent on other activities that can provide more benefit to patients.

This study showed that 1 year after discontinuing routine CP for endemic MRSA and VRE and initiation of near-universal CHG bathing, there was no increase in LabID clinical culture rates for MRSA or VRE, and the policy change provided significant cost savings on materials and HCW time. Given concerning data on patient harms and no clear benefit to the practice, discontinuing routine CP for MRSA and VRE may provide substantial benefit to patients and the health system in terms of cost savings and increased time for direct patient care.[18–29] Further data are needed on the optimal hospital settings and horizontal infection prevention strategies needed for the discontinuation of CP to be successful. If CP are effective at preventing transmission of MRSA and VRE in hospitals, further data on which patient populations benefit most from the intervention would help limit universal use. Hospitals that continue to use CP for MRSA and VRE should implement strategies to mitigate the negative impact of CP on patients.

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SUPPLEMENTARY MATERIAL

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APPENDIX

Hand Hygiene Observation Protocol

UCLA Health has a volunteer-based patient safety program that performs audits of both HH and use of PPE in our hospitals. Each volunteer undergoes an application process and then training by a senior member of the team on the HH and PPE policies. Next, the volunteer performs audits under the supervision of a senior member of the team and then they are able to perform audits on their own. The 2 program leads perform interrater reliability to make sure training is consistent. HH compliance is washing one's hands with soap and water for 15 seconds or use of an alcohol-based hand rub. PPE compliance is wearing both gloves and a gown tied behind the head and back. Observations are performed on all shifts, including nights and weekends. They are performed in all units in hospital A and primarily in the emergency room and the intensive care unit in hospital B. Each volunteer collects data for approximately 4 hours per week and collects data on 2 units per shift.