

Supplementary Online Content

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This supplementary material has been provided by the authors to give readers additional information about their work.

eTable 1: Definition of Bundle Adherence

	Scheduled Operations			Urgent or Emergent Operations
	MRSA Positive or MRSA Unknown	MRSA Negative	MRSA Negative	----
	Any MSSA status	MSSA Positive or Unknown	MSSA Negative	----
Full Adherence	Received any CHG bathing, mupirocin for ≥ 3 days, and vancomycin plus cefazolin (cefuroxime) ^a	Received any CHG bathing, mupirocin for ≥ 3 days, and cefazolin (cefuroxime) ^a	Received any CHG bathing and cefazolin (cefuroxime) ^a	Received any CHG bathing, mupirocin for ≥ 1 days, and vancomycin plus cefazolin (cefuroxime) ^a
Partial Adherence	Received any CHG bathing, or any mupirocin, or vancomycin or vancomycin plus cefazolin (cefuroxime) ^a	Received any CHG bathing, or any mupirocin, or cefazolin (cefuroxime) ^a	Received any CHG bathing or cefazolin (cefuroxime) ^a	Received any CHG bathing, or any mupirocin, or vancomycin or vancomycin plus cefazolin (cefuroxime) ^a
No Adherence	Did not receive CHG bathing, mupirocin, or vancomycin or vancomycin plus cefazolin (cefuroxime) ^a	Did not receive CHG bathing, mupirocin, or cefazolin (cefuroxime) ^a	Received neither CHG bathing nor cefazolin (cefuroxime) ^a	Did not receive CHG bathing, mupirocin, or vancomycin or vancomycin plus cefazolin (cefuroxime) ^a

^a If the patient had confirmed beta-lactam allergy, use vancomycin in place of cefazolin (cefuroxime).

Note: CHG, chlorhexidine-gluconate

eAppendix 1: Details of Bundle Implementation and Measurement of Outcomes

Participating hospital staff at each site filled out a survey regarding current use of bundle components at the site. During the pre-intervention period, all (20/20) requested that patients having elective procedures bathe with CHG for at least 1 day before their operations; 65% (13/20) bathed patients having emergent procedures with CHG for at least 1 day. All (20/20) of the hospitals screened patients for MRSA carriage; only 3 (15%) indicated PCR testing was used. Nine (45%) prescribed intranasal mupirocin for elective operations and 30% (6/20) treated patients having emergent operations with mupirocin. All sites used vancomycin prophylaxis for some patients. Nine (45%) used vancomycin only for patients with a known history of MRSA or allergy to penicillin or cephalosporin; the remainder stated vancomycin use varied by surgeon within the hospital. None of the hospitals used all components of the bundle in the pre-intervention period.

Nine hospitals reported that they prescribed mupirocin to some surgical patients during the pre-intervention period. In the subgroup analysis of these 9 hospitals, the rates of complex *S. aureus* surgical site infections decreased significantly (rate ratio: 0.51; 95% confidence interval: 0.34, 0.78) during the intervention period. Eleven hospitals reported that they did not prescribe mupirocin for surgical patients during the pre-intervention period. In the subgroup analysis of these 11 hospitals, the rates of complex *S. aureus* surgical site infections decreased, but the decrease did not attain statistical significance (rate ratio: 0.65; 95% confidence interval: 0.29, 1.43).

During the intervention period, CHG bathing was performed using one of the following products 2% CHG cloths (Sage products, Cary, IL, USA) or 4% CHG liquid (Hibiclens, Mölnlycke Health Care, Norcross, GA, USA) or 4% CHG sponge (Exidine, CareFusion, San Diego, CA). Patients were provided with instructions for CHG product application (Supplement 4). Mupirocin was provided as either generic mupirocin topical polyethylene glycol base or Bactroban ointment (Bactroban, GlaxoSmithKline). Hospital staff gave patients a compliance form on which to record their use of mupirocin and CHG and staff were instructed to enter this information into the electronic patient record.

We retrospectively applied the 2013 NHSN definition to SSIs that occurred between 2009 and 2012. All hospitals performed in-hospital surveillance for SSI. Nineteen hospitals surveyed readmitted patients for SSIs, 19 included patients treated for SSIs at other hospitals, 18 contacted physicians' offices to identify patients with SSIs, 15 received reports about patients who were treated as outpatients for SSIs, 14 received reports about patients with SSIs from long-term care facilities, and 1 hospital surveyed patients directly. We instructed sites to use the same surveillance and reporting practices during the pre-intervention and intervention periods to maintain consistency in reporting. Record-keeping processes, staff turnover among infection preventionists, and information management systems for the retrospective data varied across facilities. However, this was a pragmatic trial and these elements could not be controlled. Monthly coaching calls were used to educate sites and remind the staff about study-related adverse event forms and patient compliance forms. The study investigators validated sites' NHSN SSI report forms and information shared by sites during monthly coaching calls to identify sites requiring additional support, education, and site visits.

eAppendix 2: Teaching status definition, American Hospital Association

Major Teaching Hospitals – those with Council of Teaching (COTH) hospitals designation.

Minor Teaching Hospitals – those either Approved to participate in residency and/or internship training by the Accreditation Council for Graduate Medical Education (ACGME) or those with medical school affiliation reported to the American Medical Association.

Non-Teaching Hospitals – those without COTH, ACGME, or American Medical School (AMA) affiliation.

(<http://www.ahadataviewer.com/glossary/>)

**eTable 2: *International Classification of Diseases, Ninth Edition (ICD-9)*
Procedure Codes for Included Operations**

ICD-9 CM code	Procedure description
<i>Cardiac Operations</i>	
35.10	Open heart valvuloplasty without replacement, unspecified valve
35.11	Open heart valvuloplasty of aortic valve without replacement
35.12	Open heart valvuloplasty of mitral valve without replacement
35.13	Open heart valvuloplasty of pulmonary valve without replacement
35.14	Open heart valvuloplasty of tricuspid valve without replacement
35.20	Replacement of unspecified heart valve
35.21	Replacement of aortic valve with tissue graft
35.22	Other replacement of aortic valve, NOS
35.23	Replacement of mitral valve with tissue graft
35.24	Other replacement of mitral valve, NOS
35.25	Replacement of pulmonary valve with tissue graft
35.26	Other replacement of pulmonary valve, NOS
35.27	Replacement of tricuspid valve with tissue graft
35.28	Other replacement of tricuspid valve, NOS
35.31	Operations on papillary muscle
35.32	Operations on chordae tendineae
35.33	Annuloplasty
35.39	Operations on other structures adjacent to valves of heart
35.50	Repair of unspecified septal defect of heart with prosthesis
35.51	Repair of atrial septal defect with prosthesis, open technique
35.53	Repair of ventricular septal defect with prosthesis, open technique
35.60	Repair of unspecified septal defect of heart with tissue graft
35.61	Repair of atrial septal defect with tissue graft
35.62	Repair of ventricular septal defect with tissue graft
35.70	Other and unspecified repair of unspecified septal defect of heart, NOS
35.72	Other and unspecified repair of ventricular septal defect
35.99	Other operations on valves of heart
36.11	(Aorto)coronary bypass of one coronary artery
36.12	(Aorto)coronary bypass of two coronary arteries
36.13	(Aorto)coronary bypass of three coronary arteries
36.14	(Aorto)coronary bypass of four or more coronary arteries
36.15	Single internal mammary-coronary artery bypass
36.16	Double internal mammary-coronary artery bypass
36.17	Abdominal - coronary artery bypass
36.19	Other bypass anastomosis for heart revascularization
<i>Arthroplasty Operations</i>	
00.85	Resurfacing hip, total, acetabulum and femoral head

00.86	Resurfacing hip, partial, femoral head
00.87	Resurfacing hip, partial, acetabulum
81.51	Total hip replacement
81.52	Partial hip replacement
81.54	Total knee replacement

eTable 3. Monthly Rate of Complex *S. aureus* Surgical Site Infections

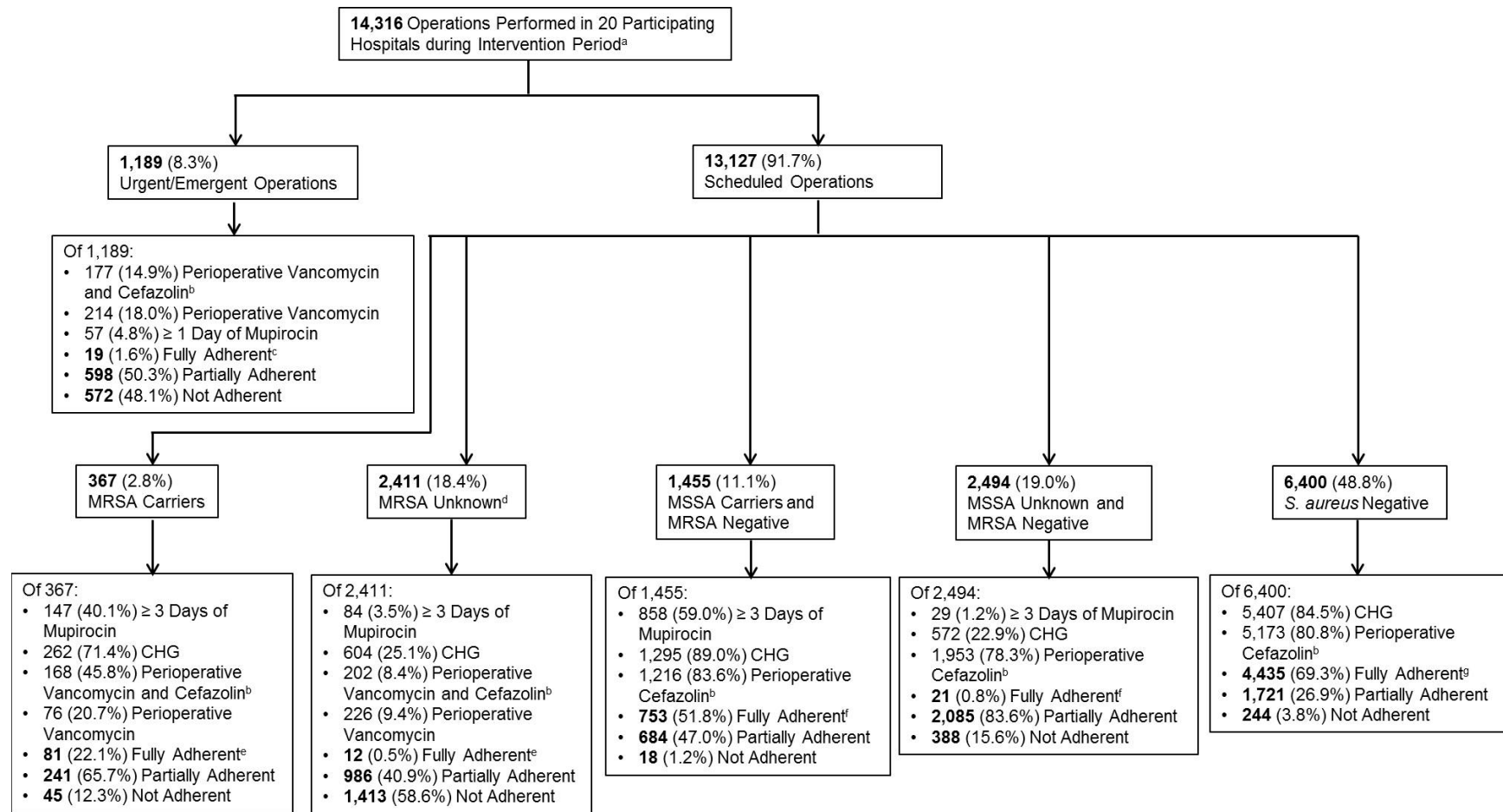
Admission Month	Number of Hospitals	Number of Operations	Number of Complex <i>S. aureus</i> SSI	Pooled Rate, per 10,000 Operations	Mean Rate \pm SD, per 10,000 Operations	Median Rate (Range), per 10,000 Operations
03/2009	20	412 ^a	2	49	57 \pm 207	0 (0 – 909)
04/2009	20	495 ^a	1	20	5 \pm 23	0 (0 – 103)
05/2009	20	673	2	30	19 \pm 58	0 (0 – 213)
06/2009	20	723	0	0	0 \pm 0	0 (0 – 0)
07/2009	20	648 ^a	0	0	0 \pm 0	0 (0 – 0)
08/2009	20	659 ^a	2	30	13 \pm 42	0 (0 – 167)
09/2009	20	676	4	59	81 \pm 250	0 (0 – 1111)
10/2009	20	711	3	42	23 \pm 86	0 (0 – 377)
11/2009	20	675	1	15	22 \pm 97	0 (0 – 435)
12/2009	20	644 ^a	6	93	70 \pm 132	0 (0 – 385)
01/2010	20	740 ^b	4	54	59 \pm 169	0 (0 – 571)
02/2010	20	742 ^b	2	27	58 \pm 225	0 (0 – 1000)
03/2010	20	801 ^b	3	37	100 \pm 373	0 (0 – 1667)
04/2010	20	725	1	14	7 \pm 33	0 (0 – 147)
05/2010	20	713	3	42	36 \pm 110	0 (0 – 377)
06/2010	20	769 ^b	7	91	167 \pm 408	0 (0 – 1429)
07/2010	20	662 ^a	1	15	11 \pm 49	0 (0 – 217)
08/2010	20	706	3	42	36 \pm 95	0 (0 – 357)
09/2010	20	726	1	14	42 \pm 186	0 (0 – 833)
10/2010	20	707	1	14	15 \pm 068	0 (0 – 303)
11/2010	20	798 ^b	2	25	35 \pm 126	0 (0 – 556)
12/2010	20	663	1	15	9 \pm 42	0 (0 – 189)
01/2011	20	814 ^b	2	25	8 \pm 36	0 (0 – 161)
02/2011	20	748 ^b	4	53	55 \pm 133	0 (0 – 500)
03/2011	20	774 ^b	3	39	23 \pm 75	0 (0 – 299)
04/2011	20	703	3	43	72 \pm 179	0 (0 – 588)
05/2011	20	700	1	14	50 \pm 224	0 (0 – 1000)
06/2011	20	725	1	14	5 \pm 22	0 (0 – 100)
07/2011	20	599 ^a	2	33	21 \pm 68	0 (0 – 270)
08/2011	20	706	2	28	16 \pm 48	0 (0 – 159)
09/2011	20	650 ^a	3	46	50 \pm 130	0 (0 – 417)
10/2011	20	686	4	58	84 \pm 229	0 (0 – 909)
11/2011	20	690	4	58	74 \pm 305	0 (0 – 1364)
12/2011	20	679	1	15	7 \pm 31	0 (0 – 141)
01/2012	20	800 ^b	8	100	94 \pm 150	0 (0 – 476)
02/2012	20	710	5	70	43 \pm 92	0 (0 – 323)
03/2012	20	712	2	28	12 \pm 39	0 (0 – 141)
04/2012	20	682	1	15	6 \pm 25	0 (0 – 111)
05/2012	20	699	2	29	45 \pm 203	0 (0 – 909)
Hospitals began implementing interventions in 6/2012						
06/2012	20	686	2	29	31 \pm 110	0 (0 – 476)
07/2012	20	655 ^a	2	31	29 \pm 92	0 (0 – 370)
08/2012	20	617 ^a	1	16	11 \pm 50	0 (0 – 222)
09/2012	20	623 ^a	2	32	33 \pm 125	0 (0 – 556)
10/2012	20	724	0	0	0 \pm 0	0 (0 – 0)
11/2012	20	667	1	15	6 \pm 27	0 (0 – 122)
12/2012	20	655 ^a	0	0	0 \pm 0	0 (0 – 0)

01/2013	20	758 ^b	0	0	0 ± 0	0 (0 – 0)
02/2013	20	720	3	42	71 ± 225	0 (0 – 870)
03/2013	20	651 ^a	2	31	24 ± 080	0 (0 – 333)
04/2013	19	750 ^b	3	40	35 ± 111	0 (0 – 435)
05/2013	19	655 ^a	0	0	0 ± 0	0 (0 – 0)
06/2013	19	738	0	0	0 ± 0	0 (0 – 0)
07/2013	19	698	6	86	95 ± 192	0 (0 – 526)
08/2013	19	620 ^a	2	32	17 ± 50	0 (0 – 179)
09/2013	19	677	3	44	54 ± 151	0 (0 – 588)
10/2013	19	784 ^b	1	13	5 ± 24	0 (0 – 103)
11/2013	19	700	0	0	0 ± 0	0 (0 – 0)
12/2013	19	746 ^b	0	0	0 ± 0	0 (0 – 0)
01/2014	19	773 ^b	3	39	66 ± 255	0 (0 – 1111)
02/2014	19	788 ^b	1	13	8 ± 33	0 (0 – 145)
03/2014	19	704	0	0	0 ± 0	0 (0 – 0)

a. Number of operations is less than the 25th percentile.

b. Number of operations is more than the 75th percentile.

eFigure1. Number of Operations Receiving Each Bundle Component during the Intervention Period (Intention-to-Treat)



^a Includes patients whose surgeons did not implement the bundle.

^b Cefazolin or cefuroxime.

^c Fully adherent among urgent/emergent operations defined as patient received both mupirocin (≥ 1 day) and prophylaxis with vancomycin and cefazolin.

^d Among MRSA unknown, 1,924 (79.8%) were MSSA unknown, 376 (15.6%) were MSSA negative, and 111 (4.6%) were MSSA carriers.

^e Fully adherent among MRSA carriers or MRSA unknown defined as patient received CHG bathing, mupirocin for ≥ 3 days, and prophylaxis with vancomycin and cefazolin.

^f Fully adherent among MSSA carriers or MSSA unknown (MRSA negative) defined as patient received CHG bathing, mupirocin for ≥ 3 days, and cefazolin prophylaxis.

^g Fully adherent among *S. aureus* negative defined as patient received both CHG bathing and cefazolin prophylaxis.

Note: CHG, chlorhexidine gluconate; MSSA, methicillin-susceptible *S. aureus*; MRSA, methicillin-resistant *S. aureus*.