CONCISE COMMUNICATION

Effect of Screening for Methicillin-Resistant *Staphylococcus aureus* Carriage by Polymerase Chain Reaction on the Duration of Unnecessary Preemptive Contact Isolation

Ilker Uçkay, MD; Hugo Sax, MD; Anne Iten, MD; Véronique Camus, RN; Gesuele Renzi, RN; Jacques Schrenzel, MD; Arnaud Perrier, MD; Didier Pittet, MD, MS

A high prevalence of methicillin-resistant *Staphylococcus aureus* (MRSA) carriage at hospital readmission among previous MRSA carriers warrants screening and preemptive isolation precautions. The replacement of culture on chromogenic agar with rapid quantitative polymerase chain reaction for readmission screening reduces the number of unnecessary preemptive isolation-days by 54% (from 6.88 to 3.14 isolation-days) and related costs by 45% (from US$113.2 to US$62.1) for patients who test negative for MRSA.

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Infections caused by methicillin-resistant *Staphylococcus aureus* (MRSA) are associated with adverse outcomes and increased hospital costs.[1] Guidelines and expert opinion recommend that, in addition to transmission precaution measures, MRSA-positive patients should be placed in single rooms or cohorted with similarly colonized patients.[2] Previous MRSA carriage is the principal risk factor for carriage at hospital readmission and is responsible for a large proportion of the institutional reservoir of MRSA patients.[3-5] Therefore, it is common practice to screen for previous carriers and to place them in preemptive isolation at hospital readmission while awaiting the results of screening.[4]

Because of logistical problems, the cost of isolation, patient discomfort, and the potential loss of care, it is desirable to shorten the latency period between screening and reporting of the results. In hospitals where there are insufficient rooms for the isolation or cohorting of MRSA-positive patients, a lower prevalence of presumed MRSA colonization reduces the need to house MRSA carriers with noncarriers in rooms with multiple beds, and thus reduces the risk of transmission. The use of polymerase chain reaction (PCR) for screening can shorten this latency period considerably, more so than the use of culture on chromogenic agar. In our study, we quantified the impact on logistics and costs of replacing the use of culture on chromogenic agar with the use of rapid multiplex quantitative PCR (qPCR)[6,7] for the screening of previous MRSA carriers at hospital admission.

METHODS

Setting. The University of Geneva Hospitals, a 2,200-bed tertiary healthcare center, had 48,073 admissions in 2006. Previous MRSA carriers are flagged by a computerized rapid alert system.[4] Our study was conducted in the general internal medicine service, which has 246 acute care beds, 9,249 annual admissions, and an average length of stay of 9.4 days. According to an audit in December 2006, 25% of MRSA-positive patients were isolated in single rooms, 24% were in rooms with noncarriers, and 51% were cohorted in rooms with either 2 or 6 beds.

Study procedures. During 2 separate 90-day periods, all patients admitted to the hospital who were previous MRSA carriers were included in our study, independent of their length of hospitalization. The intervention period (from September 23 to December 21, 2006) differed from the control period (from January 1 to March 31, 2006) in the microbiological method used to process screening samples. During the intervention period, use of culture on chromogenic agar (MRSA ID; bioMérieux), which was the microbiological method normally used for MRSA screening, was replaced by the use of qPCR.[6] During both periods, samples were obtained on 2 consecutive days from the anterior nares and the groin using a cotton swab moistened with sterile saline solution.

The main outcome variable was the number of unnecessary preemptive isolation-days among previous MRSA carriers who tested negative on readmission. The average cost for 1 isolation-day, including the use of 10 gowns and 10 pairs of gloves and assuming a nursing severity score of 3 points, was estimated at a very conservative US$15 for each patient. To account for the different proportions of MRSA-negative patients during both periods, we assessed the number of isolation-days and the other costs incurred during the intervention period both in absolute numbers and by simulating the use of a chromogenic culture method for the intervention-period population.

All patients with previous MRSA carriage were placed in single rooms or cohorted, if logistically feasible; otherwise, barrier precautions were applied to patients sharing a room with noncarriers. Preemptive isolation was stopped on the day that both admission samples were reported to have negative results. Decolonization (ie, nasal mupirocin treatment twice daily for 5 days and whole-body washing with chlorhexidine soap for 7 days) was performed for all patients who had screening results positive for MRSA and was repeated if unsuccessful.

RESULTS

Overall, 1,583 hospital admissions accounted for 16,396 patient-days during the control period, and 1,942 hospital admissions accounted for 20,060 patient-days during the intervention period. For patients with MRSA carriage, there were a total of 1,570 isolation-days during the control period

TABLE. Data on Patients Screened for Methicillin-Resistant *Staphylococcus aureus* (MRSA) Carriage Using 2 Different Screening Tests for 2 Separate Periods

Period, patient group	No. of patients	No. of isolation-days	Screening cost, US$	Isolation cost, US$	Overall cost, US$
Control period[a]					
MRSA positive	82	930	820	13,950	14,770
MRSA negative	73	502	730	7,530	8,260
Total	155	1,432	1,550	21,480	23,030
Intervention period[b]					
MRSA positive	63	1,132	945	16,980	17,925
MRSA negative	113	355	1,695	5,325	7,020
Total	176	1,487	2,640	22,305	24,945
Simulated intervention period[c]					
MRSA positive	63	1,132	630	16,980	17,610
MRSA negative	113	777	1,130	11,655	19,399
Total	176	1,909	1,760	28,635	30,395

NOTE. Two consecutive screenings were performed for each patient. The average interval between admission and reporting of negative test results to the ward was 6.88 days (95% confidence interval, 6.41–7.35; median, 7 isolation-days) during the control period and 3.14 days (95% confidence interval, 2.75–3.37; median, 3 isolation-days) during the intervention period ($P < .001$; by 2-tailed χ^2 test).

[a] Screening (from January 1 to March 31, 2006) by chromogenic agar culture, which was US$10 for each patient.

[b] Screening (from September 23 to December 21, 2006) by in-house quantitative polymerase chain reaction (qPCR), which was estimated at a very conservative US$15 for each patient. For the use of commercial PCR (at US$70 per patient), the screening cost was estimated to be US$4,410 for MRSA-positive patients and US$7,910 for MRSA-negative patients, with an overall cost of US$34,625.

[c] Simulation by use of chromogenic agar culture.

and a total of 1,986 isolation-days during the intervention period. Data on the study patients are shown in the Table for the control and intervention periods.

The average interval between admission and reporting of MRSA-negative results to the ward was 6.88 days (95% confidence interval, 6.41–7.35; median, 7 isolation-days) during the control period and 3.14 days (95% confidence interval, 2.75–3.37; median, 3 isolation-days) during the intervention period ($P < .001$; by 2-tailed χ^2 test), corresponding to a 54.4% reduction in unnecessary isolation-days. Admission screening costs were US$10 for culture and US$15 for in-house qPCR (US$5 and US$7.50 per test, respectively). The average cost per patient related to preemptive contact isolation of previous MRSA carriers who tested negative for MRSA at readmission was 45% lower during the intervention period (US$62.10) than during the control period (US$113.20) (Figure).

DISCUSSION

So far, the impact of screening known MRSA carriers at hospital readmission by PCR has only been evaluated for intensive care units, where this type of PCR screening reduced the number of isolation-days[7] and the incidence of MRSA transmission.[8] Our study is the first, to our knowledge, to evaluate the impact of screening known MRSA carriers at hosptial readmission by qPCR, instead of in vitro culture, in acute care medicine wards, and the result was a reduction of a median of 4 isolation-days per patient and a reduction in related costs for previous MRSA carriers who tested negative at readmission.

The duration of contact isolation was prolonged by the requirement that patients test negative for 2 separate samples

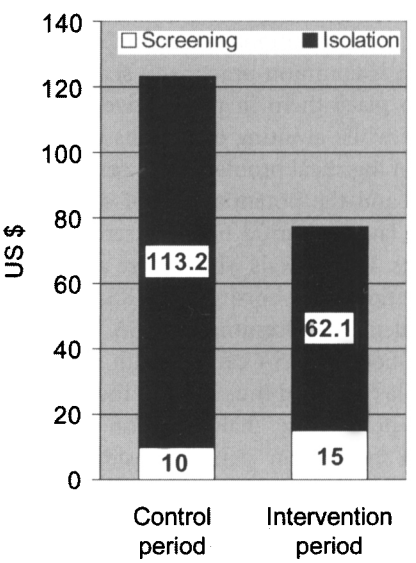

FIGURE. Total estimated average cost per patient for screening and isolation for the control period (with screening by culture) and the isolation period (with screening by in-house quantitative polymerase chain reaction).

obtained on 2 consecutive days before contact isolation was stopped. By considering only the first screening by qPCR during the intervention period, we would have missed 7 patients (11% of all MRSA-positive patients) but would have saved an additional 126 isolation-days, with a possible detrimental impact on patient safety.

The overall benefit of switching to a more rapid screening test depends on 3 key parameters: the number of patients at admission who are previous MRSA carriers; the proportion of these patients positive for MRSA; and the mean duration of contact isolation for MRSA-positive patients. The present real-life assessment demonstrates that these parameters may vary over time, even in the same hospital with the same policy for screening and contact isolation. Indeed, because of the higher number of study patients, in general, and the longer duration of contact isolation for MRSA-positive patients, in particular, the gross expenditure was slightly higher during the intervention period. To control for these confounders, we simulated the use of the chromogenic culture method for the intervention period population. In this simulation model, the use of qPCR resulted in an overall reduction in the number of isolation-days (422 [22.1%] of 1,909 isolation-days were saved) and in total cost (US$5,450 [17.9%] of US$30,395 were saved).

Our PCR cost estimates were based on use of an in-house PCR assay. However, most hospitals use commercial PCR assays, which may cost US$28–US$42. Considering an "average" PCR at US$35 per test, we found that the simulated costs would have risen by 13.9% if 2 PCR screenings were performed (Table) but would still have been reduced by 3.6% if only a single PCR test (with a single culture) was performed, which better corresponds to the reality in many hospitals.

The cost of isolation may vary according to the hospital setting. Our cost estimates are very conservative. For a neonatal intensive care unit, Karchmer et al.[9] reported minimal costs of US$30 per isolation-day for material (ie, gloves, gowns, and masks) and time.

Since the introduction of our in-house qPCR, its sensitivity has been shown to be 96%, its specificity 91%, and its negative predictive value more than 99%, compared with the standard culture technique (unpublished data). Similarly, widely used commercial tests showed negative predictive values greater than 97%.[8,10]

Because of the logistic and financial challenges for hospitals to control MRSA, it might be worth introducing PCR for MRSA screening, in addition to the promotion of hand hygiene, efficacious contact isolation, and better decolonization procedures. Because the introduction of PCR depends on several parameters, each institution should individually evaluate the possible benefits in advance. Currently, we are extending the use of qPCR to other sectors of our healthcare facility for the screening of previous MRSA carriers at hospital readmission.

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From the Infection Control Program (I.U., V.C., D.P.), the Service of General Internal Medicine (A.I., A.P.), and the Central Laboratory of Bacteriology (G.R., J.S.), University of Geneva Hospitals and Faculty of Medicine, Geneva, Switzerland.

Address reprint requests to Didier Pittet, MD, MS, Infection Control Program, University of Geneva Hospitals and Facuty of Medicine, 24 Rue Micheli-du-Crest 1211, Geneva 14, Switzerland (didier.pittet@hcuge.ch).

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