

ORIGINAL ARTICLE

Low Yield of Methicillin-Resistant *Staphylococcus aureus* Screening in Hemodialysis Patients: 10 Years' Experience

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OBJECTIVE. To determine the prevalence of methicillin-resistant *Staphylococcus aureus* (MRSA) nasal colonization in hemodialysis patients and to analyze the cost-effectiveness of our screening approach compared with an alternative strategy.

DESIGN. Screening study and cost-effectiveness analysis.

METHODS. Analysis of twice-yearly MRSA prevalence studies conducted in the hemodialysis unit of a 950-bed tertiary care hospital from January 1, 2004, through December 31, 2013. For this purpose, nasal swab samples were cultured on MRSA screening agar (mannitol-oxacillin biplate).

RESULTS. There were 20 mass screenings during the 10-year study period. We identified 415 patients participating in at least 1 screening, with an average of 4.5 screenings per patient. Of 415 screened patients, 15 (3.6%) were found to be MRSA carriers. The first mass screening in 2004 yielded the highest percentage of MRSA (6/101 [6%]). Only 7 subsequent screenings revealed new MRSA carriers, whereas 4 screenings confirmed previously known carriers, and 8 remained negative. None of the carriers developed MRSA bacteremia during the study period. The total cost of our screening approach, that is, screening and isolation costs, was US \$93,930. The total cost of an alternative strategy (ie, no mass screening administered) would be equivalent to costs of isolation of index cases and contact tracing was estimated to be US \$5,382 (difference, US \$88,548).

CONCLUSIONS. In an area of low MRSA endemicity (<5%), regular nasal screenings of a high-risk population yielded a low rate of MRSA carriers. Twice-yearly MRSA screening of dialysis patients is unlikely to be cost-effective if MRSA prevalence is low.

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Infections are a leading cause of hospitalization, loss of vascular access (catheter or arteriovenous fistula), and death in hemodialysis patients. Many infections but not all are hemodialysis catheter-associated infections and are caused by gram-positive cocci such as *Staphylococcus aureus*.^{1,2} Methicillin-susceptible *S. aureus* and methicillin-resistant *S. aureus* (MRSA) are the most common pathogens³ and may cause a wide array of infections. Colonization with *S. aureus* is a prerequisite for subsequent infection.^{4–6} Screening for MRSA is therefore a key component of successful infection control strategies in that it identifies asymptomatic reservoirs of MRSA relevant for transmission.⁷ Screening has been used to assess the burden of MRSA carriage in hemodialysis patients prior to interventions.

The aim of our study was to determine the prevalence of MRSA nasal colonization in hemodialysis patients and to analyze the cost-effectiveness of our screening approach compared with an alternative strategy in which no mass screenings would be conducted.

METHODS

Setting and Infection Prevention Strategies

The University Hospital of Bern, Switzerland, is a tertiary care hospital with 950 beds. The mass screening studies were conducted in the hemodialysis unit from January 1, 2004, through December 31, 2013. This unit accommodates 30 patients per day in a single, large treatment room, with dialysis sessions divided into morning and afternoon sessions. One nurse is responsible for 5 patients undergoing hemodialysis at a time.

Our MRSA policy included, first, screening of high-risk groups, such as hemodialysis patients and patients who were transferred from hospitals with high MRSA prevalence in the previous 6 months. Second, there were contact precautions for all MRSA colonized/infected patients with placement in single rooms, and use of a door sign, gowns, and gloves in addition to standard precautions. Precautions were discontinued once a patient had 3 consecutive negative results for MRSA during 9 months of follow-up. Third, contact screening was

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conducted for inpatients who shared the same ward with a newly identified MRSA carrier at the time of diagnosis and for those who had been concurrently hospitalized with the index case during the previous 12 months.

No decolonization methods were used for any of the MRSA carriers identified in hemodialysis screenings.

Data Collection, Laboratory Method, and Data Analysis

We determined the prevalence of MRSA in dialysis patients during twice-yearly mass screenings for the years 2004–2013. Demographic data including sex and age were collected for each patient during screening session. For laboratory purposes, we obtained NaCl 0.9% wet cotton nasal swabs, which were circled in both nares of a participant. The samples were then placed into the transport medium (Copan Transystem) immediately. The samples were cultured on a screening agar for MRSA (mannitol-oxacillin biplate). Identification was performed according to standard laboratory procedures. Susceptibility testing was performed using disk diffusion tests and the results were interpreted according to the Clinical and Laboratory Standards Institute. For determining methicillin resistance we used oxacillin disks.

Those patients who had at least one positive nasal MRSA culture were defined as MRSA carriers, whereas all patients with negative MRSA culture results were regarded as noncarriers. We determined the yield of each screening and the overall yield and expressed it as a percentage.

Cost Analysis

We compared the cost of our MRSA prevention strategy with a scenario where no active screening of MRSA carriage is performed on a routine basis (ie, the alternative strategy).

The current strategy has 2 major contributors of cost, which are mass screening and isolation of *carriers*. In contrast, the alternative strategy would generate cost due to the isolation of *infected* patients and screening of their contacts.

The screening program cost itself consists of the cost of the swab material and laboratory processing. The cost of contact precautions was calculated as cost of gloves, gowns, and handrub bottles and included the terminal cleaning of single rooms where carriers are isolated.

In the alternative strategy, in order to calculate the contact tracing costs, we assumed that the rate of hospital admission of unidentified MRSA carriers among hemodialysis patients would be similar to what we found in colonized patients over 10 years (see Results section). Of the 15 MRSA carriers among 415 hemodialysis patients, 13 [86.7%] would have been admitted under that assumption. According to the literature, MRSA carriage has a 33% likelihood of progressing to infection in the year after detection of colonization.⁸ We took this percentage to calculate the number of MRSA-colonized, hospitalized hemodialysis patients who would progress to MRSA infection—that is, 5 of the 13 admitted colonized patients. Per our MRSA policy these 5 index patients would have required isolation, thus generating cost for contact

precautions. Owing to the lack of accurate information on inpatient acquisition of MRSA in our hospital, we used the overall prevalence of MRSA from our screening study—that is, 3.6%, as a surrogate for the MRSA acquisition rate in hospitalized patients. These 5 MRSA-infected patients would be index cases to start MRSA contact screening. The average number of patients included in the contact tracing of an index case is 17 (range, 1–66) (information taken from unpublished MRSA contact tracing data of the hospital in the same study period). This subsequently led us to estimate the cost of contact tracing, which shares variables with cost of screening—that is, cost of swab transport system and laboratory processing costs for 85 (5 times 17) exposed patients.

RESULTS

There were 20 mass screenings during the 10-year study period. We identified 415 hemodialysis patients who participated in at least 1 screening, with an average of 4.5 screenings per patient. On average, 90 samples were taken at each mass screening. Overall, a total of 1,901 individual nasal swab samples were taken, among which 22 (1.2%) were positive for MRSA (Figure 1). These 22 positive swab samples were obtained from 15 patients. Of the total 415 screened individual hemodialysis patients, 15 (3.6%) were found to be MRSA carriers. One patient had 5, and 3 patients each had 2, MRSA positive nasal swabs in different screening sessions.

The first mass screening, in 2004, yielded the highest percentage of MRSA carriage (6/101 [6%]). Only 7 subsequent screenings revealed new MRSA carriers, whereas 4 screenings simply confirmed previously known carriers, and 8 screenings remained negative.

Men were predominant among the MRSA carriers (20/22 [91%]). Twenty of the 22 positive swabs came from

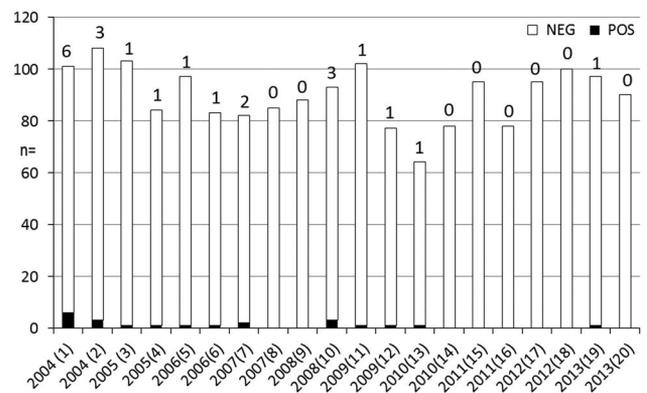


FIGURE 1. Methicillin-resistant *staphylococcus aureus* prevalence in hemodialysis patients at Bern University Hospital from January 1, 2004, through December 31, 2013. Screening occurred twice yearly; the number of the screening follows the year on the x-axis. The number of samples collected at each screening is indicated on the y-axis. NEG, negative; POS, positive.

patients aged more than 65 years, which represented the largest age group of participants (53%).

From our MRSA follow-up data, we were able to extract the median duration of MRSA carriage in 12 of these patients; it was 7 months (range, 3–23 months). Two patients had intermittent colonization and for another one, no follow-up data was available. None of the identified MRSA carriers developed MRSA bacteremia during the study period. We have found that in the 15 MRSA carriers, 13 underwent hospital admission at our center over a 10-year period.

The current laboratory cost for processing a negative sample is approximately US \$42 and for a positive sample US \$50. The total screening costs inclusive of the swab material for the 20 screenings were estimated to be US \$89,266 in 2014; the average cost for identifying each of the 15 MRSA carriers was US \$5,951. The cost of contact precautions for 13 patients who were admitted was calculated to be US \$4,664. The total cost of our screening strategy, which is the sum of screening cost and isolation cost, was US \$93,930 (Table 1).

The total cost of the alternative strategy (based on assumptions) would be equivalent to the cost for contact tracing performed on 85 patients, which would be US \$3,969, and for isolation of 5 MRSA-infected cases equaling US \$1,413 (ie, a total of 5 MRSA-infected patients and their 85 contacts), resulting in a total of US \$5,382. This results in a difference of US \$88,548 between the 2 strategies.

TABLE 1. Cost Comparison Between Screening and Alternative Strategy

Cost variable	Cost of current screening strategy (US\$)	Cost of alternative strategy (US\$)
Screening cost		
Transport media cost	801	...
Laboratory processing cost	88,465	...
Isolation cost	4,664	1,413
Contact tracing cost		
Transport media cost	...	35
Laboratory processing cost	...	3,934
Total	93,930	5,382

NOTE. Laboratory processing cost includes both negative and positive samples. Cost of isolation: estimated 100 encounters of nurses per 1 isolated patient and hand hygiene compliance 80% using 5 mL per rub that costs US \$1.03 per 100 mL handrub (5.15 cents per indication) = US \$4.12; use of gloves per indication 5 contacts with 5 glove indications each, resulting in 25 glove indications per day (4.12 cents per glove) = US \$1.03; use of gown 20 indications per day (US \$1.40 per gown) = US \$28; cleaning of positive room = US \$11.9; average estimated stay of an isolated patient = 10 days.

DISCUSSION

Screening and isolation, with or without efforts to eradicate carriage, have been associated with fewer secondary MRSA transmissions and a decreased rate of MRSA bacteremia.⁹ Starting in 2004, we found the overall prevalence of MRSA colonization in hemodialysis patients over the 2004–2013 decade to be low at 3.6% (or 1.2% of all specimens obtained). At that time, the proportion of all *S. aureus* isolates from clinical specimens that was MRSA was approximately 8% for the entire country of Switzerland, varying from 4% in central to 14% in western Switzerland.¹⁰ The fact that our institution is situated in an area of low MRSA prevalence (<5%) coincides with the results reported here. A screening study by Bühlmann et al⁷ in the same institution, which was performed on 236 patients who had contact with a MRSA patient in the hospital or were transfers from high-prevalence areas from other parts of Switzerland, yielded a 1.7% carriage rate (ie, 4 patients were positive). This suggests that our hemodialysis patients had a higher risk of MRSA colonization compared with a general patient population.

To date, a number of studies have focused on catheter site application of mupirocin¹¹ and nasal decolonization in the prevention of bloodstream infection in hemodialysis patients.^{3,4,12,13} Our study differs from these studies in that it addresses screening and isolation measures in the control of MRSA only in hemodialysis patients.

Although we lack information on subsequent rates of MRSA infection other than bacteremia, there were no bacteremia cases reported in our MRSA-colonized hemodialysis patients in the study period. Other studies have found that a substantial proportion of patients who develop MRSA infection following colonization develop pneumonia, wound infections, and others.^{8,14} Patients may still have presented to an outside hospital with MRSA infection, however.

We also determined the median time until MRSA clearance to be 7 months. This finding is in agreement with an earlier study in our hospital aiming to examine the duration of MRSA carriage, its determinants, and the influence of an eradication regimen performed on 116 patients (including but not limited to those on hemodialysis), which revealed the median time to clearance to be 7.4 months.¹⁵ Because no decolonization regimens were administered during the study period, we cannot estimate what marginal benefit in reducing MRSA infection such a strategy might have achieved.

Currently, there are no universal guidelines for hospital control of MRSA. Various hospitals and countries have used their own practices to suit their needs and resources.

Given the low rate of carriage and the high cost of our MRSA screening strategy in hemodialysis patients, we questioned the cost-effectiveness of such a strategy in a low-prevalence area. A cost comparison of MRSA screening and management in a decision tree study showed that, at a low MRSA prevalence, “no screening” produces costs comparable with targeted screening strategies. Costs for targeted screening become disproportionately high as MRSA prevalence increases.¹⁶ The prevalence of MRSA colonization

therefore exerts a significant influence on the choice of the optimal preventive strategy. As reported here, there is a significant difference of US \$88,548 for the entire study period between our relatively costly current screening strategy and an alternative strategy, which is based on certain assumptions.

Although a study in another Swiss tertiary hospital that examined MRSA admission screening of patients in a low-prevalence setting concluded that, in terms of cost-effectiveness, individualized (or targeted) screening strategies seem to be more favorable in a low-prevalence setting,¹⁷ our results showed that such a conclusion needs to be further studied.

Limitations of the study include the single-center setting and that risk factors for MRSA colonization were not identified in detail in our patients. It is also possible that we missed colonization of body sites other than the anterior nares. Genotyping was not performed, likewise, and we cannot distinguish whether the 4 patients who tested positive on more than one occasion were recolonizations by the same strain or acquired a new one.¹⁸

Although the role of decolonization treatment in controlling MRSA is controversial, with some studies showing no effect, others have reported a decrease in subsequent infection rates.¹⁹ There were no decolonization attempts in our MRSA carrier population. We also did not determine overall crude mortality.

We conclude that, in an area of low prevalence, it would be cost saving to discontinue mass screenings and instead to concentrate on tracing contacts of newly identified MRSA-infected hemodialysis patients. As a first step, we reduced mass screening from twice yearly to once yearly in our institution. Future studies may help determine the most cost-effective strategy for MRSA prevention in hemodialysis patients or other high-risk populations as a function of the local prevalence.

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