ORIGINAL RESEARCH

Management of Skin and Soft Tissue Infections in Community Practice Before and After Implementing a "Best Practice" Approach: An Iowa Research Network (IRENE) Intervention Study

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Context: **Community-acquired methicillin-resistant *Staphylococcus aureus* (CA-MRSA) is a major pathogen among skin and soft tissue infections (SSTIs). Most CA-MRSA infections are managed initially on an outpatient basis. It is critical that primary care clinicians recognize and appropriately treat patients suspected of having such infections.**

Objective: **To identify and evaluate best methods and procedures for primary care clinicians to manage skin and soft tissue infections.**

Design, Setting, and Patients: **Preintervention/postintervention study in eight Iowa Research Network offices conducted between October 2007 and August 2010. We reviewed medical records of 216 patients with SSTI before a set of interventions (preintervention) and 118 patients after the intervention (postintervention).**

Interventions: **Included a focus group meeting at each office, distribution of a modified Centers for Disease Control and Prevention (CDC) algorithm, "Outpatient Management of MRSA Skin and Soft Tissue Infections," education handouts, and an office policy for patients with skin infections.**

Main Outcome Measures: **Proportion of subjects who were prescribed an antibiotic that would cover MRSA at the initial visit and proportion who were prescribed an antibiotic that would cover MRSA at any time.**

Results: **Three hundred sixty-eight forms (244 preintervention and 124 postintervention) were returned; 216 (89%) preintervention forms and 118 (95%) postintervention forms were usable. Multivariable logistic regression models found statistically significant and independent factors associated with MRSA coverage at the initial visit included being in the postintervention rather than the preintervention group, having an abscess component compared with cellulitis alone, having a culture sent, being prescribed two or fewer antibiotics, and not being hospitalized.**

Conclusions: **The CDC algorithm was feasible for offices to use. Following a discussion of SSTI management in the outpatient setting, use of MRSA coverage increased both initially and overall. Thus, involving clinicians in a discussion about guidelines rather than simply providing guidelines or a didactic session may be a useful way to change physician practices. (J Am Board Fam Med 2011;24:524–533.)**

Keywords: **CA-MRSA, Participatory Research, Practice-based Research**

Community-acquired methicillin-resistant *Staphylococcus aureus* (CA-MRSA) is a major pathogen among skin and soft tissue infections (SSTIs). The prevalence of CA-MRSA SSTIs has increased rapidly over the past decade.[1,2] Ambulatory care total visits in the United States for SSTIs increased from

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8.6 million in 1997 to 14.2 million in 2005.[3] Studies of ambulatory patients have noted the proportion of skin and soft tissue infections caused by CA-MRSA range from 45% to 75%.[1,4–8] The Centers for Disease Control and Prevention (CDC) estimated that nearly 19,000 Americans died in 2005 from invasive MRSA infections.[9] An estimated 95,000 people developed MRSA infections during that year, of which 14% were community-acquired and 85% were health care acquired.[9]

CA-MRSA infections are defined as those that develop in individuals who have not been hospitalized or had a medical procedure, such as dialysis, surgery, or catheter placement within the past year.[4] CA-MRSA infections usually occur in otherwise healthy people.[10] CA-MRSA infections have the potential to develop quickly from a localized abscess into invasive skin infections requiring hospital admission. They have also been associated with severe complications such as sepsis and necrotizing pneumonia.[11,12]

Parchman and Munoz examined skin and soft tissue infections presenting to 4 primary care clinics collecting data on 164 skin and soft tissue infections over a 10-month period.[5] Most (67%) of the 94 cultured infections grew MRSA, and the authors suggested that presumptive treatment for MRSA may be indicated for most skin and soft tissue infections. Because most CA-MRSA infections are managed initially on an outpatient basis, it is critical that primary care clinicians recognize and appropriately treat patients suspected of having such infections. The purpose of this study was to evaluate an intervention to improve the management of patients with SSTIs.

Methods

This study compared family physicians' management of SSTIs in eight practices before and after participation in a focus group in which physicians and office staff discussed management of these infections. This is a method of quality improvement called "best practices."[13] The design was a preintervention/postintervention study. A medical record audit examining skin and soft tissue infection management was conducted during the 6- to 12-month time period before the intervention and for 6 to 12 months following the intervention. Institutional review board (IRB) approval was received for this study. Subject informed consent for the postintervention component was obtained by each office's site coordinator, who was trained in Human Subjects. Offices were provided monetary compensation for participation.

Primary Care Practice Recruitment

We invited 302 Iowa Research Network (IRENE), a practice-based research network, physicians to participate in this study. Each physician member was sent a fax that included a cover letter describing the purpose of the study, the time line for the project, and specific details about what each office would be expected to do. Fourteen physicians from 14 practices were willing to participate, but funding constraints limited the study to 8 sites (Figure 1). The final sites were selected to include practices in small towns and rural areas.

Intervention

As described by Daly et al,[14] the research team conducted a focus group with each office from October 2008 to May 2009. The purpose of these groups was to have each office discuss specific strategies that might help them improve the management of SSTIs. Two research team members traveled to each office to conduct the focus groups, which were audiotaped and transcribed. These groups generally lasted about 50 minutes. The research team shared copies of the CDC algorithm[15] (see Figure 2) and an algorithm from Lowy and colleagues[16] and asked physicians to discuss the advantages and disadvantages of each and which they preferred.

Based on ideas from the focus groups, several interventions were developed by the investigators

Figure 1. Iowa Research Network (IRENE), intervention office study sites.

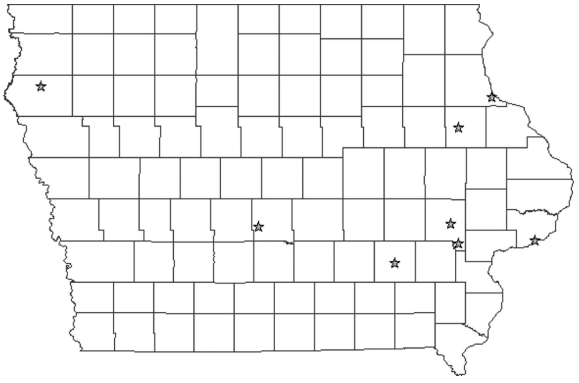
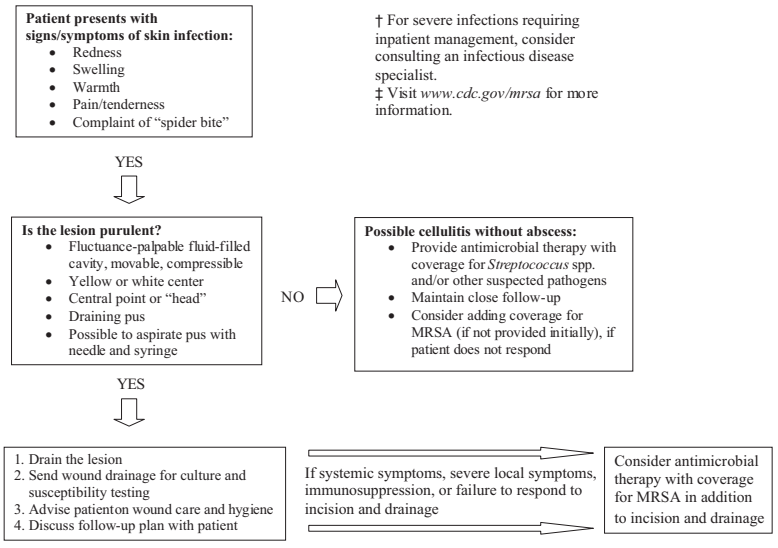


Figure 2. Outpatient† management of skin and soft tissue infections in the era of community-associated *Staphylococcus aureus* (MRSA)‡.



and made available to each office: (1) a modified CDC algorithm entitled "Outpatient Management of MRSA Skin and Soft Tissue Infections," which included additional information on medication dosages and drugs of choice in pregnancy, (2) patient education brochures entitled, "Methicillin-resistant *Staphylococcus aureus* (MRSA),"[17] "Caring for Wounds, and Wound Packing Instructions,"[18] and (3) an office policy for patients with skin infections that one of the offices had previously developed. The wound packing brochure for patients was written by the research team. The modified CDC algorithm was laminated and multiple copies were sent to each office to be posted in strategic locations. The CDC algorithm had a list of medications appropriate for treatment of MRSA. Those included clindamycin, tetracycline, trimethoprim-sulfamethoxazole, rifampin, and linezolid, and these were considered MRSA-covering antibiotics. One hundred copies of the education handouts were sent to the offices along with the office policy for patients with skin infections before postintervention data collection began.

The office policy included (1) how to provide safe care to an individual suspected of having CA-MRSA, (2) documentation of any history of CA-MRSA, and (3) specified that patients with known MRSA would be roomed immediately, and contained procedures to implement those policies.

Medical Record Review Form

A comprehensive data collection instrument to describe the management of SSTIs was developed by an interdisciplinary team of faculty and staff from the University of Iowa Carver College of Medicine Department of Family Medicine and the College of Public Health. We incorporated risk factors for CA-MRSA and hospital-acquired MRSA previously identified and published.[19–23] The instrument was revised after pilot testing with family medicine faculty.

The 44-item instrument included demographics (age, sex, race, ethnicity, insurance coverage, rural-urban code), antibiotic allergies, risk factors for MRSA infection (immunosuppression; diabetes; nursing home residence; hog-confinement work; history of MRSA infection or colonization; family member with MRSA; history of nursing home admission, hospitalization, dialysis or surgery in the previous month; use of indwelling catheter; athletic participation; eczema); clinical information (body temperature; presence of abscess or cellulitis; infection site and size, whether incision and drainage were performed, whether the wound was packed, antibiotics prescribed, whether a culture was sent, culture results, whether follow-up visits were scheduled, whether the patient was hospitalized, and the cause of infection such as type of trauma). Because we were examining SSTIs that presented in an outpatient setting, even though we collected

some risk factors traditionally associated with HA-MRSA, we did not exclude individuals with these risk factors, because the distinction between CA-MRSA and HA-MRSA is no longer clear-cut.[16] In addition, information on all follow-up visits was collected, including the number of days since the original visit, whether the infection resolved or improved clinically, need for additional antibiotics, and whether the patient needed to be seen elsewhere, such as an emergency department. Each data form included a study identification number but did not contain personal identifying information.

The postintervention SSTI contained similar items to the preintervention form, plus additional items addressing time to resolution of infection by office staff making telephone calls.

Education of Study Site Coordinators

Two research team members traveled to each office and met with the designated site coordinator and reviewed the preintervention abstracting form with them. For this component of the study, subjects were identified using standard International Classification of Diseases-9 codes for abscess and cellulitis. Subjects were identified using the following International Classification of Diseases-9 codes for abscess and cellulitis: carbuncle and furuncle (680.x) and code range 680.0 – 680.9; cellulitis and abscess of finger and toe (681.x) (codes 681.0 (finger), 681.1 (toe), 681.9 (cellulitis and abscess of unspecified digit); 682 (other cellulitis and abscess) and codes 682.0 – 682.9); 684 impetigo; 685 pilonidal cyst (codes 685.0 – 685.1); and 686 other local infections of skin and subcutaneous tissue (codes 686.0 – 686.9).[24]

Site coordinators were given a list of Iowa zip codes matched to the county's Rural-Urban Continuum Codes (RUC).[25] Site coordinators converted the zip code of residence to the appropriate RUC. These codes have nine categories, in which "1" designates counties in metropolitan areas of 1 million population or more and "9" designates towns with fewer than 2500 inhabitants and not adjacent to a metropolitan area. Subjects were considered rural if they came from counties categorized as "8 (completely rural or less than 2500 urban population, adjacent to a metro area)" or "9"; the rest were considered urban.

The completed forms were returned by mail from the site coordinator each month. Reminders were provided by e-mail every 2 weeks. If there was no response through e-mail, then the site coordinator was called. Each site was asked to abstract 30 medical records completed before the date of the focus group meeting, referred to as the preintervention group.

For the postintervention component of the study, the site coordinators were mailed instructions and thirty folders with numbered skin forms and informed consents after the focus group meetings were held. After receipt of the information, the process of obtaining informed consent was reviewed by telephone. Office coordinators were asked to review the daily schedules for possible subjects. Postintervention study recruitment began after each office's respective focus group meeting and ended August 2010.

Data Analyses

The main outcomes compared preintervention and postintervention were (1) proportion of subjects who received an antibiotic which covered MRSA at the initial visit and (2) the proportion that were prescribed an antibiotic which covered MRSA at any visit related to the infection.

Data analyses include preintervention and postintervention descriptive statistics and comparisons (χ^2 for proportions; t tests or ANOVA for continuous data). SAS 9.2 for Windows was used for analysis (SAS 9.2, SAS Institute, Inc., Cary, NC). Proc Genmod and Generalized Estimating Equations were utilized to model dichotomous outcomes. An exchangeable correlation structure was used to control for a constant correlation within office clusters.

To assess the effect of the intervention and other predictor variables, univariate analysis was performed to obtain candidate predictors for a multivariate analysis. Variables were tested in the multivariate model if they were associated with a significance level of less than 0.20 in the univariate analysis. A stepwise procedure allowed variables to enter the model at the 0.15 significance level of significance and to be removed if they no longer met this criterion in subsequent steps. Only variables significant at the 0.05 level remained in the final model. Odds ratios and 95% confidence intervals were computed for each of these variables. P values <0.05 and 95% confidence intervals that did not cross 1 were considered statistically significant.

Offices contributed data in regards to usable preintervention forms fairly equally, ranging from 12% to 14% of the data. However, data contributed through usable postintervention forms was dominated by two of the offices, accounting for approximately 46% of the data. This disparity raised concerns of whether or not there was a true change in the main outcomes between groups. This matter was accommodated through the use of logistic regression analysis, which allowed us to control for office-level random effects. Accounting for these measures of correlation allowed for valid interpretation of significant findings in the regression analysis.

Results

A total of 368 forms (244 preintervention and 124 postintervention) were returned. Of these, 216 (89%) preintervention forms and 118 (95%) postintervention forms were usable (see Table 1). Forms were unusable and thus excluded when they contained information such as poison ivy or shingles. The mean age of patients was 41 years, and 47% were male. Demographic characteristics were not significantly different between the preintervention and postintervention groups except for insurance coverage, where more postintervention subjects had private insurance and fewer had no insurance coverage (see Table 2).

Presenting characteristics of the patients in the pre- and postintervention groups were similar for site of infection, temperature, duration days of infection before being seen, number of risk factors, diabetes, being hospitalized, and having allergies to antibiotics. There were more abscess-only infections in the preintervention group and more combined abscess/cellulitis infections in the postintervention group. Of those cultured, MRSA was cultured more frequently in the preintervention than the postintervention group (51% vs. 31%, $P = .025$) (see Table 2). Methicillin-sensitive *S aureus* was the second most frequently cultured organism, followed by no growth or unable to identify.

Treatment for the infections was similar between groups with respect to incision and drainage, culturing the wound, packing the wound, and providing verbal wound care instructions (see Table 2). In the postintervention group, there was an increase in use of an antibiotic that covered MRSA at the initial visit (52% vs. 30%, $P < .0001$) and in use of an antibiotic at any point in time during the infection that covered MRSA (62% vs. 37%, $P < .0001$). In the two groups, there were no differences in the total number of different antibiotics prescribed over the course of the infection. A trend toward scheduling follow-up visits was noticed after the intervention (61% vs. 51%, $P = .076$) (see Table 2).

Of the 285 antibiotics prescribed for the preintervention group throughout the course of the infection, cephalosporins (71% were cephalexin) were prescribed the most often (n = 123, 43%), followed by trimethoprim-sulfamethoxazole (n = 52, 18%) subjects. The choice of antibiotics differed in the postintervention group, in which of 171 antibiotics prescribed, 50 (29%) received trimethoprim-sulfamethoxazole and 43 (25%) received cephalosporins.

Multivariable logistic regression models that utilized correlation matrices to account for clinic level clustering to model our outcomes of interest were used. The models were developed for predictors of MRSA antibiotic coverage: (1) at the initial visit and (2) at any time during the course of the infec-

Table 1. Data Collection Form Return Rate

IRENE Office No.	City	City Population	No. of Usable and Returned Preintervention Forms	No. of Usable and Returned Postintervention Forms
(1)	Davenport	98,359	25/31	8/10
(2)	Guttenberg	1987	26/30	24/25
(3)	Manchester	5257	26/30	9/9
(4)	Le Mars	9237	29/30	11/11
(5)	Riverside	928	25/30	5/7
(6)	Sigourney	2209	25/33	12/14
(7)	Iowa City	62,220	30/30	30/30
(8)	Urbandale	29,072	30/30	19/19
Total			216/244	118/124

Table 2. Demographic Characteristics, Clinical Aspects, Management, and Treatment of Skin Infections*

	Preintervention Group N = 216 N (%)	Postintervention Group N = 118 N (%)	*P* Value
Demographic characteristics			
Age (years)			
<20	44 (21)	28 (24)	0.34
20 to 39	54 (25)	35 (30)	
40 to 64	74 (34)	39 (33)	
≥65	43 (20)	15 (13)	
Male	108 (50)	50 (42)	0.18
Caucasian	161 (95)	111 (94)	0.65
Hispanic	10 (6)	5 (4)	0.53
Insurance coverage			
Private	122 (57)	78 (70)	0.03
Medicaid	36 (17)	20 (18)	
Medicare	40 (19)	12 (11)	
Uninsured	15 (7)	2 (2)	
Lives rural county	60 (28)	34 (29)	0.80
Patient presenting characteristics			
Site of infection			
Face/neck	26 (12)	15 (14)	0.73
Groin/pubic/lower extremities	102 (48)	48 (43)	
Thorax/upper extremities	85 (40)	48 (43)	
Initial temperature (°F)			
<99°	170 (90)	104 (90)	0.99
≥99°	18 (10)	11 (10)	
Duration of infection prior to being seen			
<5 days	101 (55)	61 (56)	0.94
≥5 days	81 (45)	48 (44)	
Has ≥1 MRSA risk factor	85 (39)	54 (46)	0.26
Hospitalized with infection	10 (5)	3 (3)	0.36
Diabetic wound type	32 (15)	20 (17)	0.61
Abscess only	74 (34)	18 (15)	<0.0001
Cellulitis only	119 (55)	69 (58)	
Abscess and cellulitis	23 (11)	25 (21)	
Management and treatment			
Incision and drainage done	68 (32)	33 (28)	0.50
Culture done	79 (37)	52 (44)	0.18
MRSA cultured (of those cultured) only for those who had an incision and drainage done	40 (51)	16 (31)	0.03
Wound packed	28 (41)	8 (24)	0.10
Verbal wound care instructions provided (n = 65 preintervention and n = 110 post intervention)	56 (86)	88 (80)	0.30
Follow-up visit scheduled	110 (51)	70 (61)	0.08
Antibiotics prescribed			
Antibiotic prescribed at initial visit	201 (93)	115 (98)	0.09
Antibiotic(s) prescribed at initial visit			
covered MRSA	60 (30)	60 (52)	<0.0001
Second antibiotic was prescribed with first	17 (8)	17 (14)	0.06
Antibiotics prescribed that covered MRSA at some time during infection	75 (37)	72 (62)	<0.0001

Continued

Table 2. Continued

	Preintervention Group N = 216 N (%)	Postintervention Group N = 118 N (%)	*P* Value
Total number of antibiotics used over the course of the infection			
≤2	197 (91)	106 (90)	0.68
>2	19 (9)	12 (10)	
Total number of different antibiotics used over course of infection			
0	14 (6)	1 (1)	0.14
1	145 (67)	79 (67)	
2	38 (18)	26 (22)	
3	14 (6)	10 (8)	
4	3 (1)	1 (1)	
5	2 (1)	0	
6	0	1 (1)	
Cephalosporins	52 (18)	20 (12)	<0.0001
Trimethoprim-sulfamethoxazole	40 (14)	50 (29)	0.006

*If a cell does not total the N, then there were missing data.
MRSA, *Staphylococcus aureus*

tion. Independent factors associated with MRSA coverage at the initial visit included the study intervention, an abscess component rather than cellulitis alone, the infection being cultured, two or fewer antibiotics prescribed over the course of the infection, and not being hospitalized for the infection. Independent factors associated with MRSA coverage at any time during the course of the infection were the study intervention, an abscess component rather than cellulitis alone, the infection being cultured, and patient age between 20 and 65 years (see Table 3).

Discussion

This study was conducted in a Midwestern practice-based research network. Antibiotic choices for community-acquired infections before and after a bundled intervention that included a review of CDC guidelines and was based on physician perceived "best practices" were compared. The intervention for this study was a multifaceted intervention that included a focus group meeting at each participating practice in which two major skin infection guidelines were discussed.[15,16] Based on the focus groups, a modified CDC algorithm that included pregnancy categories for MRSA medication, skin infection patient education handouts prepared by the American Academy of Family Physicians,[17,18] and an office policy for patients with skin infections developed by one of the offices but given to all participating offices. After the intervention, patients were more likely to be placed

Table 3. Predictors of *Staphylococcus aureus* (MRSA) Antibiotic Coverage*

	Initial Antibiotic Covered MRSA N = 308 Odds Ratio (CI), *P* Value	MRSA Antibiotic Coverage at Any Time N = 313 Odds Ratio (CI), *P* Value
Postintervention vs. preintervention group	2.67 (1.54, 4.62), 0.0005	2.70 (1.68, 4.32), <0.0001
Abscess or abscess plus cellulitis vs. cellulitis alone	2.81 (1.62, 4.87), <0.0001	2.61 (1.63, 4.18), <0.0001
Culture sent vs. not sent	3.03 (1.72, 5.35), 0.0003	2.54 (1.62, 3.99), <0.0001
Prescribed ≤ 2 antibiotics vs. > 2	7.67 (2.19, 26.88), <0.0001	
Antibiotics		
Patient not hospitalized vs. hospitalized	10.55 (1.35, 82.60), 0.0186	
Age between 20 and 60 vs. other ages		1.69 (1.17, 2.57), 0.0112

*Multivariate logistic regression.

on an antibiotic that covered MRSA both initially and at some time during the course of the infection. Patients who had their wounds cultured were also more likely to be prescribed an antibiotic that covered MRSA both initially and at some point during the course of the infection, which is consistent with the CDC guidelines if MRSA is suspected.

The focus group meetings allowed time for the health care providers and researchers to discuss many aspects of skin and soft tissue infections. The providers shared knowledge and experience about MRSA in their practices. The discussions included epidemiology, lesion appearance, diagnosis, treatment (types and cost of antibiotics), follow-up management, prevention, and special populations.[14] The CDC[15] and UpToDate[16] management algorithms for skin and soft tissue management were discussed in detail during the meetings.

The intervention for this study was a bundled intervention which included the focus group meeting, dissemination of education handouts, and the CDC algorithm, "Outpatient Management of MRSA Skin and Soft Tissue Infections," which was modified after focus group input to include drug dosages and categories for pregnant women. Previous studies to determine the effectiveness of any intervention are difficult to compare with our intervention. Continuing medical education as an intervention belies a belief that a gain in knowledge will improve practice and improve patient outcomes. In fact, several studies have found a lack of effect on physician performance.[26,27] There is an imperfect evidence base to support decisions about which guideline dissemination and implementation strategies are most effective.[28] The implementation strategy for this intervention was different from what most have done; it was multifocal and included face-to-face visits with each practice, opportunity for providers to comment on current SSTI guidelines, and an opportunity to include aspects they thought would make the guidelines more useful.

Continuing medical education was not provided to the participants of the focus groups. However, the focus groups were a form of academic detailing in that the PI provided evidenced-based information on the management of SSTIs.[29] Academic detailing is a method of continuing medical education often used to modify physicians' pharmaceutical prescribing habits.[30] The intention of the focus groups was to discuss physicians' perceptions of the current guidelines for SSTIs. Participants freely discussed their confusion about the best management and treatment for SSTIs.

In our focus groups, we discussed that incision and drainage (I&D) of an abscess followed by no antibiotic treatment is acceptable, but a change in this behavior was not noted. However, 57 (84%) of 68 who had an I&D in the preintervention group received an antibiotic, whereas after the intervention, 32 (97%) of 33 who had an I&D received an antibiotic. Lee and colleagues found that CA-MRSA skin and soft tissue abscesses less than 5 cm in diameter in healthy children can be managed with therapeutic drainage without the use of antibiotics,[31] and the CDC guidelines suggest that I&D alone may be appropriate.[15]

This study was not a randomized controlled trial; it was a preintervention/postintervention study examining current primary care management of SSTIs. To conduct this study in multiple primary care offices, IRB approval was lengthy having to obtain individual practice agreements, HIPAA Privacy Rule Waiver of Authorization forms, and Community Based Research IRB Authorization Agreements between the University of Iowa and the Research Affiliate for an Individual Protocol, which limited the time for the actual research due to the contract nature of the research. Because of the nature of a preintervention/postintervention study, temporal trends are an issue. Publicity of MRSA through the press for Iowa during this study was not tracked.

Offices had difficulty recruiting subjects for the postintervention portion of the study due to the need for identification of individuals with possible SSTIs and the time needed to obtain adequate informed consent. Site visits were made to each of the offices to encourage study recruitment. Measurement of the use of the CDC algorithm, education handouts, or office policy for patients with skin infections was not tracked.

The main reason for unusable subjects for this study was the patients did not have an infection; forms were completed for poison ivy, scabies, and other irrelevant skin problems. No information was collected on individuals who chose not to be in the study, therefore no comparison of participants versus nonparticipants for the postintervention portion is available.

The CDC algorithm for outpatient management of skin and soft tissue infections was feasible to use in primary care offices, and providers indicated that the algorithm could be followed in busy

primary care settings. Following our multifaceted intervention, MRSA antibiotic coverage increased both initially and during follow-up visits. This leads us to believe that involving clinicians in a discussion about guidelines may have a greater effect on physician practice than more traditional continuing education or academic detailing.[30]

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