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Elimination of Routine Contact Precautions for Endemic MRSA and VRE: A Retrospective Quasi-Experimental Study

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Elimination of Routine Contact Precautions for Endemic MRSA and VRE: A  
Retrospective Quasi-Experimental Study

A thesis submitted in satisfaction of the requirements  
for the degree Master of Science in Clinical Research

by

Elise Marie Martin

2016



## ABSTRACT OF THE THESIS

Elimination of Routine Contact Precautions for Endemic MRSA and VRE: A  
Retrospective Quasi-Experimental Study

By

Elise Marie Martin

Masters of Science in Clinical Research

University of California, Los Angeles, 2016

Professor Douglas Bell, Chair

**Objective:** Given controversy over use of contact precautions (CP), this study evaluates the impact of discontinuing 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:** 2 California hospitals.

**Participants:** Inpatients.

**Methods:** We compared hospital-wide LabID 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 (PPE) 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 ( $p=0.09$ ), and 0.48 and 0.40 cultures/100 admissions for VRE ( $p=0.14$ ). When combining isolation gown and CHG costs, the health system saved \$643,776 in one year. Prior to the change, 28.5% ICU and 19% Medicine/Surgery beds were on CP for MRSA/VRE. Based on average room entries and donning time, estimated nursing time spent donning PPE 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 one year. With cost savings on materials, increased healthcare worker time, and no concomitant increase in possible infections, elimination of routine CP may add substantial value to inpatient care delivery.

The thesis of Elise Marie Martin is approved.

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2016

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## CHAPTER 1. MANUSCRIPT

### ABSTRACT

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admissions for VRE (p=0.14). When combining isolation gown and CHG costs, the health system saved \$643,776 in one year. Prior to the change, 28.5% ICU and 19% Medicine/Surgery beds were on CP for MRSA/VRE. Based on average room entries and donning time, estimated nursing time spent donning PPE 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 one year. With cost savings on materials, increased healthcare worker time, and no concomitant increase in possible infections, elimination of routine CP may add substantial value to inpatient care delivery.

## **INTRODUCTION**

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).<sup>1,2</sup> Although common practice, CP for endemic MRSA and VRE have become increasingly controversial given associations with patient harms.<sup>3-5</sup>

Data demonstrating that CP (gown and gloves) decrease transmission of endemic MRSA and VRE are limited.<sup>3</sup> Most studies on the effectiveness of CP include horizontal infection prevention strategies, including improved hand hygiene (HH), decolonization, and/or active surveillance cultures (ASC), not just organism specific vertical prevention

strategies.<sup>3</sup> Although combination strategies have shown decreases in MDRO acquisition, colonization, and invasive disease, there is no strong evidence supporting use of CP in absence of additional strategies for endemic MRSA or VRE.<sup>3,6-17</sup>

CP have been associated with patient harms, including fewer healthcare workers (HCW) bedside visits, shorter HCW contact time, and less documentation compared to patients not on CP.<sup>18-23</sup> Patients experience delays in admission from the emergency room and discharge to skilled nursing facilities.<sup>23-26</sup> CP were also associated with increased preventable adverse events, including falls, pressure ulcers, and medication administration errors.<sup>23,27</sup> Patients on CP had increased anxiety and depression, and lower satisfaction.<sup>23,28-30</sup> The results of newer studies, however, have conflicting findings and do not show increased adverse events.<sup>31</sup>

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

The purpose of this study was to determine the impact of discontinuing routine CP for endemic MRSA and VRE on 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 vast 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 7/1/14 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. Prior to 7/1/14, 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 7/1/14,

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* (*C. difficile*). Policies for droplet and airborne precautions were unchanged. Data were collected for 1 year after the policy change at both hospitals.

CHG bathing was required in ICUs since 2012, except neonatal. Starting in 5/2014, daily 2% CHG bathing was implemented in all units. All patients over 2 months of age undergo CHG bathing, except neonatal ICU, newborn nursery, and perinatal patients without a central line or cesarean section.

#### **HAI Data Collection and Rate Calculations:**

Surveillance for MRSA, VRE and *C. difficile* were performed monthly by Infection Preventionists using the National Healthcare Safety Network (NHSN) Lab ID Event method.<sup>33</sup> Hospital A reported all clinical specimens to NHSN and rate data for each culture is available for the entire study period. Hospital B only reported MRSA and VRE bloodstream infections to NHSN prior to 1/2014, and all clinical specimens from 1/2014 to 6/2015. 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 PCR 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:**

UCLA Health has a volunteer based patient safety program that performs audits of both hand hygiene (HH) and use of personal protective equipment (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 two 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. These trained volunteers directly observed opportunities for HH and PPE, and documented observed and correctly completed opportunities. 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.

**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 ASC nasal swab testing on all high-risk patients.<sup>34,35</sup>

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.

### **Hospital Outcomes:**

Pre and post 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 8/2013.

Washable gowns were phased in at hospital B throughout the study period.

### **Healthcare Worker 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 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 entries per hour was calculated and broken down by ICU or medicine/surgery floor.

Time-driven activity-based costing (TDABC) 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.<sup>36,37</sup> The capacity cost calculated using TDABC was \$1.75 per minute for floor nurses and \$1.66 per minute for ICU nurses (internal financial data).

### **Statistical Analysis:**

Pre and post 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 two ways for each infection. The first set of models included a binary term for pre versus post intervention period, with separate analyses for each hospital alone and both hospitals combined, producing 3 sets of results. Based on 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 carried out using SAS 9.4 (SAS institute, Cary, NC).

Pre versus post intervention comparisons were made for resistant isolates, MRSA ASC, VRE surveillance, HH compliance, PPE compliance, length of stay, 30-day readmissions, and in-hospital mortality using chi-square tests for categorical variables and t-tests for continuous variables. These analyses were carried out using Stata 14.0 (StataCorp LP, College Station, TX). P-values <0.05 were considered statistically significant.

## **RESULTS**

### **Impact On Infections:**

Throughout the study, admissions and patient days were relatively constant (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 2). There were monthly fluctuations in both the pre and post periods (Figure 1). All rates were lower in the post period, 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 with rate ratios of 0.80 (95% CI:0.62-1.04, p=0.09) for MRSA and 0.83 (95% CI: 0.66-1.06, p=0.14) for VRE.

There were higher overall rates in hospital A compared to B for both MRSA (p=0.015) and VRE (p<0.0001), but not *C. difficile* (p=0.17). An evaluation for interaction between hospital and before/after period was performed and was not statistically significant for any culture (data not show).

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 were discontinued. There were no differences found (Table 3).

There was no change in percent positive MRSA screening in high-risk patients after CP per discontinued (Table 4). There was a trend toward fewer VRE positive screening tests in the post period, 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 5). PPE compliance improved after CP were no longer required in hospital A from 64% to 74% ( $p<0.001$ ), but did not change in hospital B.

There was no change in 30-day readmissions or in-hospital mortality at either hospital (Table 6). The combined length of stay was also unchanged, with an average of 5.71 days before and 5.85 days after ( $p=0.09$ ).

### **Impact on Costs:**

After MRSA/VRE CP were discontinued, isolation gown usage decreased, leading to cost savings of \$729,572 (Table 7). 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 1.71 times per hour on medicine/surgery floors. Average PPE donning time was 38 (SD±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 one year donning PPE for MRSA and VRE was over 45,000 hours. Using TDABC, 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 8). While 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, they remain common practice for MRSA and VRE.<sup>3-5</sup> 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 marker of HAIs (LabID clinical culture rates) for MRSA and VRE after one year.

Further, the 95% confidence intervals for the rate ratios are narrow and based on 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.

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.<sup>38</sup>

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 two 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.<sup>39,40</sup> 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 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 the true rates may actually be lower. While 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 not all patients are cultured for resistant organisms.

While these initial findings are encouraging, the data are limited to 2 institutions in a single health system and only one year of post data. Follow up data after one 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.<sup>18-23</sup> Although it only took 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.<sup>21</sup> There may also be an observation bias. These factors could lead to an over-estimation of the donning time. This number, however, does not reflect all of the other providers that spend time donning gowns, including physicians, allied health workers, housekeeping, etc. Although data on 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 one year after discontinuing routine contact precautions 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, 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.<sup>18-29</sup> 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.

**Table 1:** Average admissions and patients days at both hospitals before and after the policy change.

		<b>Before</b>	<b>After</b>
Average Monthly Admissions	Hospital A	1,534	1,707
	Hospital B	1,414	1,356
Average Monthly Patient Days	Hospital A	11,560	11,901
	Hospital B	5,901	5,873

Hospital A = Ronald Reagan UCLA Medical Center

Hospital B = Santa Monica UCLA Medical Center

Before = Before contact precautions were discontinued at each site.

After = After contact precautions were discontinued at each site.

**Table 2:** Mean MRSA, VRE, and *C. difficile* LabID clinical culture rates (marker of healthcare associated infections) before and after discontinuing routine contact precautions for endemic MRSA and VRE.

	<b>Hospital</b>	<b>Rate Before*</b>	<b>Rate After*</b>	<b>Rate Ratio</b>	<b>P-value</b>
<b>MRSA</b>	A	0.43 (0.35-0.54)	0.38 (0.31-0.48)	0.88 (0.64-1.20)	0.41
	B	0.33 (0.23-0.48)	0.25 (0.18-0.34)	0.74 (0.46-1.21)	0.23
	Combined	0.40 (0.33-0.48)	0.32 (0.27-0.38)	0.80 (0.62-1.04)	0.09
<b>VRE</b>	A	0.62 (0.52-0.74)	0.58 (0.48-0.69)	0.93 (0.72-1.20)	0.58
	B	0.17 (0.10-0.28)	0.17 (0.12-0.25)	1.04 (0.55-1.98)	0.90
	Combined	0.48 (0.40-0.57)	0.40 (0.34-0.47)	0.83 (0.66-1.06)	0.14
<b><i>C. difficile</i></b>	A	11.53 (9.88-13.47)	11.83 (10.18-13.76)	1.03 (0.83-1.27)	0.82
	B	10.87 (8.70-13.60)	9.51 (7.48-12.08)	0.87 (0.63-1.21)	0.42
	Combined	11.31 (9.96-12.85)	11.06 (9.74-12.57)	0.98 (0.82-1.17)	0.81

Rates displayed with 95% confidence intervals.

Hospital A = Ronald Reagan UCLA Medical Center.

Hospital B = Santa Monica UCLA Medical Center.

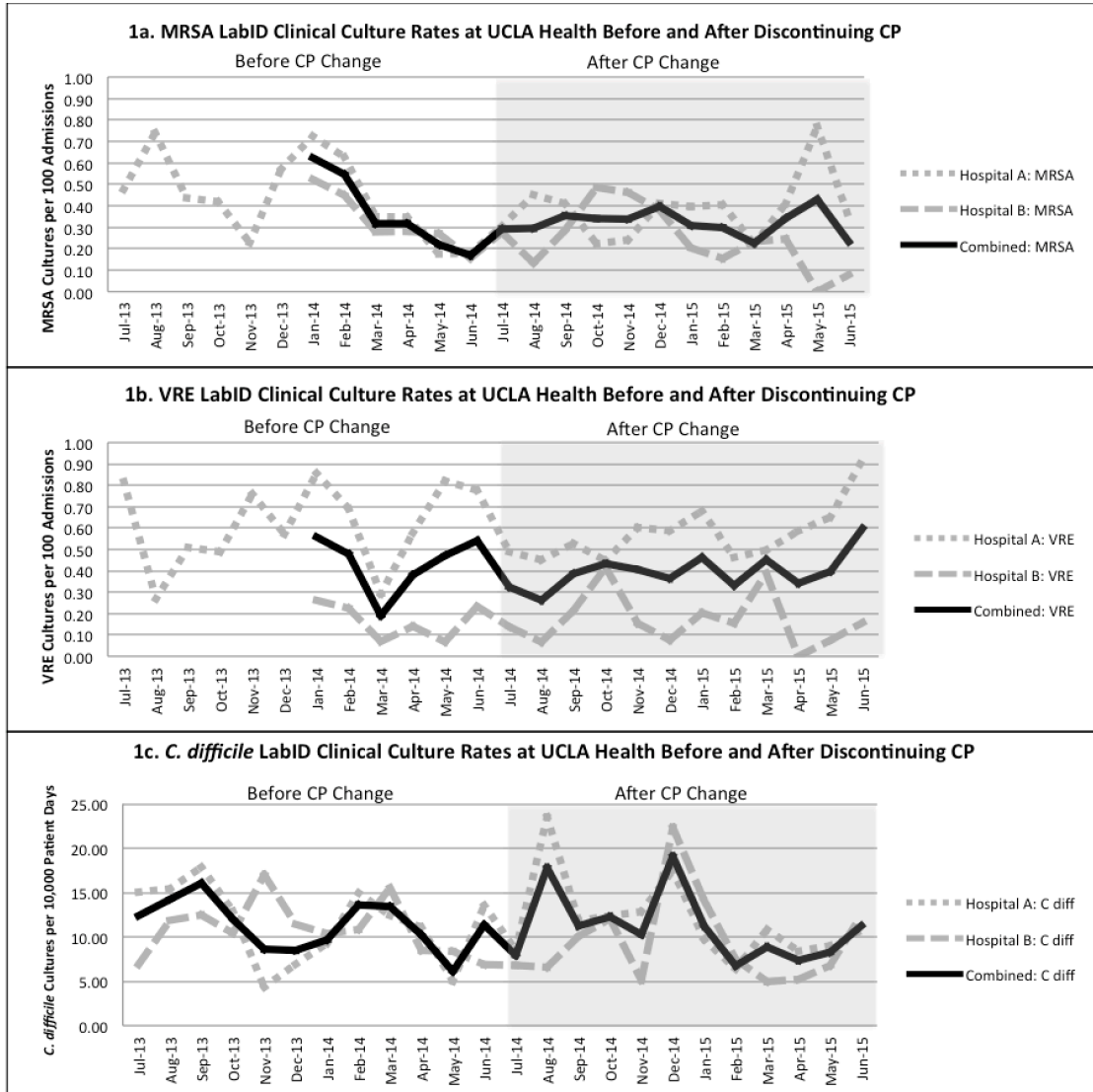
Before = Before contact precautions were discontinued at each site.

After = After contact precautions were discontinued at each site.

Combined = Aggregated data from Ronald Reagan UCLA Medical Center and Santa Monica UCLA Medical Center.

\*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.

**Figure 1:** Graphs of the MRSA, VRE, and *C. difficile* LabID clinical culture rates (marker of healthcare associated infections) before and after discontinuing routine contact precautions for endemic MRSA and VRE\*.



Hospital A = Ronald Reagan UCLA Medical Center

Hospital B = Santa Monica UCLA Medical Center

Combined = Aggregated data from Ronald Reagan UCLA Medical Center and Santa Monica UCLA Medical Center.

\*Data not available from 7/2013 to 12/2013 for SMH for MRSA or VRE cultures.

**Table 3:** Comparison of percentage of all isolates positive for MRSA and VRE 1 year before and after the CP policy change.

		<b>Before CP were discontinued</b>	<b>After CP were discontinued</b>	<b>P value</b>
<i>Staphylococcus aureus</i>	% MRSA*	37.0%	40.0%	0.26
	n	699	672	
<i>Enterococcus</i>	% VRE †	37.7%	39.1%	0.62
	n	596	567	

\* % MRSA = Percent of all *Staphylococcus aureus* clinical isolates found to be MRSA

† % VRE = Percent of all *Enterococcus* clinical isolates found to be VRE

Data above is combined from both hospitals.

**Table 4:** Comparison of percentages of positive surveillance screening for MRSA and VRE before and after the CP policy change.

		<b>Before CP were discontinued</b>	<b>After CP were discontinued</b>	<b>P value</b>
MRSA Nasal Swabs	% Positive	4.5%	4.9%	0.255
	n	11641	11543	
VRE Rectal Swabs	% Positive	31.7%	22.6%	0.084
	n	1045	84	

**Table 5:** Hand hygiene rates before and after CP policy change.

	<b>Compliance Rate Before</b>	<b>Compliance Rate After</b>	<b>P value</b>
<b>Hand Hygiene</b>			
Hospital A	94% n=22,890	96% n=46,589	<0.001
Hospital B	88% n=1,772	84% n=2,013	<0.001
<b>PPE</b>			
Hospital A	64% n=1,078	74% n=1,540	<0.001
Hospital B	56% n=185	50% n=151	0.33

Hospital A = Ronald Reagan UCLA Medical Center

Hospital B = Santa Monica UCLA Medical Center

PPE = Personal protective equipment (gown and gloves)

**Table 6:** Comparison of hospital outcomes before and after the contact precautions policy change.

		<b>Before</b>	<b>After</b>	<b>P-value</b>
30-day Readmission Rate	Hospital A	2.5%	2.4%	0.49
	Hospital B	1.6%	1.5%	0.43
In-hospital Mortality	Hospital A	5.3%	5.3%	0.87
	Hospital B	3.7%	3.6%	0.63

Hospital A = Ronald Reagan UCLA Medical Center

Hospital B = Santa Monica UCLA Medical Center

Before = Before contact precautions were discontinued at each site.

After = After contact precautions were discontinued at each site.

**Table 7:** Cost Analysis before and after the CP policy change.

<b>Cost Savings:</b>	<b>Monthly Cost Before:</b>	<b>Monthly Cost After:</b>	<b>Monthly Cost Difference:</b>	<b>Yearly Cost Difference:</b>
Gowns	\$106,476	\$45,679	\$60,798	\$729,572
<b>Total Savings</b>				<b>\$729,572</b>
Additional Costs:				
CHG Bathing	\$16,476	\$23,626	\$7,150	\$85,796
<b>Additional Costs</b>			<b>\$7,150</b>	<b>\$85,796</b>
			<b>Total Cost Savings:</b>	<b>\$643,776</b>

CHG = Chlorhexidine gluconate

**Table 8:** Nursing time analysis before and after CP policy change.

	Total Beds	% on CP Before *	% on CP After *	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
<b>Total</b>	805					<b>45,277</b>		<b>\$4,611,851</b>

\*For MRSA and VRE only. Does not include *C. difficile* or multidrug resistant gram-

negative organisms.

## CHAPTER 2. STATISTICAL APPENDIX

### Sample Size and Power

The primary analysis of this study was on the impact of discontinuing routine contact precautions for MRSA and VRE on the MRSA and VRE clinical culture rates. The study was designed to look at the impact across the health system after one year. Given the analysis was performed after a finite amount of time, a convenience sample was used, instead of a sample size based on power calculations. After the study was complete, we found no statistically significant change in LabID clinical culture rates for MRSA or VRE at either hospital or in the combined data after CP were no longer required for MRSA and VRE (as shown in Table 1). The rate ratios for the combined data trended toward favoring discontinuation of CP with rate ratios of 0.80 (95% CI:0.62-1.04,  $p=0.09$ ) for MRSA and 0.83 (95% CI: 0.66-1.06,  $p=0.14$ ) for VRE. The confidence intervals crossed 1 for each of the analyses.

Given the study was likely underpowered to detect a small change in MRSA or VRE clinical culture rates, we calculated the effect size that the study was in fact powered to detect using Poisson regression, based on the assumptions of 80% power and a p-value of 0.05 as significant. The statistical analyses were carried out using SAS 9.4 (SAS institute, Cary, NC). Across the health system, there were an average of 2,948 admissions per month before the policy change and 3,063 after. When solving for the minimum effect size that could be statistically significant based on the available sample size, the study could have detected a difference of 0.13 MRSA clinical cultures per 100 admissions, which is much larger than the actual change of 0.08 (Table 9). Similarly, the



study was powered to detect a change of 0.14 VRE clinical cultures per 100 admissions (Table 9), which is also larger than the actual change of 0.079. As predicted, the study was not powered to detect a small change in clinical culture rates for MRSA or VRE.

The minimum change in clinical culture rate was also calculated using Poisson regression for *C. difficile* (Table 9) based on a power of 80% and p-value of 0.05 as significant. The statistical analysis was carried out using SAS 9.4 (SAS institute, Cary, NC). The average patient days before and after contact precautions were discontinued for MRSA and VRE were 2,948 and 3,063 per month across the health system. When calculating for the minimum effect size that could have been detected from this available sample, the study was powered to detect a change of 2.83, which is more than 10 times greater than the actual change found in this study of 0.25 clinical cultures per 10,000 patient days.

### **Effect of Month**

The original Poisson regression models used in the primary analysis also considered the role of hospital and the intervention by hospital interaction, both of which were not statistically significant for any of the clinical culture rates. The question of the impact of the month was raised during the development of the models. There are several challenges with evaluating the impact of month as a variable. When the data was analyzed in JMP® Pro version 12.0.1, the model failed to converge with month as a variable. This was, however, expected. The Poisson regression model used monthly rates as the unit of analysis and there was only 24 months worth of data. By evaluating each month as a variable, this added 12 additional variables in the model. The model also

included the treatment effect. The number of variables was too high in relation to the amount of data available and therefore, the impact of month could not be effectively evaluated in the model. In order to further assess the potential monthly variation in clinical culture rates, the data were analyzed graphically using excel. The data from Hospital A and Hospital B were graphed with the data from each year overlapping (Figure 2). There was no clear monthly variation based on the data for MRSA, VRE, or *C. difficile* clinical culture rates.

**Table 9:** Minimum changes needed in the MRSA, VRE, and *C. difficile* LabID clinical culture rates after discontinuing routine contact precautions for endemic MRSA and VRE for the study to finding statistical significance.

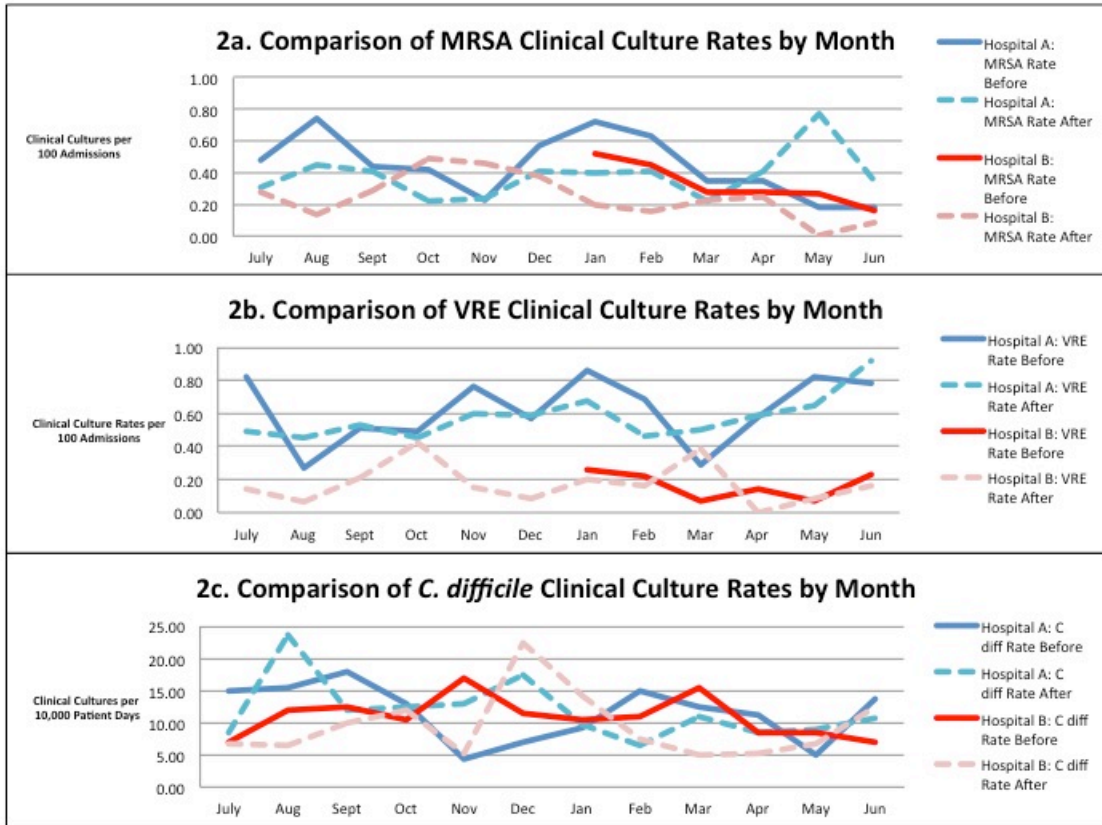
	Actual Values from Study				Values Needed for 80% Power	
	Before	After	Difference	p-value	<i>After*</i>	<i>Difference*</i>
<b>MRSA</b>	0.40	0.32	0.08	0.093	<i>0.27</i>	<i>0.13</i>
<b>VRE</b>	0.48	0.40	0.079	0.136	<i>0.34</i>	<i>0.14</i>
<b>CDIFF</b>	11.31	11.06	0.25	0.81	<i>8.48</i>	<i>2.83</i>

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.

\* = Minimum change that could have been detected from the available sample size

**Figure 2:** Graphs of the MRSA, VRE, and *C. difficile* LabID clinical culture rates (marker of healthcare associated infections) before and after discontinuing routine contact precautions for endemic MRSA and VRE overlaid to compare variations by month.\*



Hospital A = Ronald Reagan UCLA Medical Center

Hospital B = Santa Monica UCLA Medical Center

\*Data not available from 7/2013 to 12/2013 for SMH for MRSA or VRE HAI.

## REFERENCES

1. Calfee DP, Salgado CD, Milstone AM, et al. Strategies to prevent methicillin-resistant *Staphylococcus aureus* transmission and infection in acute care hospitals: 2014 update. *Infect Control Hosp Epidemiol* 2014;35:772-796.
2. Muto CA, Jernigan JA, Ostrowsky BE, et al. SHEA guideline for preventing nosocomial transmission of multidrug-resistant strains of *Staphylococcus aureus* and enterococcus. *Infect Control Hosp Epidemiol* 2003;24:362-386.
3. Morgan DJ, Murthy R, Munoz-Price LS, et al. Reconsidering Contact Precautions for Endemic Methicillin-Resistant *Staphylococcus aureus* and Vancomycin-Resistant Enterococcus. *Infect Control Hosp Epidemiol* 2015;36:1163-1172.
4. Fatkenheuer G, Hirschel B, Harbarth S. Screening and isolation to control methicillin-resistant *Staphylococcus aureus*: sense, nonsense, and evidence. *Lancet* 2015;385:1146-1149.
5. Morgan DJ, Kaye KS, Diekema DJ. Reconsidering isolation precautions for endemic methicillin-resistant *Staphylococcus aureus* and vancomycin-resistant Enterococcus. *JAMA* 2014;312:1395-1396.
6. Bearman GM, Marra AR, Sessler CN, et al. A controlled trial of universal gloving versus contact precautions for preventing the transmission of multidrug-resistant organisms. *Am J Infect Control* 2007;35:650-655.
7. Derde LP, Cooper BS, Goossens H, et al. Interventions to reduce colonisation and transmission of antimicrobial-resistant bacteria in intensive care units: an interrupted time series study and cluster randomised trial. *Lancet Infect Dis* 2014;14:31-39.

8. Harbarth S, Fankhauser C, Schrenzel J, et al. Universal screening for methicillin-resistant *Staphylococcus aureus* at hospital admission and nosocomial infection in surgical patients. *JAMA* 2008;299:1149-1157.
9. Harris AD, Pineles L, Belton B, et al. Universal glove and gown use and acquisition of antibiotic-resistant bacteria in the ICU: a randomized trial. *JAMA* 2013;310:1571-1580.
10. Huang SS, Yokoe DS, Hinrichsen VL, et al. Impact of routine intensive care unit surveillance cultures and resultant barrier precautions on hospital-wide methicillin-resistant *Staphylococcus aureus* bacteremia. *Clin Infect Dis* 2006;43:971-978.
11. Huskins WC, Huckabee CM, O'Grady NP, et al. Intervention to reduce transmission of resistant bacteria in intensive care. *N Engl J Med* 2011;364:1407-1418.
12. Jain R, Kralovic SM, Evans ME, et al. Veterans Affairs initiative to prevent methicillin-resistant *Staphylococcus aureus* infections. *N Engl J Med* 2011;364:1419-1430.
13. Lucet JC, Paoletti X, Lolom I, et al. Successful long-term program for controlling methicillin-resistant *Staphylococcus aureus* in intensive care units. *Intensive Care Med* 2005;31:1051-1057.
14. Marshall C, Richards M, McBryde E. Do active surveillance and contact precautions reduce MRSA acquisition? A prospective interrupted time series. *PLoS One* 2013;8:e58112.
15. Robicsek A, Beaumont JL, Paule SM, et al. Universal surveillance for methicillin-resistant *Staphylococcus aureus* in 3 affiliated hospitals. *Ann Intern Med* 2008;148:409-418.

16. Safdar N, Marx J, Meyer NA, Maki DG. Effectiveness of preemptive barrier precautions in controlling nosocomial colonization and infection by methicillin-resistant *Staphylococcus aureus* in a burn unit. *Am J Infect Control* 2006;34:476-483.
17. De Angelis G, Cataldo MA, De Waure C, et al. Infection control and prevention measures to reduce the spread of vancomycin-resistant enterococci in hospitalized patients: a systematic review and meta-analysis. *J Antimicrob Chemother* 2014;69:1185-1192.
18. Dashiell-Earp CN, Bell DS, Ang AO, Uslan DZ. Do physicians spend less time with patients in contact isolation?: a time-motion study of internal medicine interns. *JAMA Intern Med* 2014;174:814-815.
19. Evans HL, Shaffer MM, Hughes MG, et al. Contact isolation in surgical patients: a barrier to care? *Surgery* 2003;134:180-188.
20. Masse V, Valiquette L, Boukhoudmi S, et al. Impact of methicillin resistant *Staphylococcus aureus* contact isolation units on medical care. *PLoS One* 2013;8:e57057.
21. Morgan DJ, Pineles L, Shardell M, et al. The effect of contact precautions on healthcare worker activity in acute care hospitals. *Infect Control Hosp Epidemiol* 2013;34:69-73.
22. Saint S, Higgins LA, Nallamotheu BK, Chenoweth C. Do physicians examine patients in contact isolation less frequently? A brief report. *Am J Infect Control* 2003;31:354-356.
23. Stelfox HT, Bates DW, Redelmeier DA. Safety of patients isolated for infection control. *JAMA* 2003;290:1899-1905.

24. Gilligan P, Quirke M, Winder S, Humphreys H. Impact of admission screening for methicillin-resistant *Staphylococcus aureus* on the length of stay in an emergency department. *J Hosp Infect* 2010;75:99-102.
25. McLemore A, Bearman G, Edmond MB. Effect of contact precautions on wait time from emergency room disposition to inpatient admission. *Infect Control Hosp Epidemiol* 2011;32:298-299.
26. Goldszer RC TE, Yokoe DS, Shadick N, Bardon CG, Johnson PA, Hogan J, Kahlert T, Whittermore A. A program to remove patients from unnecessary contact precautions. *Journal of Clinical Outcomes Management* 2002;9:553-556.
27. Karki S, Leder K, Cheng AC. Patients under contact precautions have an increased risk of injuries and medication errors: a retrospective cohort study. *Infect Control Hosp Epidemiol* 2013;34:1118-1120.
28. Catalano G, Houston SH, Catalano MC, et al. Anxiety and depression in hospitalized patients in resistant organism isolation. *South Med J* 2003;96:141-145.
29. Day HR, Morgan DJ, Himelhoch S, Young A, Perencevich EN. Association between depression and contact precautions in veterans at hospital admission. *Am J Infect Control* 2011;39:163-165.
30. Mehrotra P, Croft L, Day HR, et al. Effects of contact precautions on patient perception of care and satisfaction: a prospective cohort study. *Infect Control Hosp Epidemiol* 2013;34:1087-1093.
31. Croft LD, Liquori M, Ladd J, et al. The Effect of Contact Precautions on Frequency of Hospital Adverse Events. *Infect Control Hosp Epidemiol* 2015;36:1268-1274.



- 32.** Edmond MB, Masroor N, Stevens MP, Ober J, Bearman G. The Impact of Discontinuing Contact Precautions for VRE and MRSA on Device-Associated Infections. *Infect Control Hosp Epidemiol* 2015;36:978-980.
- 33.** Surveillance for *C. difficile*, MRSA and other drug-resistant infections. Multidrug-resistant organism and *Clostridium difficile* infection (MDRO/CDI) module protocol. . 2015.  
[http://www.cdc.gov/nhsn/PDFs/pscManual/12pscMDRO\\_CDADcurrent.pdf](http://www.cdc.gov/nhsn/PDFs/pscManual/12pscMDRO_CDADcurrent.pdf). Accessed July 29, 2015, 2015.
- 34.** California Senate Bill No. 158. An act to amend Sections 1288.5 and 1288.8 of, and to add Sections 1279.6, 1279.7, 1288.45 and 1288.95 to, the Health and Safety Code, relating to health facilities. . In: Senate C, ed. *1582008*.
- 35.** California Senate Bill No. 1058. An act to add Sections 1255.8 and 1288.55 to the Health and Safety Code, relating to health. . In: Senate C, ed. *10582008*.
- 36.** Kaplan RS, Anderson SR. Time-driven activity-based costing. *Harv Bus Rev* 2004;82:131-138, 150.
- 37.** Kaplan RS, Porter ME. How to solve the cost crisis in health care. *Harv Bus Rev* 2011;89:46-52, 54, 56-61 passim.
- 38.** Huang SS, Platt R. Risk of methicillin-resistant *Staphylococcus aureus* infection after previous infection or colonization. *Clin Infect Dis* 2003;36:281-285.
- 39.** Larson E. A causal link between handwashing and risk of infection? Examination of the evidence. *Infect Control Hosp Epidemiol* 1988;9:28-36.
- 40.** . *WHO Guidelines on Hand Hygiene in Health Care: First Global Patient Safety Challenge Clean Care Is Safer Care*. Geneva2009.