American Journal of Infection Control 43 (2015) 31-4

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major article

Collateral benefit of screening patients for methicillin-resistant *Staphylococcus aureus* at hospital admission: Isolation of patients with multidrug-resistant gram-negative bacteria

Makoto Jones MD [a,b], Christopher Nielson MD [c,d], Kalpana Gupta MD, MPH [e,f], Karim Khader PhD [b], Martin Evans MD [g,h,i,*]

[a] *Veterans Affairs Salt Lake City Health Care System, Salt Lake City, UT*
[b] *Department of Internal Medicine, University of Utah, Salt Lake City, UT*
[c] *Veterans Affairs Reno Medical Center, Reno, NV*
[d] *Department of Internal Medicine, University of Nevada, Reno, NV*
[e] *Department of Veterans Affairs, Boston Veterans Affairs Health Care System, National Center for Occupational Health and Infection Control, Office of Public Health, Boston, MA*
[f] *Department of Internal Medicine, Boston University, Boston, MA*
[g] *Department of Veterans Affairs, MRSA/MDRO Prevention Office, National Infectious Diseases Service, Veterans Health Administration, Washington, DC*
[h] *Lexington Veterans Affairs Medical Center, Lexington, KY*
[i] *Department of Internal Medicine, University of Kentucky, Lexington, KY*

Key Words:
MRSA
MDRO
Pseudomonas aeruginosa Acinetobacter
Enterobacteriaceae
Carbapenem-resistant Enterobacteriaceae
Screening
Infection control
Contact precautions

Background: Surveillance at hospital admission for multidrug-resistant (MDR) gram-negative bacteria (GNB) is not often performed, potentially leaving patients carrying these organisms unrecognized and not placed in transmission precautions until they develop infection. Veterans Affairs (VA) facilities screen all admissions for methicillin-resistant *Staphylococcus aureus* (MRSA) and place positive patients in contact precautions. We assessed how often patients with MDR GNB in clinical cultures obtained within 30 days following admission would have been in contact precautions because of a positive MRSA admission screen.
Methods: MRSA screening and MDR GNB culture results were extracted from a database of patients admitted to all VA acute care medical facilities from January 2009-December 2012.
Results: Of patients with MDR GNB-positive cultures within 30 days following admission, up to 44.3% (dependent on bacterial species) would have been in contact precautions because of a clinical positive admission MRSA nasal screen. Admissions with a positive MRSA screen had odds for MDR GNB in a culture 2.5 times greater than those with a negative screen (95% confidence interval [CI], 2.4-2.6). Odds ratios were 2.4 (95% CI, 2.3-2.5) for MDR *Enterobacteriaceae*, 2.7 (95% CI, 2.5-2.9) for MDR *Pseudomonas aeruginosa*, and 4.3 (95% CI, 3.8-4.8) for MDR *Acinetobacter* spp.
Conclusions: Patients may be serendipitously placed in contact precautions for MDR GNB when isolated for a positive admission MRSA screen.

Programs using active screening of the anterior nares for methicillin-resistant *Staphylococcus aureus* (MRSA) colonization have been associated with decreased MRSA transmissions and health care–associated infections (HAIs).[1-5] One of these programs also reported decreased HAIs because of vancomycin-resistant *Enterococci* and *Clostridium difficile*.[1] There may be an effect on nontargeted pathogens if MRSA-positive nasal surveillance tests serve as a marker for colonization with other multidrug-resistant organisms (MDROs). If this is true, then isolation for MRSA may result in the serendipitous isolation of patients harboring other MDROs, including multidrug-resistant (MDR) gram-negative bacteria (GNB).

Currently available rapid molecular tests and noninvasive sampling methods make screening for MRSA colonization relatively simple compared with screening for other MDROs. By Veterans Health Administration Directive,[6] after verbal informed consent, all

* Address correspondence to Martin E. Evans, MD, 1101 Veterans Dr, Room B415, Lexington, KY 40502.
E-mail address: martin.evans@va.gov (M. Evans).
Funding/support: None reported.
Conflicts of interest: None to report.

0196-6553/$00.00 - Published by Elsevier Inc. on behalf of the Association for Professionals in Infection Control and Epidemiology, Inc.
http://dx.doi.org/10.1016/j.ajic.2014.09.016

facility admissions nationwide are screened for MRSA. Positive patients are placed in contact precautions[7] as soon as the results are returned. Because polymerase chain reaction (PCR) testing is usually used for admission screening, the median turnaround time from admission to reporting of the screening result is 12.5 hours.[8] Positive patients usually remain in contact precautions for the duration of their admission and are again placed in contact precautions without rescreening if readmitted within 1 year.

We evaluated a large national Veterans Affairs (VA) database to determine how frequently inpatients with MDR GNB-positive clinical cultures within 30 days following admission might have already been isolated if they had been placed in contact precautions for a positive MRSA screen at admission.

METHODS

Nasal screening and clinical culture results from patients admitted to VA acute care medical facilities from January 2009-December 2012 were extracted from national clinical microbiology laboratory data using an approach described previously.[9] Nasal screening was performed as previously described,[1] and a clinical culture was defined as a specimen obtained from any body site, fluid, or drainage other than the specimens obtained for screening. As a measure of nasal MRSA carriage status, all nasal screens for MRSA obtained 12 months prior to and within 24 hours after admission to an acute care facility were identified. MDR GNB were defined as organisms with acquired nonsusceptibility to a least 1 agent in $\geq$3 antimicrobial classes.[10] A history of MDROs was defined as MRSA, vancomycin-resistant *Enterococcus*, or MDR GNB isolated from a clinical culture or surveillance screen within 12 months prior to hospital admission. A new MDR GNB event was defined as recovery of an MDR GNB within 30 days following admission in a clinical culture, therefore capturing some MDR GNB that were present but unknown on admission or were hospital acquired. The MDR GNB of interest for this analysis included MDR *Enterobacteriaceae* (including extended-spectrum β-lactamase producing bacteria and carbapenem-resistant bacteria), MDR *Pseudomonas aeruginosa* (including carbapenem-resistant organisms), and MDR *Acinetobacter* spp (including carbapenem-resistant organisms). Bacteria from clinical cultures were isolated, identified, and characterized using standard procedures observed at each facility. Clinical cultures were restricted to those that underwent antimicrobial susceptibility testing.

Comparisons of proportions were made using the χ^2 test. Generalized linear mixed models were used to predict the binary outcome of MDR GNB-positive clinical cultures during or after admission from MRSA PCR screening results. Random effects of facilities were also incorporated. Stata version 12.1 (StataCorp, College Station, TX) was used.

This analysis was approved by the Research Review Committee of the VA Salt Lake City Health Care System and the Institutional Review Board of the University of Utah.

RESULTS

During the 4-year analysis period, there were 1.6 million VA acute care facility admissions (759,759 unique patients) nationwide that received a PCR MRSA nasal screen. Of these, 14.7% were positive at admission or had been positive within the prior year, and 6.3% had a history of a positive MDRO culture in the prior year. The percentage of admissions with MRSA-positive nasal screening or previous positive MDRO culture was 17.7%.

The frequencies of clinical cultures yielding MDR GNB within 30 days following admission were evaluated with respect to initial MRSA screening results. Overall, 2.4% of patients with a MRSA-positive screening had a subsequent new MDR GNB clinical culture compared with 0.9% of those with a negative MRSA screen ($P < .001$). Among admissions with a positive MRSA screen, the percentage that had a subsequent positive MDR GNB clinical culture varied by organism and ranged from 0.2% for MDR *Acinetobacter* spp to 1.9% for MDR *Enterobacteriaceae*. Of the 17,677 admissions with a MDR GNB, 1,163 had isolates producing extended-spectrum β-lactamases and 3,054 had isolates that were carbapenem resistant.

Overall, 30.7% of admissions with a subsequent MDR GNB-positive clinical culture had a positive admission MRSA screen (sensitivity) (Table 1; Fig 1). The percentage ranged from 29.8% for MDR *Enterobacteriaceae* to 44.3% for MDR *Acinetobacter*. The percentage increased from 36.3%-54.0% (by species) if patients with an MDRO in the year prior to admission were also included. Of note, 85.5% of admissions without a subsequent MDR GNB-positive clinical culture had a negative admission MRSA screen (specificity).

Table 1
Relationship between MDR GNB clinical culture isolates obtained within 30 days following hospital admission and MRSA polymerase chain reaction nares admission screen or history of positive multidrug-resistant organism* culture within the last year

MDR GNB	Patients with MDR GNB	Patients with MDR GNB and MRSA positive at admission	Patients with MDR GNB and MRSA positive at admission or with history of multidrug-resistant organism* in last 12 months
MDR *Enterobacteriaceae*†	14,607	4,359 (29.8)	5,351 (36.6)
MDR *Pseudomonas aeruginosa*‡	2,761	887 (32.1)	1,077 (39.0)
MDR *Acinetobacter* spp‡	1,141	505 (44.3)	616 (54.0)
Any of above	17,677	5,422 (30.7)§	6,646 (37.6)§

NOTE. Values are n or n (%).
GNB, gram-negative bacteria; *MDR*, multidrug-resistant; *MRSA*, methicillin-resistant *Staphylococcus aureus*.
*Including MDR GNB, MRSA, and vancomycin-resistant *Enterococci*.
†Including extended-spectrum β-lactamase and carbapenem-resistant organisms (defined in Methods section).
‡Including carbapenem-resistant organisms.
§Pooled values.

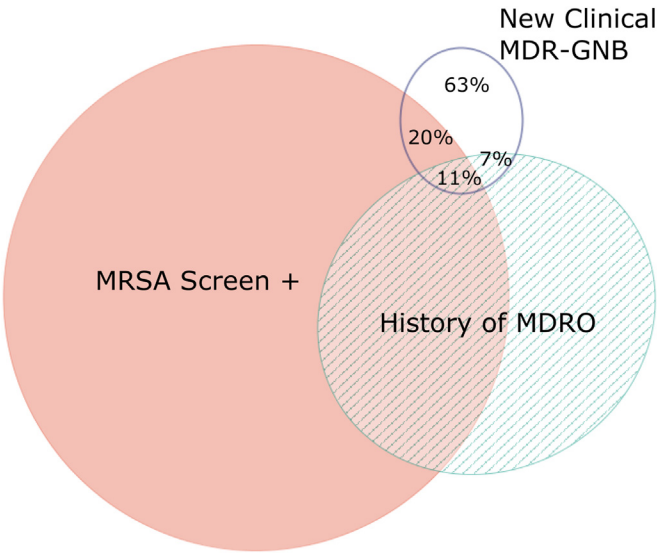

Fig 1. Euler diagram of admissions that have a positive (+) methicillin-resistant *Staphylococcus aureus* (MRSA) polymerase chain reaction hospital admission nares screen, have a history of a clinical multidrug-resistant organism (MDRO) (including MRSA, vancomycin-resistant *Enterococci*, and multidrug-resistant gram-negative bacteria [MDR-GNB]), and have a new clinical MDR-GNB isolated within 30 days following admission to the hospital. Numbers are rounded from actual values.