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National Nosocomial Infections Surveillance (NNIS) System Report, data summary from January 1992 through June 2004, issued October 2004

A report from the NNIS System*
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This report is a summary of the data collected and reported by hospitals participating in the National Nosocomial Infections Surveillance (NNIS) System from January 1992 through June 2004 and updates previously published data.[1-4]

The NNIS System was established in 1970 when selected hospitals in the United States routinely began reporting their nosocomial infection surveillance data for aggregation into a national database. Hospitals participating in the NNIS System provide general medical-surgical inpatient services to adults or children requiring acute care. Identity of the nearly 300 hospitals currently participating in the NNIS System is confidential.

All NNIS data are collected using standardized protocols, called ''surveillance components'': adult and pediatric intensive care unit (ICU), high-risk nursery (HRN), and surgical patient.[5-7] The components may be used singly or simultaneously, but once selected, they must be used for a minimum of 1 calendar month. All infections are categorized into major and specific infection sites using standard CDC definitions that include laboratory and clinical criteria.[6]

ADULT AND PEDIATRIC ICU SURVEILLANCE COMPONENT

Infection control professionals (ICPs) collect data on all sites of nosocomial infection in patients located in ICUs, as well as ICU-specific denominator data. Site-specific infection rates can be calculated by using as a denominator the number of patients at risk, patient-days, and days of indwelling urinary catheterization, central vascular cannulation (central line), or ventilation.

HRN SURVEILLANCE COMPONENT

ICPs collect data on all sites of nosocomial infection in patients located in HRN, and HRN-specific denominator data. Site-specific infection rates can be calculated by using as a denominator the number of patients at risk, patient-days, and days of umbilical catheter/central line use or ventilation for each of 4 birth-weight categories (≤1000 gm, 1001-1500 gm, 1501-2500 gm, and ≥2500 gm).

SURGICAL PATIENT SURVEILLANCE COMPONENT

ICPs select from the NNIS operative procedure list those procedures they wish to follow up and monitor the patients undergoing those procedures for all infections or surgical site infections (SSI) only. A record on every patient undergoing the selected procedure is generated that includes information on risk factors for SSI such as wound class,[8] duration of operation, and American Society of Anesthesiology (ASA) score.[9] Using a composite index for predicting the risk of SSI after operation, ICPs can calculate rates by the number of risk factors present.[4]

The time periods for the data contained in this report vary depending on the table. Each table represents NNIS data from one of the surveillance components. For the ICU and HRN surveillance components where data volume was large after risk stratification, we were able

*See Appendix D.
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Table 1. Pooled means and percentiles of the distribution of device-associated infection rates, by type of ICU, ICU component, January 2002 through June 2004

Urinary catheter-associated UTI rate*				Percentile				
Type of ICU	**No. of units**	**Urinary catheter-days**	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
Coronary	60	170,759	4.5	0.8	2.6	4.0	7.5	10.2
Cardiothoracic	48	193,424	3.0	0.0	1.1	2.4	3.9	6.2
Medical	94	448,161	5.1	0.7	2.5	4.7	7.1	9.5
Medical-surgical								
Major teaching	99	593,100	3.9	1.3	2.1	3.3	5.2	7.5
All others	108	757,531	3.3	0.6	1.6	3.1	5.1	6.9
Neurosurgical	29	99,039	6.7	1.8	3.1	6.0	7.8	9.5
Pediatric	52	104,788	4.0	0.0	1.6	3.6	6.1	8.1
Surgical	99	486,575	4.4	1.4	2.3	3.8	6.5	8.8
Trauma	22	104,181	6.0	2.1	3.8	5.7	7.3	9.3
Burn	14	44,342	6.7	—	—	—	—	—
Respiratory	6	17,784	6.4	—	—	—	—	—
Central line-associated BSI rate†				**Percentile**				
Type of ICU	**No. of units**	**Central line-days**	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
Coronary	60	116,546	3.5	1.0	1.5	3.2	7.0	9.0
Cardiothoracic	48	182,407	2.7	0.0	0.9	1.8	2.7	4.9
Medical	94	312,478	5.0	0.5	2.4	3.9	6.4	8.8
Medical-surgical								
Major teaching	100	430,979	4.0	1.7	2.6	3.4	5.1	7.6
All others	109	486,115	3.2	0.8	1.6	3.1	4.3	6.1
Neurosurgical	30	56,645	4.6	0.0	0.9	3.1	5.8	10.6
Pediatric	54	161,314	6.6	0.9	3.0	5.2	8.1	11.2
Surgical	99	358,578	4.6	0.0	2.0	3.4	5.9	8.7
Trauma	22	70,372	7.4	1.9	3.3	5.2	8.2	11.9
Burn	14	43,002	7.0	—	—	—	—	—
Respiratory	6	12,593	4.8	—	—	—	—	—
Ventilator-associated pneumonia rate‡				**Percentile**				
Type of ICU	**No. of units**	**Ventilator-days**	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
Coronary	59	76,145	4.4	0.0	1.9	4.0	6.8	9.8
Cardiothoracic	47	98,358	7.2	1.2	2.9	6.3	12.6	15.5
Medical	92	268,518	4.9	0.5	2.1	3.7	6.2	8.9
Medical-surgical								
Major teaching	99	320,916	5.4	1.2	2.6	4.6	7.2	9.9
All others	109	351,705	5.1	1.7	2.9	5.1	6.7	8.9
Neurosurgical	29	45,073	11.2	0.0	2.4	6.2	13.5	16.8
Pediatric	52	133,995	2.9	0.0	0.9	2.3	4.8	8.1
Surgical	98	253,900	9.3	2.2	4.7	8.3	12.2	17.9
Trauma	22	63,137	15.2	4.3	8.0	11.4	16.6	25.3
Burn	14	23,117	12.0	—	—	—	—	—
Respiratory	6	18,838	4.9	—	—	—	—	—

UTI, Urinary tract infection; *BSI*, bloodstream infection.

* $\frac{\text{Number of urinary catheter-associated UTIs}}{\text{Number of urinary catheter-days}} \times 1000$

† $\frac{\text{Number of central line-associated BSIs}}{\text{Number of central line-days}} \times 1000$

‡ $\frac{\text{Number of ventilator-associated pneumonias}}{\text{Number of ventilator-days}} \times 1000$

to construct tables comprised of data from fewer and more recent years only (January 2002 through June 2004; Tables 1-4). However for the surgical patient component, we had to use all the data from January 1992 through June 2004, because the numbers of operations in each procedure-risk-stratum was too small to produce stable rates when only more recent years' data were used (Tables 5-8). Similarly, Tables 9

Table 2. Pooled means and percentiles of the distribution of device utilization ratios, by type of ICU, ICU component, January 2002 through June 2004

	Urinary catheter utilization*			Percentile				
Type of ICU	**No. of units**	**Patient-days**	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
Coronary	60	305,911	0.56	0.26	0.46	0.60	0.70	0.78
Cardiothoracic	48	230,487	0.84	0.58	0.76	0.88	0.95	0.96
Medical	94	596,588	0.75	0.58	0.65	0.76	0.83	0.88
Medical-surgical								
Major teaching	99	759,464	0.78	0.65	0.74	0.82	0.87	0.90
All others	108	979,550	0.77	0.67	0.73	0.78	0.84	0.87
Neurosurgical	29	116,931	0.85	0.65	0.76	0.82	0.92	0.95
Pediatric	53	349,258	0.30	0.11	0.20	0.30	0.41	0.47
Surgical	99	590,220	0.82	0.65	0.76	0.86	0.92	0.96
Trauma	22	115,099	0.91	0.77	0.85	0.93	0.96	0.98
Burn	14	76,877	0.58	—	—	—	—	—
Respiratory	6	26,567	0.67	—	—	—	—	—
	Central line utilization†			**Percentile**				
Type of ICU	**No. of units**	**Patient-days**	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
Coronary	60	305,911	0.38	0.15	0.22	0.36	0.51	0.60
Cardiothoracic	48	230,487	0.79	0.55	0.70	0.83	0.87	0.93
Medical	95	596,588	0.52	0.31	0.37	0.52	0.64	0.75
Medical-surgical								
Major teaching	100	759,464	0.57	0.36	0.47	0.56	0.66	0.74
All others	109	979,550	0.50	0.29	0.38	0.49	0.58	0.66
Neurosurgical	30	116,931	0.48	0.23	0.33	0.50	0.55	0.65
Pediatric	54	349,258	0.46	0.20	0.31	0.46	0.57	0.64
Surgical	100	590,220	0.61	0.34	0.52	0.63	0.72	0.81
Trauma	22	115,099	0.61	0.40	0.49	0.60	0.71	0.79
Burn	14	76,877	0.56	—	—	—	—	—
Respiratory	6	26,567	0.47	—	—	—	—	—
	Ventilator utilization‡			**Percentile**				
Type of ICU	**No. of units**	**Patient-days**	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
Coronary	60	305,911	0.25	0.11	0.14	0.23	0.36	0.41
Cardiothoracic	48	230,487	0.43	0.25	0.31	0.40	0.48	0.58
Medical	94	596,588	0.46	0.22	0.32	0.46	0.57	0.67
Medical-surgical								
Major teaching	99	759,464	0.43	0.23	0.32	0.43	0.55	0.62
All others	109	979,550	0.37	0.22	0.28	0.35	0.42	0.52
Neurosurgical	29	116,931	0.39	0.19	0.26	0.34	0.45	0.56
Pediatric	52	349,258	0.39	0.17	0.25	0.36	0.49	0.57
Surgical	99	590,220	0.44	0.19	0.31	0.46	0.53	0.65
Trauma	22	115,099	0.56	0.39	0.44	0.50	0.67	0.77
Burn	14	76,877	0.31	—	—	—	—	—
Respiratory	6	26,567	0.71	—	—	—	—	—

* $\frac{\text{Number of urinary catheter-days}}{\text{Number of patient-days}}$

† $\frac{\text{Number of central line-days}}{\text{Number of patient-days}}$

‡ $\frac{\text{Number of ventilator-days}}{\text{Number of patient-days}}$

and 10 required use of data reported since January 1998 through June 2004.

Tables 1 and 2 from the ICU component update previously published device-associated rates and device utilization (DU) ratios by type of ICU.[1,2] As noted above, data from a shorter, more recent time period is presented which differs from previous reports. In general, the device-associated urinary tract and

Table 3. Pooled means and percentiles of the distribution of device-associated infection rates, by birth-weight category, HRN component, January 2002 through June 2004

Umbilical and central line-associated BSI rate*				Percentile				
Birth-weight category	No. of HRNs	Central line-days	Pooled mean	10%	25%	50% (median)	75%	90%
≤1000 g	104	204,468	9.1	1.6	5.4	8.5	11.6	16.1
1001-1500 g	98	95,254	5.4	0.0	1.8	4.0	7.4	12.2
1501-2500 g	97	79,904	4.1	0.0	0.0	3.2	6.5	8.9
>2500 g	94	97,202	3.5	0.0	0.0	1.9	4.1	7.4
Ventilator-associated pneumonia rate†				**Percentile**				
Birth-weight category	**No. of HRNs**	**Ventilator-days**	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
≤1000 g	102	204,117	3.5	0.0	0.0	2.4	5.8	8.5
1001-1500 g	91	50,204	2.4	0.0	0.0	0.0	3.2	8.0
1501-2500 g	86	39,957	1.9	0.0	0.0	0.0	1.5	6.1
>2500 g	90	55,038	1.4	0.0	0.0	0.0	0.9	3.2

BSI, Bloodstream infection.

* $\frac{\text{Number of umbilical and central line-associated BSIs}}{\text{Number of umbilical and central line-days}} \times 1000$

† $\frac{\text{Number of ventilator-associated pneumonia}}{\text{Number of ventilator-days}} \times 1000$

Table 4. Pooled means and percentiles of the distribution of device utilization ratios, by birth-weight category, HRN component, January 2002 through June 2004

Umbilical and central line utilization ratio*				Percentile				
Birth-weight category	No. of HRNs	Patient-days	Pooled mean	10%	25%	50% (median)	75%	90%
≤1000 g	105	489,195	0.42	0.21	0.31	0.43	0.55	0.70
1001-1500 g	104	319,316	0.30	0.08	0.16	0.29	0.46	0.58
1501-2500 g	103	388,630	0.21	0.05	0.09	0.17	0.31	0.54
>2500 g	103	335,430	0.29	0.06	0.12	0.20	0.41	0.54
Ventilator utilization ratio†				**Percentile**				
Birth-weight category	**No. of HRNs**	**Patient-days**	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
≤1000 g	105	489,195	0.43	0.22	0.32	0.43	0.53	0.63
1001-1500 g	104	319,316	0.16	0.05	0.09	0.15	0.20	0.35
1501-2500 g	103	388,630	0.10	0.03	0.05	0.07	0.16	0.27
>2500 g	103	335,430	0.17	0.04	0.06	0.11	0.21	0.33

* $\frac{\text{Number of umbilical and central line-days}}{\text{Number of patient-days}}$

† $\frac{\text{Number of ventilator-days}}{\text{Number of patient-days}}$

bloodstream infection rates are slightly lower than before. In these tables, the percentile distributions that display the infection rates and DU ratios require data from at least 20 different units. Each of the analyses of ICU data excluded rates or DU ratios for units that did not report at least 50 device-days or patient-days. Because of this, the number of units contributing data in the tables is not exactly the same.

The number of units reporting data from burn and respiratory ICUs is not adequate to provide distributions of infection rates and DU ratios. The data for combined medical/surgical ICUs are split into 2 groups by type of hospital: ''major teaching'' and ''all others.'' Major teaching status is defined as a hospital that is an important part of the teaching program of a medical school and a major unit in the clinical

Table 5. SSI rates*, by operative procedure and risk index category, Surgical Patient component, January 1992 through June 2004

Operative procedure category		Duration cut point (h)	Risk index category	N	Rate	Risk index category	N	Rate	Risk index category	N	Rate	Risk index category	N	Rate
CARD	Cardiac	5	0	2147	0.70	1	49,135	1.50	2,3	15,215	2.21		—	—
CBGB	CABG-chest and donor site	5	0	2718	1.25	1	380,340	3.39	2	82,535	5.43	3	246	9.76
CBGC	CABG-chest only	4	0	160	0.00	1	15,248	2.19	2,3	6,499	3.72		—	—
OCVS	Other cardiovascular	2	0,1	11,233	0.60	2	3828	1.28	3	153	3.92		—	—
ORES	Other respiratory	2	0,1,2,3	1728	2.43		—	—		—	—		—	—
THOR	Thoracic	3	0	1423	0.42	1	5250	0.99	2,3	1,984	2.47		—	—
APPY	See Table 7													
BILI	Liver/pancreas	5	0	482	3.11	1,2,3	1736	7.37		—	—		—	—
CHOL	See Table 7													
COLO	See Table 7													
GAST	See Table 7													
OGIT	Other digestive	2	0	1418	1.90	1	2559	3.01	2,3	1,108	5.69		—	—
SB	Small bowel	3	0	1749	4.97	1	4218	7.11	2	2,144	8.63	3	362	11.60
XLAP	Laparotomy	2	0	6414	1.71	1	8082	3.08	2	4,542	4.71	3	987	7.19
NEPH	Nephrectomy	4	0,1,2,3	3747	1.04		—	—		—	—		—	—
OGU	Other genitourinary	2	0	13,831	0.36	1	7896	0.85	2,3	1,953	2.92		—	—
PRST	Prostatectomy	4	0	2732	0.81	1,2,3	2389	2.05		—	—		—	—
HN	Head and neck	7	0	660	2.27	1	962	5.30	2,3	408	12.50		—	—
OENT	Other ENT	3	0	2909	0.07	1	1389	0.72	2,3	307	2.61		—	—
HER	Herniorrhaphy	2	0	12,659	0.81	1	8397	2.14	2,3	2,033	4.53		—	—
MAST	Mastectomy	3	0	16,287	1.74	1	10,700	2.20	2,3	1,112	3.42		—	—
CRAN	Craniotomy	4	0	4717	0.91	1	14,864	1.72	2,3	4,666	2.40		—	—
ONS	Other nervous system	4	0,1,2,3	2356	1.53		—	—		—	—		—	—
VSHN	Ventricular shunt	2	0	4208	4.42	1,2,3	12,324	5.36		—	—		—	—
CSEC	Cesarean section	1	0	154,141	2.71	1	46,081	4.14	2,3	4,871	7.53		—	—
HYST	Abdominal hysterectomy	2	0	49,024	1.36	1	24,064	2.32	2,3	5,053	5.17		—	—
OOB	Other obstetric	1	0,1,2,3	1363	0.51		—	—		—	—		—	—
VHYS	Vaginal hysterectomy	2	0,1,2,3	29,857	1.31		—	—		—	—		—	—
AMP	Limb amputation	2	0,1,2,3	10,732	3.50		—	—		—	—		—	—
FUSN	Spinal fusion	4	0	51,057	1.04	1	30,619	2.64	2,3	8,122	6.35		—	—
FX	Open reduction of fracture	2	0	16,142	0.79	1	26,372	1.41	2	5,081	2.81	3	523	4.97
HPRO	Hip prosthesis	2	0	44,454	0.86	1	71,336	1.65	2,3	18,941	2.52		—	—
KPRO	Knee prosthesis	2	0	66,360	0.88	1	74,029	1.28	2,3	18,051	2.26		—	—
LAM	Laminectomy	2	0	73,846	0.88	1	55,517	1.35	2,3	18,106	2.46		—	—
OMS	Other musculoskeletal	3	0	18,805	0.63	1	13,527	0.94	2,3	3,927	1.78		—	—
OPRO	Other prosthesis	3	0,1,2,3	3882	0.62		—	—		—	—		—	—
OBL	Other hem/lymph system	3	0,1,2,3	1050	1.90		—	—		—	—		—	—
OES	Other endocrine system	3	0	2607	0.15	1,2,3	2043	0.78		—	—		—	—
OEYE	Other eye	3	0,1,2,3	593	0.67		—	—		—	—		—	—
OSKN	Other integumentary system	2	0,1,2,3	9589	1.29		—	—		—	—		—	—
SKGR	Skin graft	3	0	1288	0.93	1	2155	1.72	2,3	1,526	4.19		—	—
SPLE	Splenectomy	3	0,1,2,3	1609	2.80		—	—		—	—		—	—
TP	Organ transplant	6	0,1	4964	4.63	2	1824	13.71	3	50	26.00		—	—
VS	Vascular	3	0	7901	0.90	1	70,717	1.72	2,3	28,458	4.34		—	—

CBGB, Coronary artery bypass graft with chest and donor site incisions (eg, femoral or radial artery harvested as donor vessel for bypass graft); *CBGC*, coronary artery bypass graft with chest incision only (eg, use of internal mammary artery for bypass graft); *ENT*, ear, nose, and throat.
*Per 100 operations.

clerkship program. The combined medical/surgical ICUs from major teaching hospitals had significantly higher infection rates and DU ratios than combined medical/surgical ICUs from all of the other hospitals. Teaching affiliation was not an important factor for any other type of ICU.

For the ICU component, device-days consist of the total number of ventilator-days, central line-days, and urinary catheter-days. The DU of an ICU is one measure of the unit's invasive practices that constitutes an extrinsic risk factor for nosocomial infection.[2] As such, DU may also serve as a marker for severity of illness of

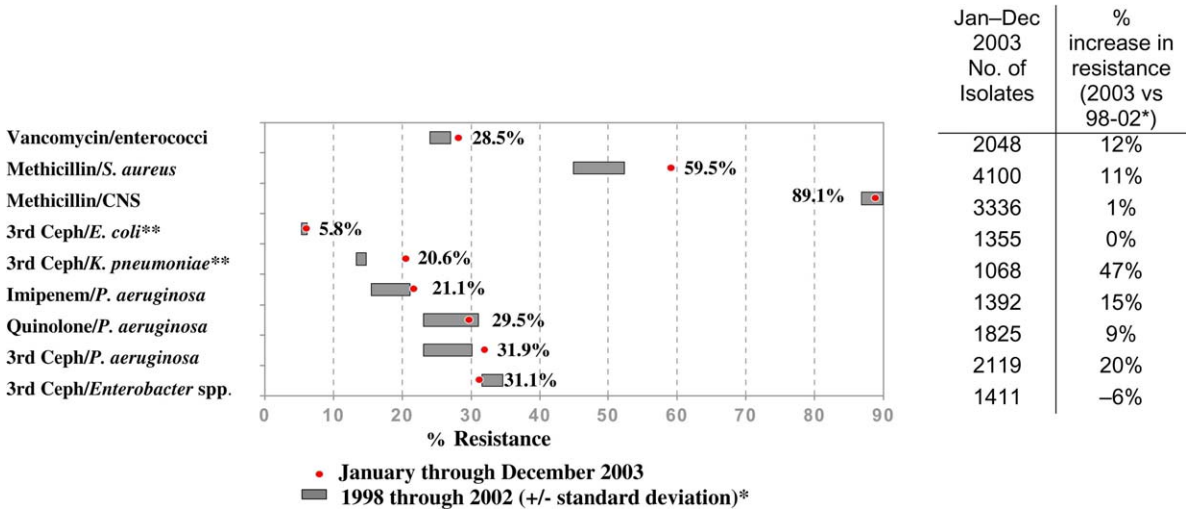

Fig 1. Selected antimicrobial-resistant pathogens associated with nosocomial infections in ICU patients, comparison of resistance rates from January through December 2003 with 1998 through 2002, NNIS System. *CNS*, Coagulase-negative staphylococci; *3rd Ceph*, resistance to 3rd generation cephalosporins (either ceftriaxone, cefotaxime, or ceftazidime); *Quinolone*, resistance to either ciprofoxacin or ofloxacin. *Percent (%) increase in resistance rate of current year (January-December 2003) compared with mean rate of resistance over previous 5 years (1998-2002): [(2003 rate – previous 5-year mean rate)/previous 5-year mean rate] × 100. **"Resistance" for *E coli* or *K pneumoniae* is the rate of nonsusceptibility of these organisms to either 3rd Ceph group or aztreonam.

patients in the unit, that is, patients' intrinsic susceptibility to infection.

Site distributions of infections for coronary care, medical, pediatric, and combined medical-surgical ICUs have been published elsewhere.[10-13]

Figure 1 shows the rates of antimicrobial resistance among selected pathogens identified from patients in the ICU with nosocomial infections. For each antimicrobial/pathogen pair, the pooled mean rate of resistance for January through December 2003 is displayed. Next to or overlapping this point is the average rate of resistance (±1 SD) over the previous 5-year period (shaded bars). The number of isolates tested from January through December 2003 and the percentage increase in the resistance rate during 2003 compared with the previous 5 years are shown in the 2 columns to the right of the graph. The continuing increase in antimicrobial resistance in U.S. hospitals remains a concern. Of note, the proportion of *Staphylococcus aureus* isolates that were resistant to methicillin, oxacillin, or nafcillin continues to rise and is nearly 60%, and there has been a nearly 50% increase in nonsusceptible *Klebsiella pneumoniae* isolates to 3rd generation cephalosporins between 2002 and 2003. However, the rate of increase has diminished for several pathogens, including vancomycin-resistant *Enterococcus,* which was reported as +31% in 2000 compared to +12% in 2003.[14] Although these data are limited to patients in ICUs, they are not otherwise risk-adjusted and comparisons of these rates between hospitals should be made with caution.

Tables 3 and 4 from the HRN component update the previously published, device-associated rates and DU ratios in each of 4 birth weight categories.[1,3] For the HRN component, device-days consist of the total number of ventilator-days and umbilical catheter- or central line-days. Each of the analyses of HRN data excluded rates or DU ratios for units that did not report at least 50 device-days or patient-days. Because of this, the number of units contributing data in the tables is not exactly the same. As for the ICU component, there were sufficient data to limit the analysis to the period January 2002 through June 2004. Although the percentile distribution of the rates is provided, for most birth-weight categories the number of pneumonias and ventilator-days is still relatively small and the data should be considered provisional. Percent distributions of infections by major site of nosocomial infection and pathogens by major site, and other HRN analyses, have been published.[15]

Tables 5 through 8 from the surgical patient component update previously published rates.[1,4] Table 5 displays SSI rates by operative procedure and NNIS risk index category. When the SSI rates for adjacent risk categories for a particular operation were not statistically different, they were combined into a single risk category. For example, because the SSI rates for cardiac surgery with 2 or 3 risk factors were similar, the data

Table 6. Percentiles of the distribution of SSI rates,* by operative procedure and risk index category,† Surgical Patient component, January 1992 through June 2004

Operative procedure category		Risk index category	No. hospitals	Pooled mean rate	Percentile				
					10%	25%	50% (median)	75%	90%
CARD	Cardiac	1	109	1.50	0	0.47	1.2	1.78	2.91
CARD	Cardiac	2,3	88	2.21	0	0	1.47	3.03	4.67
CBGB	CABG-chest and donor site	0	33	1.25	0	0	0.49	2.14	3.38
CBGB	CABG-chest and donor site	1	184	3.39	1.56	2.17	3.17	4.36	6.02
CBGB	CABG-chest and donor site	2	174	5.43	2.28	3.64	5.16	7.64	9.86
CBGC	CABG-chest only	1	107	2.19	0	0	1.51	3.43	4.36
CBGC	CABG-chest only	2,3	69	3.72	0	0.99	2.44	4.47	7.02
OCVS	Other cardiovascular	0,1	36	0.60	0	0	0	0.67	1.83
OCVS	Other cardiovascular	2	23	1.28	0	0	0	1.1	2.33
THOR	Thoracic	0	21	0.42	0	0	0	0	2.34
THOR	Thoracic	1	37	0.99	0	0	0	1.3	2.73
THOR	Thoracic	2,3	22	2.47	0	0	1.64	3.54	6.04
APPY	Appendectomy	M	22	0.67	0	0	0	0.74	1.38
APPY	Appendectomy	0	47	1.31	0	0	1.13	2.05	3.24
APPY	Appendectomy	1	58	2.55	0	1.28	2.22	3.29	5.78
APPY	Appendectomy	2,3	39	4.85	0	1.63	3.97	5.97	10.15
CHOL	Cholecystectomy	M	88	0.45	0	0	0	0.53	1.17
CHOL	Cholecystectomy	0	92	0.68	0	0	0.4	1.12	2.38
CHOL	Cholecystectomy	1	76	1.78	0	0	1.32	3.11	5.12
CHOL	Cholecystectomy	2	46	3.27	0	0.56	3.23	4.65	6.6
COLO	Colon	M0	99	3.98	0	1.93	3.22	5	6.42
COLO	Colon	1	107	5.66	1.91	3.36	5.1	6.97	8.96
COLO	Colon	2	84	8.54	3.92	5.48	9.09	11.62	17.16
COLO	Colon	3	28	11.25	2.11	6.67	13.33	16.22	21.67
GAST	Gastric	0	29	2.58	0	0	2.58	4.22	5.98
GAST	Gastric	1	53	4.69	0.21	1.89	4.21	6.97	9.41
GAST	Gastric	2,3	34	8.34	0.85	3.64	7.27	12.52	19.41
OGIT	Other digestive	1	22	3.01	0	0	2.13	3.37	6.45
SB	Small bowel	0	27	4.97	0	2.58	4.77	6.08	8.71
SB	Small bowel	1	37	7.11	2.45	4.34	5.9	7.69	11.12
SB	Small bowel	2	28	8.63	4.63	5.56	7.52	12	16.78
XLAP	Laparotomy	0	39	1.71	0	0	1.29	2.19	2.87
XLAP	Laparotomy	1	45	3.08	0	1.14	2.42	3.93	6.7
XLAP	Laparotomy	2	35	4.71	0	1.65	3.82	6.67	10.17
NEPH	Nephrectomy	0,1,2,3	28	1.04	0	0	0.85	2.33	4.98
OGU	Other genitourinary	0	33	0.36	0	0	0.14	0.52	1.3
OGU	Other genitourinary	1	29	0.85	0	0	0.5	1.89	2.36
PRST	Prostatectomy	0	31	0.81	0	0	0	0.79	2.1
PRST	Prostatectomy	1,2,3	25	2.05	0	0	0.93	3.69	4.65
HER	Herniorrhaphy	0	51	0.81	0	0	0.8	2	2.83
HER	Herniorrhaphy	1	53	2.14	0	0.81	1.92	3.66	5.96
HER	Herniorrhaphy	2,3	27	4.53	0	0	3.82	5.76	7.41
MAST	Mastectomy	0	59	1.74	0	0	0.69	1.61	3.04
MAST	Mastectomy	1	53	2.20	0	0.75	2.07	3.8	6.38
CRAN	Craniotomy	0	42	0.91	0	0	0	1.87	3.79
CRAN	Craniotomy	1	70	1.72	0	0	1.04	2.39	4.05
CRAN	Craniotomy	2,3	48	2.40	0	0	1.3	3.45	5.56
ONS	Other nervous system	0,1,2,3	20	1.53	0	0	0	1.75	2.33
VSHN	Ventricular shunt	0	30	4.42	0	0	2.63	4.83	8.17
VSHN	Ventricular shunt	1,2,3	44	5.36	0	1.49	3.45	6.06	8.61
CSEC	Cesarean section	0	130	2.71	0.42	1.26	2.17	4.32	6.74
CSEC	Cesarean section	1	117	4.14	0	1.42	3.19	5.53	8.07
CSEC	Cesarean section	2,3	51	7.53	0	2.42	5.38	10.39	13.62
HYST	Abdominal hysterectomy	0	107	1.36	0	0	0.91	2.18	3.44
HYST	Abdominal hysterectomy	1	100	2.32	0	0.7	1.96	3.33	4.65
HYST	Abdominal hysterectomy	2,3	53	5.17	0	2.06	4.21	8.31	9.93

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Table 6. (Continued)

Operative procedure category		Risk index category	No. hospitals	Pooled mean rate	Percentile				
					10%	25%	50% (median)	75%	90%
VHYS	Vaginal hysterectomy	0,1,2,3	71	1.31	0	0.28	0.91	1.98	3.92
AMP	Limb amputation	0,1,2,3	40	3.50	0	1.27	2.86	5.3	7.41
FUSN	Spinal fusion	0	110	1.04	0	0	0.68	1.38	2.46
FUSN	Spinal fusion	1	114	2.64	0	0.83	2.16	3.5	4.72
FUSN	Spinal fusion	2,3	77	6.35	0	2.34	4.78	7.27	10.19
FX	Open reduction of fracture	0	68	0.79	0	0	0.3	1.16	1.89
FX	Open reduction of fracture	1	76	1.41	0	0	1	1.68	2.47
FX	Open reduction of fracture	2	46	2.81	0	1.02	2.7	4.45	6.4
HPRO	Hip prosthesis	0	162	0.86	0	0	0.5	1.21	2.17
HPRO	Hip prosthesis	1	189	1.65	0	0.36	1.41	2.25	3.33
HPRO	Hip prosthesis	2,3	153	2.52	0	0.75	2.06	3.7	5.63
KPRO	Knee prosthesis	0	162	0.88	0	0	0.66	1.28	2.29
KPRO	Knee prosthesis	1	179	1.28	0	0.29	1.09	1.86	2.86
KPRO	Knee prosthesis	2,3	152	2.26	0	0.74	2.04	3.57	5.94
LAM	Laminectomy	0	133	0.88	0	0	0.59	1.35	2.59
LAM	Laminectomy	1	137	1.35	0	0.49	1.35	1.89	3.05
LAM	Laminectomy	2,3	110	2.46	0	1.09	2.11	3.52	5.22
OMS	Other musculoskeletal	0	44	0.63	0	0	0.34	0.81	1.36
OMS	Other musculoskeletal	1	45	0.94	0	0	0.54	1.39	2.32
OMS	Other musculoskeletal	2,3	23	1.78	0	0.35	1.58	3.51	4.31
OPRO	Other prosthesis	0,1,2,3	29	0.62	0	0	0	0.59	2.2
OES	Other endocrine system	0	20	0.15	0	0	0	0	0.27
OSKN	Other integumentary system	0,1,2,3	29	1.29	0	0.44	1.03	1.73	2.55
SPLE	Splenectomy	0,1,2,3	20	2.80	0	0	2.22	4.41	6.13
TP	Organ transplant	0,1	20	4.63	1.11	2	2.99	5.14	9.66
VS	Vascular	0	70	0.90	0	0	0	1.71	3.28
VS	Vascular	1	110	1.72	0	0.81	1.54	2.66	3.81
VS	Vascular	2,3	103	4.34	1.01	2.98	4.79	6.67	8.38

CBGB, Coronary artery bypass graft with chest and donor site incisions (eg, femoral or radial artery harvested as donor vessel for bypass graft); *CBGC*, coronary artery bypass graft with chest incision only (eg, use of internal mammary artery for bypass graft).

*Per 100 operations.

†Includes only those procedure-risk categories for which at least 20 hospitals have reported at least 20 operations.

were combined into a new category 2,3. Thus, the number of risk index categories in the tables will differ depending upon the operation. For small bowel and organ transplant operations, rates for risk categories 2 and 3 are now reported separately. For digestive tract operations, rates for risk categories 0 and 1 are now reported separately. However, for 3 other operations, fewer risk categories are reported, ie, for appendectomy and gastric operations, categories 2 and 3 are combined, and for colon operations, categories M and 0 are combined. Further, the duration cut point for liver/pancreas operations increased from 4 to 5 hours, and for other eye operations, it increased from 2 to 3 hours.

For a hospital to be represented in Table 6, it must have reported sufficient data, that is, at least 20 operations in a given risk index category for the procedure. Note that the percentile distributions are not available for every operative procedure and risk index category because percentile distributions of the procedure-specific and risk-index-specific rates required sufficient data from at least 20 hospitals.

Laparoscopes and endoscopes are being used with increasing frequency to perform operations. Table 7 lists 4 operations in which the use of a laparoscope has been incorporated into the SSI risk index. When other risk factors were controlled, cholecystectomy, colon operation, gastric operation, and appendectomy had lower SSI rates when a scope was used. However, there were some differences among these operations. For cholecystectomy and colon operations, the influence of scope use was captured by subtracting 1 from the number of risk factors (ASA score ≥ 3; duration of operation $>$75th percentile; or contaminated or dirty wound class) present whenever the procedure was done laparoscopically. ''M'' indicates minus 1 (-1) in the modified risk category, where no risk factors were present and the procedure was performed with a laparoscope (ie, $0 - 1 = -1$). For colon operations, in contrast to the previously published report,[1] there is now no significant difference in the rates between risk category M and 0 and so is displayed as a combined M,0 rate in Table 7. For appendectomy and gastric operation, the use of

Table 7. SSI rates,* by selected operative procedure and modified risk index category incorporating laparoscope use,† Surgical Patient component, January 1992 through June 2004

Operative procedure category	Duration cut point (h)	Risk index category	N	Rate	Risk index category	N	Rate	Risk index category	N	Rate	Risk index category	N	Rate	Risk index category	N	Rate
CHOL Cholecystectomy	2	M	33,789	0.45	0	27,579	0.68	1	12,804	1.78	2	4460	3.27	3	475	5.68
COLO Colon	3	M,0	20,637	3.98	1	33,527	5.66	2	13,777	8.54	3	1876	11.25		—	—
APPY Appendectomy	1	0-Yes	3146	0.67	0-No	8220	1.31	1	11,222	2.55	2,3	4291	4.85		—	—
GAST Gastric	3	0-Yes	732	0.68	0-No	3522	2.58	1	7253	4.69	2,3	3345	8.34		—	—

*Per 100 operations.

†This table uses a modified risk index that incorporates the influence of laparoscope on SSI rates. The influence of scope on SSI rates was different across the 4 procedures: For cholecystectomy and colon operation, when the operation was done laparoscopically, 1 was subtracted from the number of risk factors present (ASA score of 3, 4, or 5; duration of surgery >75th percentile; or contaminated or dirty wound class) in the NNIS risk index. For example, when 2 risk factors were present and the procedure was done laparoscopically, the new modified risk index category is 1 (ie, 2 – 1 = 1). When no risk factors were present and the procedure was performed with a laparoscope (ie, 0 – 1 = −1), we designated this new modified risk category as –1 or "M".

For appendectomy and gastric operations, the use of a scope was important only if the patient had no other risk factors. We split patients with no other risk factors into two groups: 0-Yes (laparoscope used) and 0-No (laparoscope not used).

Table 8. SSI rates* following coronary artery bypass graft (CBGB) operation, by risk index category and specific site, Surgical Patient component, January 1992 through June 2004

Risk index category	0		1		2		3	
Infection site	**No. SSIs**	**Rate**	**No. SSIs**	**Rate**	**No. SSIs**	**Rate**	**No. SSIs**	**Rate**
Leg (Donor Site)	**20**	**0.74**	**5436**	**1.43**	**2024**	**2.45**	**5**	**2.03**
Superficial incisional	15	0.55	4203	1.10	1577	1.91	5	2.03
Deep incisional	5	0.18	1233	0.32	447	0.54	0	0.00
Chest	**14**	**0.51**	**7440**	**1.96**	**2459**	**2.98**	**19**	**7.72**
Superficial incisional	7	0.26	2796	0.74	933	1.13	5	2.03
Deep incisional	4	0.15	2091	0.55	627	0.76	9	3.66
Organ/space	3	0.11	2553	0.67	899	1.09	5	2.03
Total	**34**	**1.25**	**12,876**	**3.39**	**4483**	**5.43**	**24**	**9.76**

Denominators for the risk categories are as follows: Category 0 = 2718; Category 1 = 380,340; Category 2 = 82,535; Category 3 = 246.
*Per 100 operations.

a scope was only important if the patient had no other risk factors. Therefore, we split the index value of 0 risk factors into 0-No and 0-Yes. The percentile distributions of the 4 operative procedures with modified SSI risk index categories have not been developed at this time.

Table 8 displays SSI rates by specific site after coronary artery bypass graft operations in which incisions are made at both the chest and the donor vessel harvest sites.

The data in Tables 9 and 10 are from Phase 3 (January 1998 through November 1999) of the Intensive Care Antimicrobial Resistance Epidemiology (ICARE) Project and the NNIS Antimicrobial Use and Resistance (AUR) component (December 1999 through June 2004) and update previously published reports.[1,16,17] For the purpose of analysis, grams of antimicrobial agents were converted into number of defined daily doses used each month in each hospital area. A defined daily dose is the average daily dose in grams of a specific antimicrobial agent given to an average adult patient (Appendix A).[18,19] Note that unless otherwise indicated, we used the 2004 WHO DDD values,[19] which is different from previous reports. Table 9 shows use of selected oral and parenteral antimicrobial agents in defined daily doses. Antimicrobial use was stratified by route of administration and hospital area. Because outpatient antimicrobial use could not be estimated reliably from hospital pharmacy records, data on outpatient antimicrobial use were not collected. Antimicrobial agents with similar spectrum or clinical indications were grouped and shown in Appendix A. On the basis of detailed analysis, antimicrobial usage rates were found to vary by type of ICU, so usage rates and percentiles are shown for each type of ICU for which there were at least 20 units reporting data. The number of burn and respiratory ICUs reporting usage data is insufficient to include in

Table 9. Pooled means and percentiles of the distribution of antimicrobial usage rates (defined daily dose* rates†), by non-ICU inpatient areas and various types of ICU, ICARE/AUR, January 1998 through June 2004

Non-ICU Inpatient Areas (n = 74)			Percentile				
Antimicrobial agent	**No. DDD***	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
Penicillin group	759,866	60.9	9.2	16.7	28.9	63.8	96.5
Ampicillin group	1,899,047	152.1	83.2	111.1	141.7	186.3	266.9
Antipseudomonal penicillins	251,036	20.1	3.1	8.1	16.4	29.0	42.9
Antistaphylococcal penicillins	245,777	19.7	2.9	5.1	12.5	24.2	35.8
First-generation cephalosporins	982,573	78.7	43.9	57.4	76.1	106.6	125.1
Second-generation cephalosporins	368,970	29.6	10.3	16.5	25.3	41.5	54.9
Third-generation cephalosporins	793,340	63.5	21.9	32.2	53.6	79.5	92.5
Carbapenem group	85,779	6.9	0.4	1.8	4.7	9.4	17.1
Aztreonam	34,078	2.7	0.1	0.7	1.8	4.3	6.4
Fluoroquinolones	1,166,836	93.5	37.9	57.9	91.7	130.3	202.2
Trimethoprim/sulfamethoxazole	595,248	47.7	5.3	14.8	24.5	39.2	106.3
Vancomycin (oral)	38,279	3.1	0.1	0.5	1.4	2.5	4.2
Vancomycin (parenteral)	415,887	33.3	13.1	17.1	24.6	41.0	65.7
Coronary Care Unit (n = 32)			**Percentile**				
Antimicrobial agent	**No. DDD***	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
Penicillin group	4296	30.8	0.0	0.4	7.2	41.7	106.4
Ampicillin group	12,356	88.5	8.6	44.8	88.3	172.1	245.9
Antipseudomonal penicillins	4599	32.9	0.0	3.3	20.8	42.8	58.6
Antistaphylococcal penicillins	3679	26.3	0.0	3.6	12.0	46.2	68.2
First-generation cephalosporins	6978	50.0	9.0	27.7	36.5	54.4	104.9
Second-generation cephalosporins	4286	30.7	1.5	7.1	19.8	32.5	42.4
Third-generation cephalosporins	12,540	89.8	25.1	32.8	73.5	98.0	143.5
Carbapenem group	1635	11.7	0.0	0.2	6.1	12.1	27.4
Aztreonam	777	5.6	0.0	0.0	2.0	10.8	14.9
Fluoroquinolones	12,390	88.7	11.3	27.3	58.9	112.3	214.4
Trimethoprim/sulfamethoxazole	5585	40.0	0.0	6.0	16.5	43.4	112.8
Vancomycin (oral)	526	3.8	0.0	0.0	0.0	1.3	7.0
Vancomycin (parenteral)	7713	55.2	11.2	19.8	36.9	89.3	105.9
Cardiothoracic ICU (n = 21)			**Percentile**				
Antimicrobial agent	**No. DDD***	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
Penicillin group	3736	38.4	0.0	0.0	4.8	40.9	83.0
Ampicillin group	7044	72.4	3.3	16.6	58.5	97.6	143.2
Antipseudomonal penicillins	2139	22.0	1.4	6.3	16.1	32.1	45.4
Antistaphylococcal penicillins	2483	25.5	0.0	0.0	6.4	31.0	38.6
First-generation cephalosporins	25,925	266.6	36.5	210.3	258.7	465.4	697.9
Second-generation cephalosporins	8997	92.5	2.7	6.8	22.7	73.4	470.1
Third-generation cephalosporins	8941	91.9	17.8	32.2	61.8	97.0	151.1
Carbapenem group	1663	17.1	0.0	1.6	11.8	18.9	49.4
Aztreonam	740	7.6	0.0	0.5	1.9	5.3	9.2
Fluoroquinolones	8065	82.9	8.6	23.2	65.5	101.4	187.4
Trimethoprim/sulfamethoxazole	1601	16.5	0.0	0.5	8.8	21.8	43.9
Vancomycin (oral)	557	5.7	0.0	0.0	0.0	2.5	10.7
Vancomycin (parenteral)	12,081	124.2	26.0	45.6	97.0	156.9	210.9
Hematology/Oncology/Transplant Wards (n = 17)			**Percentile**				
Antimicrobial agent	**No. DDD***	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
Penicillin group	3416	27.6	—	—	—	—	—
Ampicillin group	17,578	141.8	—	—	—	—	—
Antipseudomonal penicillins	3,599	29.0	—	—	—	—	—
Antistaphylococcal penicillins	1975	15.9	—	—	—	—	—
First-generation cephalosporins	6017	48.5	—	—	—	—	—
Second-generation cephalosporins	2904	23.4	—	—	—	—	—

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Table 9. (Continued)

Hematology/Oncology/Transplant Wards (n = 17)			Percentile				
Antimicrobial agent	**No. DDD***	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
Third-generation cephalosporins	27,434	221.3	—	—	—	—	—
Carbapenem group	1863	15.0	—	—	—	—	—
Aztreonam	935	7.5	—	—	—	—	—
Fluoroquinolones	20,690	166.9	—	—	—	—	—
Trimethoprim/sulfamethoxazole	4003	32.3	—	—	—	—	—
Vancomycin (oral)	540	4.4	—	—	—	—	—
Vancomycin (parenteral)	10,172	82.1	—	—	—	—	—
Medical ICU (n = 36)			**Percentile**				
Antimicrobial agent	**No. DDD***	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
Penicillin group	11,598	55.1	0.0	4.9	39.1	63.0	97.5
Ampicillin group	46,702	222.0	89.4	135.5	181.4	253.0	345.4
Antipseudomonal penicillins	14,887	70.8	13.1	30.6	60.4	104.0	170.5
Antistaphylococcal penicillins	9368	44.5	0.0	3.5	25.1	43.6	84.9
First-generation cephalosporins	7456	35.4	10.6	19.5	30.7	39.5	70.3
Second-generation cephalosporins	5986	28.5	1.2	7.0	21.7	47.9	67.1
Third-generation cephalosporins	53,488	254.2	58.2	88.8	140.2	199.3	317.3
Carbapenem group	7889	37.5	0.0	8.0	23.2	37.2	98.3
Aztreonam	1995	9.5	0.0	1.5	6.1	11.8	17.7
Fluoroquinolones	35,393	168.2	39.3	82.5	134.0	184.4	307.7
Trimethoprim/sulfamethoxazole	22,058	104.8	0.0	21.6	40.5	91.7	185.3
Vancomycin (oral)	366	1.7	0.0	0.0	0.3	1.8	6.7
Vancomycin (parenteral)	27,921	132.7	42.9	56.9	79.0	156.4	222.1
Medical-surgical ICU (n = 61)			**Percentile**				
Antimicrobial agent	**No. DDD***	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
Penicillin group	21,837	46.5	0.0	2.3	13.6	38.7	113.4
Ampicillin group	94,566	201.4	33.1	79.1	185.0	300.8	376.9
Antipseudomonal penicillins	35,471	75.5	18.2	37.2	61.7	95.4	115.5
Antistaphylococcal penicillins	12,079	25.7	1.4	4.8	13.8	29.3	49.0
First-generation cephalosporins	48,262	102.8	23.9	53.5	76.7	126.6	209.2
Second-generation cephalosporins	16,107	34.3	2.6	6.4	19.0	42.5	91.7
Third-generation cephalosporins	67,688	144.1	61.2	80.4	116.4	163.4	200.6
Carbapenem group	17,727	37.8	3.4	8.2	26.8	47.0	62.9
Aztreonam	4785	10.2	0.0	1.9	6.2	14.0	23.9
Fluoroquinolones	96,695	205.9	55.4	92.8	167.5	301.2	360.3
Trimethoprim/sulfamethoxazole	31,448	67.0	0.0	11.5	24.2	68.6	203.4
Vancomycin (oral)	2868	6.1	0.0	0.0	2.4	5.9	9.3
Vancomycin (parenteral)	40,303	85.8	33.1	53.2	66.7	122.9	143.0
Neurosurgical ICU (n = 11)			**Percentile**				
Antimicrobial agent	**No. DDD***	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
Penicillin group	3294	55.6	—	—	—	—	—
Ampicillin group	6892	116.3	—	—	—	—	—
Antipseudomonal penicillins	2669	45.0	—	—	—	—	—
Antistaphylococcal penicillins	4296	72.5	—	—	—	—	—
First-generation cephalosporins	6949	117.2	—	—	—	—	—
Second-generation cephalosporins	1157	19.5	—	—	—	—	—
Third-generation cephalosporins	7339	123.8	—	—	—	—	—
Carbapenem group	1821	30.7	—	—	—	—	—
Aztreonam	82	1.4	—	—	—	—	—
Fluoroquinolones	5754	97.1	—	—	—	—	—
Trimethoprim/sulfamethoxazole	3835	64.7	—	—	—	—	—
Vancomycin (oral)	74	1.2	—	—	—	—	—
Vancomycin (parenteral)	5923	99.9	—	—	—	—	—

Continued on next page

Table 9. (Continued)

Surgical ICU (n = 37)			Percentile				
Antimicrobial agent	**No. DDD***	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
Penicillin group	17,167	56.3	0.0	8.1	34.7	71.1	109.8
Ampicillin group	63,393	207.8	43.0	100.5	222.5	305.7	445.1
Antipseudomonal penicillins	16,711	54.8	10.1	31.0	49.4	80.7	102.2
Antistaphylococcal penicillins	9107	29.9	0.7	2.9	17.9	35.6	88.4
First-generation cephalosporins	54,317	178.1	38.9	101.2	157.0	365.5	498.0
Second-generation cephalosporins	8081	26.5	3.4	12.8	29.4	47.4	69.2
Third-generation cephalosporins	45,082	147.8	34.4	71.3	99.9	116.7	180.7
Carbapenem group	15,383	50.4	1.0	10.3	19.6	54.9	74.6
Aztreonam	1780	5.8	0.4	4.1	7.1	11.5	19.3
Fluoroquinolones	46,268	151.7	52.2	73.5	131.2	211.0	291.1
Trimethoprim/sulfamethoxazole	22,816	74.8	5.3	10.0	23.9	54.8	179.9
Vancomycin (oral)	1272	4.2	0.0	0.0	0.8	3.1	11.3
Vancomycin (parenteral)	48,435	158.8	45.4	65.9	99.1	155.3	196.0
Pediatric ICU (n = 16)			**Percentile**				
Antimicrobial agent	**No. DDD***	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
Penicillin group	2162	41.6	—	—	—	—	—
Ampicillin group	4818	92.7	—	—	—	—	—
Antipseudomonal penicillins	575	11.1	—	—	—	—	—
Antistaphylococcal penicillins	1829	35.2	—	—	—	—	—
First-generation cephalosporins	2531	48.7	—	—	—	—	—
Second-generation cephalosporins	1690	32.5	—	—	—	—	—
Third-generation cephalosporins	7564	145.6	—	—	—	—	—
Carbapenem group	421	8.1	—	—	—	—	—
Aztreonam	90	1.7	—	—	—	—	—
Fluoroquinolones	668	12.8	—	—	—	—	—
Trimethoprim/sulfamethoxazole	908	17.5	—	—	—	—	—
Vancomycin (oral)	160	3.1	—	—	—	—	—
Vancomycin (parenteral)	3329	64.1	—	—	—	—	—

*Defined daily dose (DDD) of antimicrobial agent is calculated by dividing the total grams of the antimicrobial agent used in a hospital area by the number of grams in an average daily dose of the agent given to an adult patient.

†$\text{DDD per 1000 patient-days} = \frac{\text{DDD of specific agent used}}{\text{Total number of patient-days}} \times 1000$

the table. The number of neurosurgical and pediatric ICUs and hematology/oncology/transplant wards is insufficient to provide percentile distributions; only pooled mean usage rates are displayed. Table 10 shows ICARE/AUR resistance data for selected antimicrobial-resistant bacteria on the basis of reported antimicrobial susceptibility test results on all non-duplicate clinical isolates processed by the laboratory during each study month. A duplicate isolate was defined as an isolate of the same species of bacteria with the same antimicrobial susceptibility pattern in the same patient in the same month, regardless of the site of isolation. All isolates, whether responsible for hospital-acquired or community-acquired infection or for colonization, were reported to ICARE/AUR by participating hospitals. Hospitals used National Committee for Clinical Laboratory Standards interpretive standards for minimum inhibitory concentration, or zone diameter testing standards to report numbers of susceptible, intermediate, or resistant organisms. A minimum of 10 isolates must be tested in a hospital area for resistance rates to be calculated for that area. Resistance data have been combined for all ICU types because detailed analysis demonstrated that, in general, resistance rates (percent prevalence) did not differ by type of ICU. Also, these data show that for most antimicrobial-resistant bacteria, resistance rates are highest in the ICU areas, followed by non-ICU inpatient areas, with lowest rates in the outpatient areas.

If you would like to compare your hospital's rates and ratios with those in this report, you must first collect information from your hospital in accordance with the methods described for the NNIS System.[5-7] You should also refer to Appendices B and C for further instructions. Appendix B discusses the calculation of infection rates and DU ratios for the ICU or HRN surveillance components. Appendix C gives a step-by-step method for interpretation of percentiles of infection rates or DU ratios. A high rate or ratio (>90th percentile) does not necessarily define a problem; it

Table 10. Pooled means and percentiles of the distribution of antimicrobial resistance rates*, by all ICUs combined, non-ICU inpatient units and by outpatients, ICARE/AUR, January 1998 through June 2004

All ICUs combined				**Percentile**				
Antimicrobial-resistant pathogen	**No. units**	**No. tested**	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
MRSA	157	22,899	52.90	20.0	32.7	48.1	60.3	67.9
Methicillin-resistant CNS	141	13,553	76.60	57.0	69.4	76.3	83.8	88.4
Vancomycin-resistant *Enterococcus* spp	140	14,140	13.90	0	5	13.6	24.3	39.2
Ciprofloxacin/ofloxacin-resistant *Pseudomonas aeruginosa*	134	13,473	34.80	8.3	17.4	29.3	41.3	51.6
Levofloxacin-resistant *P aeruginosa*	68	5895	35.30	9.7	18.2	29.1	40.8	47.7
Imipenem-resistant *P aeruginosa*	123	11,986	19.10	4.8	8.3	13.2	25.5	38
Ceftazidime-reisistant *P aeruginosa*	129	12,805	13.90	0	5	10.8	16.9	23.6
Piperacillin-resistant *P aeruginosa*	118	11,640	17.50	2.4	7.5	14.3	19.5	31.4
Cef3-resistant *Enterobacter* spp	111	5328	27.70	10.0	17.4	26.1	36.4	47.4
Carbapenem-resistant *Enterobacter* spp	93	4663	0.70	0	0	0	0	3.8
Cef3-resistant *Klebsiella pneumoniae*	119	7529	6.20	0	0	2.0	8.0	20.7
Cef3-resistant *Escherichia coli*	140	12,011	1.30	0	0	0	2.6	6.5
Quinolone-resistant *E coli*	136	11,776	7.30	0	0	3.3	8.2	19.4
Penicillin-resistant pneumococci	46	1331	18.90	0	5.3	13	24.0	50.0
Cefotaxime/ceftriaxone-resistant pneumococci	33	854	7.50	0	0	3.4	9.6	28.0
Non-ICU Inpatient Areas				**Percentile**				
Antimicrobial-resistant pathogen	**No. units**	**No. tested**	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
MRSA	56	42,502	46.00	25.6	31.9	44.9	52.0	60.8
Methicillin-resistant CNS	53	23,525	65.70	52.2	57.1	65.2	71.1	75.9
Vancomycin-resistant *Enterococcus* spp	55	32,924	12.00	1.9	3.5	7.1	14.2	18.6
Ciprofloxacin/ofloxacin-resistant *Pseudomonas aeruginosa*	55	21,302	27.70	13	20.5	27.4	36.8	40.6
Levofloxacin-resistant *P aeruginosa*	30	10,077	30.50	15.6	21.8	28.7	33.3	44.1
Imipenem-resistant *P aeruginosa*	53	17,142	12.30	5.6	6.8	10.0	14.4	20.6
Ceftazidime-reisistant *P aeruginosa*	53	19,587	8.80	1.9	4.0	7.0	11.0	14.1
Piperacillin-resistant *P aeruginosa*	53	16,828	11.60	3.4	6.5	9.2	14.0	18.3
Cef3-resistant *Enterobacter* spp	50	7509	21.00	7.7	13.9	20.7	25.7	30.9
Carbapenem-resistant *Enterobacter* spp	46	5976	1.00	0	0	0	1.2	3.2
Cef3-resistant *Klebsiella pneumoniae*	55	14,204	5.80	0	0.2	1.5	4.4	14.5
Cef3-resistant *Escherichia coli*	55	40,751	1.50	0	0	0.6	1.7	3.2
Quinolone-resistant *E coli*	56	40,694	8.20	0.4	1.8	3.6	7.0	18.9
Penicillin-resistant pneumococci	41	3629	18.20	2.6	5.9	12.0	20.0	31.8
Cefotaxime/ceftriaxone-resistant pneumococci	34	2148	7.60	0	0.9	5.2	10.5	16.3
Outpatient Areas				**Percentile**				
Antimicrobial-resistant pathogen	**No. units**	**No. tested**	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
MRSA	49	35,489	31.10	15.0	19.3	24.6	30.8	49.7
Methicillin-resistant CNS	48	16,054	50.20	38.5	43.1	48.9	57.8	61.5
Vancomycin-resistant *Enterococcus* spp	46	24,840	4.60	0.8	1.3	3.6	6.1	9.3
Ciprofloxacin/ofloxacin-resistant *Pseudomonas aeruginosa*	47	14,881	23.40	13.0	17.0	23.1	34.1	39
Levofloxacin-resistant *P aeruginosa*	24	6388	24.50	12.5	15.1	20.3	30.7	34.8
Imipenem-resistant *P aeruginosa*	46	11,769	7.00	3.0	4.0	6.4	9.2	13
Ceftazidime-reisistant *P aeruginosa*	46	13,407	4.60	0	2.3	4.3	6.3	7.9
Piperacillin-resistant *P aeruginosa*	43	11,281	6.00	0	1.9	4.8	6.7	10.9
Cef3-resistant *Enterobacter* spp	43	5941	9.60	2.3	6.0	10.4	14.5	17.7
Carbapenem-resistant *Enterobacter* spp	39	4054	0.50	0	0	0	0.2	2.5
Cef3-resistant *Klebsiella pneumoniae*	45	16,260	1.80	0	0	0.8	1.8	6.0
Cef3-resistant *Escherichia coli*	49	96,267	0.60	0	0	0.2	0.6	1.6
Quinolone-resistant *E coli*	48	92,931	3.60	0.2	1.1	2.0	3.0	7.3
Penicillin-resistant pneumococci	41	4607	16.80	3.0	5.9	10.0	20.5	28.6
Cefotaxime/ceftriaxone-resistant *pneumococci*	36	3272	4.80	0	0	2.0	7.5	26.3

MRSA, Methicillin-resistant *Staphylococcus aureus*; *CNS,* coagulase-negative staphylococci; *Cef3*, ceftazidime, cefotaxime, or ceftriaxone; *Quinolone,* ciprofloxacin, ofloxacin, or levofloxacin; *Carbapenem,* imipenem or meropenem.

*For each antimicrobial agent and pathogen combination, resistance rates were calculated as:

$$\frac{\text{Number of resistant isolates}}{\text{Number of isolates tested}} \times 100$$

only suggests an area for further investigation. Similarly, a low rate or ratio (<10th percentile) may be the result of inadequate infection detection.

Hospitals should use these data to guide local improvement efforts aimed at reducing infection rates as much as possible.

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Appendix A. Defined daily dose (DDD) of antimicrobial agents, by class and group

Class	Group	Antimicrobial Agent	DDD
β-lactams	Penicillin group	Penicillin G	1.2×10^6 U*
		Procaine Penicillin G	2.4×10^6 U*
		Penicillin G benzathine	1.2×10^6 U*
		Penicillin V	1g*
	Ampicillin group	Ampicillin (parenteral)	2g
		Ampicillin (oral)	2g
		Ampicillin/sulbactam	2g
		Amoxicillin (oral)	1g
		Amoxicillin/Clavulanic Acid (oral)	1g
	Antistaphylococcal penicillins (Methicillin group)	Nafcillin	4g*
		Oxacillin	2g
		Dicloxacillin (oral)	2g
	Antipseudomonal penicillins	Piperacillin	14g
		Piperacillin/Tazobactam	14g
		Ticarcillin	15g
		Ticarcillin/Clavulanic Acid	15g
	First-generation cephalosporins	Cefazolin	3g
		Cephalothin	4g
		Cefadroxil (oral)	2g
		Cephalexin (oral)	2g
	Second-generation cephalosporins	Cefotetan	4g
		Cefmetazole	4g*
		Cefoxitin	6g

Continued on next page

Appendix A. (Continued)

Class	Group	Antimicrobial Agent	DDD
		Cefuroxime	3g
		Cefuroxime axetil (oral)	1g*
		Cefaclor (oral)	1g
		Cefprozil (oral)	1g
	Third-generation cephalosporins	Cefotaxime	4g
		Ceftazidime	4g
		Ceftizoxime	4g
		Ceftriaxone	2g
		Cefixime (oral)	0.4g
		Cefipime	2g
	Carbapenems	Meropenem	2g
		Imipenem cilastatin	2g
Other β -lactams		Aztreonam	4g
Glycopeptides		Vancomycin (parenteral)	2g
		Vancomycin (oral)	1g*
Fluoroquinolones		Ciprofloxacin (parenteral)	0.5g
		Ciprofloxacin (oral)	1g
		Ofloxacin (parenteral)	0.4g
		Ofloxacin (oral)	0.4g
		Levofloxacin (parenteral)	0.5g
		Levofloxacin (oral)	0.5g
		Trovafloxacin (parenteral)	0.2g
		Trovafloxacin (oral)	0.2g
		Sparfloxacin (oral)	0.2g
		Norfloxacin (oral)	0.8g
		Lomefloxacin	0.4g*
Trimethoprim/Sulfamethoxazole		Trimethoprim component (oral)	0.4g
		Trimethoprim compound (parenteral)	0.4g

DDD for those agents marked with an asterisk (*) are adapted from Amsden GW, Schentag JJ. Tables of antimicrobial agent pharmacology. In: Mandell GL, Bennett JE, Dolin R, editors. Principles and practice of infectious diseases. 4th ed. New York: Churchill Livingstone; 1995. p. 492-528. All other DDD are from: WHO Collaborating Centre for Drug Statistics Methodology. Anatomical Therapeutic Chemical (ATC) classification index with defined daily doses (DDD). 2004. Available from: http://www.whocc.no/atcddd/.

Appendix B.

HOW TO CALCULATE A DEVICE-ASSOCIATED INFECTION RATE AND DEVICE UTILIZATION RATIO WITH ICU AND HRN COMPONENT DATA

Calculation of Device-associated Infection Rate

Step 1: Decide on the time period for your analysis. It may be a month, a quarter, 6 months, a year, or some other period.

Step 2: Select the patient population for analysis, ie, the type of ICU or a birthweight category in the HRN.

Step 3: Select the infections to be used in the numerator. They must be site-specific and must have occurred in the selected patient population. Their date of onset must be during the selected time period.

Step 4: Determine the number of device-days which is used as the denominator of the rate. Device-days are the total number of days of exposure to the device (central line, ventilator, or urinary catheter) by all of the patients in the selected population during the selected time period.

Example: Five patients on the first day of the month had one or more central lines in place: 5 on day 2; 2 on day 3; 5 on day 4; 3 on day 5; 4 on day 6; and 4 on day 7. Adding the number of patients with central lines on days 1 through 7, we would have 5 + 5 + 2 +5 + 3 + 4 + 4 = 28 central line-days for the first week. If we continued for the entire month, the number of central line-days for the month is simply the sum of the daily counts.

Step 5: Calculate the device-associated infection rate (per 1000 device-days) using the following formula:

$$\text{Device-associated infection rate} = \frac{\text{Number of device-associated infections for a specific site}}{\text{Number of device-days}} \times 1000$$

Example:

$$\text{Central line-associated bloodstream infection rate} = \frac{\text{Number of central line-associated bloodstream infections}}{\text{Number of central line-days}} \times 1000$$

Calculation of DU Ratio

Steps 1,2,4: Same as that for device-associated infection rates, plus determine the number of patient-days which is used as the denominator of the DU ratio. Patient-days are the total number of days that patients are in the ICU (or HRN) during the selected time period. *Example*: Ten patients were in the unit on the first day of the month; 12 on day 2; 11 on day 3; 13 on day 4; 10 on day 5; 6 on day 6; and 10 on day 7; and so on. If we counted the patients in the unit from days 1 through 7, we would add 10 + 12 + 11 + 13 + 10 + 6 + 10 for a total of 72 patient-days for the first week of the month. If we continued for the entire month, the number of patient-days for the month is simply the sum of the daily counts.
Step 5: Calculate the DU ratio with the following formula:

$$\text{DU ratio} = \frac{\text{Number of device-days}}{\text{Number of patient-days}}$$

With the number of device-days and patient-days from the examples above, DU = 28/72 = 0.39 or 39% of patient-days were also central line-days for the first week of the month.
Step 6: Examine the size of the denominator for your hospital's rate or ratio. Rates or ratios may not be good estimates of the true rate or ratio for your hospital if the denominator is small, ie, <50 device-days or patient-days.
Step 7: Compare your hospital's ICU/HRN rates or ratios with those found in the tables of this report. Refer to Appendix C for interpretation of the percentiles of the rates/ratios.

Appendix C.

INTERPRETATION OF PERCENTILES OF INFECTION RATES OR DEVICE UTILIZATION RATIOS

Step 1: Evaluate the rate (ratio) you have calculated for your hospital and confirm that the variables in the rate (both numerator and denominator) are identical to the rates (ratios) in the table.
Step 2: Examine the percentiles in each of the tables and look for the 50th percentile (or median). At the 50th percentile, 50% of the hospitals have lower rates (ratios) than the median and 50% have higher rates (ratios).
Step 3: Determine if your hospital's rate (ratio) is above or below this median.

Determining whether your hospital's rate or ratio is a HIGH outlier

Step 4: If it is above the median, determine whether the rate (ratio) is above the 75th percentile. At the 75th percentile, 75% of the hospitals had lower rates (ratios) and 25% of the hospital had higher rates (ratios).
Step 5: If the rate (ratio) is above the 75th percentile, determine whether it is above the 90th percentile. If it is, then the rate (ratio) is a high outlier which *may* indicate a problem.

Determining whether your hospital's rate or ratio is a LOW outlier

Step 6: If it is below the median, determine whether the rate (ratio) is below the 25th percentile. At the 25th percentile, 25% of the hospitals had lower rates (ratios) and 75% of the hospitals had higher rates (ratios).
Step 7: If the rate (ratio) is below the 25th percentile, determine whether it is below the 10th percentile. If the rate is, then it is a low outlier which may be due to underreporting of infections. If the ratio is below the 10th percentile, it is a low outlier and may be a result of infrequent DU, short duration of DU, or both.
Note: Device-associated infection rates and device utilization ratios should be examined together so that preventive measures may be appropriately targeted. For example, you find that the ventilator-associated pneumonia rate for a certain type of ICU is consistently above the 90th percentile and the ventilator utilization ratio is routinely between the 75th and 90th percentile. Since the ventilator is a significant risk factor for pneumonia, you may want to target your efforts on reducing the use of ventilators or limiting the duration with which they are used on patients in order to lower the ventilator-associated pneumonia rate in the unit.

Appendix D

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