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National Nosocomial Infections Surveillance (NNIS) System Report, data summary from January 1992 through June 2003, issued August 2003

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 2003 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 more than 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 Centers for Disease Control Prevention 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 for patients located in ICUs, and 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.

*See Appendix D.
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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.

Tables 1 and 2 from the ICU component update previously published device-associated rates and

Table 1. Pooled means and percentiles of the distribution of device-associated infection rates, by type of ICU, ICU component, January 1995 through June 2003*

Urinary catheter-associated UTI rate†				**Percentile**				
Type of ICU	**No. of units**	**Urinary catheter-days**	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
Burn	21	91,739	8.5	0.3	4.5	7.3	10.0	11.6
Coronary	114	567,232	5.4	0.7	2.7	4.7	8.2	10.7
Cardiothoracic	71	655,566	3.1	0.6	1.2	2.5	3.7	5.5
Medical	142	1,399,462	6.2	2.4	3.7	5.5	7.6	9.8
Medical-surgical								
Major teaching	132	1,356,490	5.3	1.7	2.9	4.9	6.8	9.2
All others	186	2,088,460	3.8	0.7	1.9	3.5	5.3	7.0
Neurosurgical	52	329,201	7.7	2.1	4.2	6.7	9.5	12.9
Pediatric	75	301,096	4.7	0	2.3	4.3	6.5	7.9
Surgical	161	1,640,514	5.1	1.2	2.6	4.4	7.0	9.0
Trauma	28	250,258	6.4	3.7	5.2	6.7	8.1	9.3
Respiratory	9	53,835	5.5	—	—	—	—	—

Central line-associated BSI rate‡				**Percentile**				
Type of ICU	**No. of units**	**Central line-days**	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
Burn	21	82,294	8.5	0	3.8	7.3	13.0	18.1
Coronary	114	363,976	4.2	0	1.9	4.2	5.8	8.4
Cardiothoracic	71	598,118	2.9	0.4	1.3	2.2	3.5	4.9
Medical	143	975,318	5.7	2.1	3.4	5.0	6.8	9.6
Medical-surgical								
Major teaching	133	936,223	5.0	2.2	3.0	4.9	6.3	7.7
All others	187	1,295,477	3.7	0	1.8	3.3	5.0	6.8
Neurosurgical	52	180,581	4.8	0	2.5	4.1	6.5	9.0
Pediatric	79	428,104	7.3	0.7	3.8	5.9	8.8	11.5
Surgical	160	1,267,959	5.2	1.1	2.6	4.7	6.9	9.3
Trauma	28	178,179	7.8	2.5	5.2	6.6	10.0	12.3
Respiratory	9	33,688	3.4	—	—	—	—	—

Ventilator-associated pneumonia rate*§				**Percentile**				
Type of ICU	**No. of units**	**Ventilator-days**	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
Burn	15	9394	9.6	—	—	—	—	—
Coronary	49	30,586	4.2	0	0	3.1	6.4	11.2
Cardiothoracic	43	36,871	7.9	0	2.4	5.1	11.8	15.6
Medical	82	111,764	5.0	0	1.9	3.6	6.7	9.6
Medical-surgical								
Major teaching	85	115,900	5.8	0	2.8	4.9	7.8	12.1
All others	100	138,716	6.0	0	3.1	5.6	7.8	11.2
Neurosurgical	25	19,149	12.9	1.7	5.3	9.6	17.4	19.4
Pediatric	45	49,239	2.9	0	0	2.2	4.3	9.0
Surgical	86	107,162	9.9	2.2	5.1	8.3	13.8	18.4
Trauma	17	23,179	15.1	—	—	—	—	—
Respiratory	5	7829	4.2	—	—	—	—	—

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

*Ventilator-associated pneumonia data are for January 2002 through June 2003 only.

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

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

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

Table 2. Pooled means and percentiles of the distribution of device utilization ratios by type of ICU, ICU component, January 1995 through June 2003

Urinary catheter utilization*				Percentile				
Type of ICU	No. of units	Patient-days	Pooled mean	10%	25%	50% (median)	75%	90%
Burn	21	160,022	0.57	0.29	0.33	0.57	0.70	0.90
Coronary	114	1,120,967	0.51	0.26	0.40	0.51	0.63	0.72
Cardiothoracic	71	751,547	0.87	0.70	0.78	0.89	0.95	0.96
Medical	142	1,905,674	0.73	0.54	0.65	0.75	0.81	0.87
Medical-surgical								
Major teaching	133	1,688,840	0.80	0.58	0.74	0.81	0.87	0.91
All others	186	2,770,191	0.75	0.57	0.68	0.76	0.82	0.87
Neurosurgical	52	401,236	0.82	0.49	0.72	0.83	0.91	0.94
Pediatric	81	936,169	0.32	0.12	0.19	0.28	0.38	0.45
Surgical	161	1,958,691	0.84	0.66	0.77	0.85	0.91	0.95
Trauma	28	280,074	0.89	0.70	0.87	0.93	0.97	0.98
Respiratory	9	74,113	0.73	—	—	—	—	—

Central line utilization†				Percentile				
Type of ICU	No. of units	Patient-days	Pooled mean	10%	25%	50% (median)	75%	90%
Burn	21	160,022	0.51	0.18	0.22	0.50	0.58	0.75
Coronary	115	1,120,967	0.32	0.13	0.21	0.29	0.42	0.58
Cardiothoracic	71	751,547	0.80	0.57	0.70	0.82	0.91	0.95
Medical	143	1,905,674	0.51	0.30	0.37	0.52	0.64	0.75
Medical-surgical								
Major teaching	133	1,688,840	0.55	0.35	0.45	0.55	0.64	0.73
All others	187	2,770,191	0.47	0.25	0.34	0.47	0.57	0.63
Neurosurgical	52	401,236	0.45	0.26	0.38	0.49	0.55	0.63
Pediatric	82	936,169	0.46	0.20	0.30	0.41	0.53	0.60
Surgical	160	1,958,691	0.65	0.44	0.55	0.67	0.76	0.86
Trauma	28	280,074	0.64	0.47	0.57	0.65	0.75	0.85
Respiratory	9	74,113	0.45	—	—	—	—	—

Ventilator utilization‡				Percentile				
Type of ICU	No. of units	Patient-days	Pooled mean	10%	25%	50% (median)	75%	90%
Burn	21	160,022	0.33	0.07	0.14	0.25	0.43	0.66
Coronary	113	1,120,967	0.22	0.08	0.13	0.21	0.29	0.38
Cardiothoracic	71	751,547	0.46	0.28	0.37	0.47	0.53	0.59
Medical	143	1,905,674	0.48	0.24	0.35	0.47	0.59	0.67
Medical-surgical								
Major teaching	133	1,688,840	0.46	0.26	0.35	0.42	0.54	0.64
All others	187	2,770,191	0.36	0.21	0.27	0.35	0.43	0.50
Neurosurgical	52	401,236	0.38	0.20	0.28	0.36	0.45	0.52
Pediatric	83	936,169	0.43	0.17	0.30	0.39	0.47	0.57
Surgical	160	1,958,691	0.46	0.23	0.34	0.46	0.55	0.66
Trauma	28	280,074	0.58	0.38	0.51	0.58	0.70	0.76
Respiratory	9	74,113	0.57	—	—	—	—	—

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

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

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

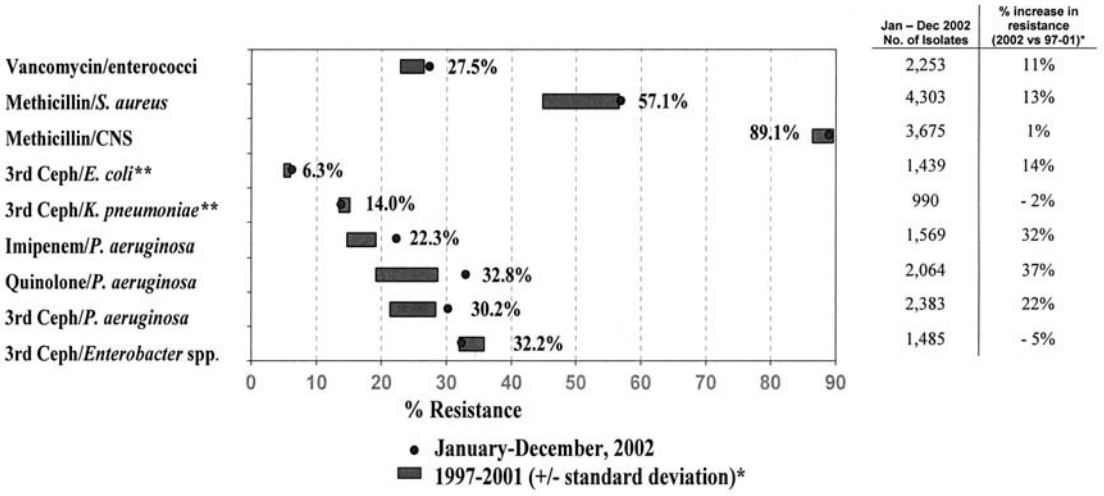

Fig 1. Selected antimicrobial-resistant pathogens associated with nosocomial infections in ICU patients, comparison of resistance rates from January to December 2002 with 1997-2001, NNIS System. *CNS*, Coagulase-negative staphylococci, *3rd Ceph*, resistance to 3rd generation cephalosporins (either ceftriaxone, cefotaxime, or ceftazidime), Quinolone, resistance to either ciprofoxacin or ofloxacin. *Percent (%) increase in resistance rate of current year (January-December 2002) compared with mean rate of resistance over previous 5 years (1997-2001): [(2002 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.

device utilization (DU) ratios by type of ICU.[1,2] 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 respiratory ICUs is still 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 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, except for the ventilator-associated pneumonia rate. Teaching affiliation was not an important factor for any other type of ICU.

It is important to note that the ventilator-associated pneumonia rates include only data from January 2002 through June 2003, because in January 2002, NNIS hospitals began using new criteria for defining nosocomial pneumonia. For the first time, there were sufficient data to report the percentile distribution of the rates for each type of ICU except burn, trauma, and respiratory (Table 1). Because the definitions of ventilator-days did not change, we used all data available during the period January 1995 through June 2003 to calculate the ventilator utilization ratios shown in Table 2.

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 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 2002 is displayed. Next to or overlapping this point is the average rate of resistance (±1SD) during the previous 5-year period (shaded bars). Finally, the number of isolates tested from January through December 2002, and the percentage increase in the resistance rate during 2002 compared with the previous 5 years, are shown in the 2 columns to the right of the graph. The continuing

Table 3. Pooled means and percentiles of the distribution of device-associated infection rates, by birth-weight category, HRN component, January 1995 through June 2003*

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	143	638,319	10.6	4.1	7.4	10.3	13.3	17.0
1001-1500 g	141	308,723	6.4	1.9	4.4	6.3	9.5	12.7
1501-2500 g	137	240,109	4.1	0	1.5	3.7	6.0	9.0
>2500 g	141	329,503	3.7	0	1.2	2.8	4.8	7.3
Ventilator-associated pneumonia rate*‡				**Percentile**				
Birth-weight category	No. of HRNs	Ventilator-days	Pooled mean	10%	25%	50% (median)	75%	90%
≤1000	96	111,823	3.3	0	0	2.0	5.2	9.3
1001-1500 g	84	27,602	2.5	0	0	0	3.1	8.5
1501-2500 g	78	20,580	2.1	0	0	0	0	6.9
>2500 g	78	28,931	1.4	0	0	0	0.4	4.3

BSI, Bloodstream infection.

*Ventilator-associated pneumonia data are for January 2002 through June 2003 only.

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

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

Table 4. Pooled means and percentiles of the distribution of device utilization ratios by birth-weight category, HRN component, January 1995 through June 2003

Umbilical and central line use ratio*				Percentile				
Birth-weight category	No. of HRNs	Patient-days	Pooled mean	10%	25%	50% (median)	75%	90%
≤1000 grams	146	1,529,060	0.42	0.21	0.29	0.41	0.56	0.62
1001-1500 g	147	1,061,575	0.29	0.10	0.16	0.26	0.40	0.56
1501-2500 g	148	1,171,026	0.21	0.05	0.09	0.15	0.32	0.45
>2500 g	148	1,071,697	0.31	0.07	0.14	0.23	0.41	0.56
Ventilator use ratio†				**Percentile**				
Birth-weight category	No. of HRNs	Patient-days	Pooled mean	10%	25%	50% (median)	75%	90%
≤1000 g	146	1,529,060	0.42	0.25	0.30	0.41	0.49	0.62
1001-1500 g	147	1,061,575	0.17	0.08	0.10	0.15	0.23	0.36
1501-2500 g	148	1,171,026	0.12	0.03	0.06	0.09	0.16	0.32
>2500 g	148	1,071,697	0.19	0.04	0.07	0.13	0.25	0.33

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

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

increase in antimicrobial resistance in US hospitals remains a concern. Of note, the proportion of *Staphylococcus aureus* isolates that were resistant to methicillin, oxacillin, or nafcillin continues to increase, and is more than 55%. However, the rate of increase has diminished for several pathogens, including vancomycin-resistant *Enterococcus*, which was reported as +31% in 2000 compared with +11% in 2002.[14] Although these data are limited to patients in ICUs, they are not 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

Table 5. SSI rates,* by operative procedure and risk index category, Surgical Patient component, January 1992 through June 2003

Operative procedure category		Duration cut point (h)	Risk index category	N	Rate
CARD	Cardiac	5	0	1998	0.70
CBGB	CABG-chest and donor site	5	0	2458	1.18
CBGC	CABG-chest only	4	0	150	0
OCVS	Other cardiovascular	2	0,1	10,013	0.57
ORES	Other respiratory	2	0,1,2,3	1670	2.51
THOR	Thoracic	3	0	1378	0.36
BILI	Liver/pancreas	4	0	402	2.99
OGIT	Other digestive	2	0,1	3590	2.67
SB	Small bowel	3	0	1586	5.17
XLAP	Laparotomy	2	0	6020	1.76
NEPH	Nephrectomy	4	0,1,2,3	3427	1.11
OGU	Other genitourinary	2	0	13,084	0.37
PRST	Prostatectomy	4	0	2603	0.81
HN	Head and neck	7	0	609	2.30
OENT	Other ENT	3	0	2743	0.07
HER	Herniorrhaphy	2	0	11,215	0.79
MAST	Mastectomy	3	0	14,935	1.81
CRAN	Craniotomy	4	0	4312	0.86
ONS	Other nervous system	4	0,1,2,3	2252	1.51
VSHN	Ventricular shunt	2	0	3747	4.22
CSEC	Cesarean section	1	0	137,885	2.82
HYST	Abdominal hysterectomy	2	0	44,786	1.37
OOB	Other obstetric	1	0,1,2,3	1282	0.47
VHYS	Vaginal hysterectomy	2	0,1,2,3	26,549	1.22
AMP	Limb amputation	2	0,1,2,3	9959	3.62
FUSN	Spinal fusion	4	0	42,824	1.10
FX	Open reduction of fracture	2	0	15,097	0.77
HPRO	Hip prosthesis	2	0	36,668	0.88
KPRO	Knee prosthesis	2	0	53,759	0.87
LAM	Laminectomy	2	0	64,547	0.92
OMS	Other musculoskeletal	3	0	17,311	0.61
OPRO	Other prosthesis	3	0,1,2,3	3467	0.66
OBL	Other hem/lymph system	3	0,1,2,3	1017	1.97
OES	Other endocrine system	3	0	2350	0.17
OEYE	Other eye	2	0,1,2,3	571	0.70
OSKN	Other integumentary system	2	0,1,2,3	8909	1.29
SKGR	Skin graft	3	0	1152	0.95
SPLE	Splenectomy	3	0,1,2,3	1500	2.93
TP	Organ transplant	6	0,1	4412	4.53
VS	Vascular	3	0	7356	0.91

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.

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 in the ICUs, the ventilator-associated pneumonia rates for HRN include only data from January 2002 through June 2003 because of the definition changes. 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

Risk index category	N	Rate	Risk index category	N	Rate	Risk index category	N	Rate
1	43,488	1.50	2,3	13,287	2.21		—	—
1	340,225	3.45	2	72,723	5.51	3	215	10.23
1	14,333	2.20	2,3	5880	3.88		—	—
2	3555	1.29	3	138	3.62		—	—
	—	—		—	—		—	—
1	4819	1.02	2,3	1735	2.48		—	—
1,2,3	1606	7.35		—	—		—	—
2,3	1011	6.03		—	—		—	—
1	3699	7.49	2,3	2232	9.23		—	—
1	7360	3.11	2	4066	4.82	3	887	7.22
	—	—		—	—		—	—
1	7244	0.90	2,3	1771	2.99		—	—
1,2,3	2224	2.20		—	—		—	—
1	899	5.23	2,3	382	12.57		—	—
1	1274	0.78	2,3	274	2.55		—	—
1	7316	2.08	2,3	1751	4.40		—	—
1	9609	2.20	2,3	981	3.26		—	—
1	13,012	1.65	2,3	4047	2.32		—	—
	—	—		—	—		—	—
1,2,3	10,483	5.39		—	—		—	—
1	40,932	4.21	2,3	4131	7.65		—	—
1	21,593	2.28	2,3	4460	5.34		—	—
	—	—		—	—		—	—
	—	—		—	—		—	—
	—	—		—	—		—	—
1	24,873	2.76	2,3	6621	6.30		—	—
1	24,464	1.38	2	4737	2.68	3	497	4.63
1	59,390	1.61	2,3	15,967	2.49		—	—
1	60,090	1.26	2,3	14,659	2.22		—	—
1	47,354	1.39	2,3	15,316	2.49		—	—
1	12,322	0.94	2,3	3609	1.72		—	—
	—	—		—	—		—	—
	—	—		—	—		—	—
1,2,3	1813	0.83		—	—		—	—
	—	—		—	—		—	—
	—	—		—	—		—	—
1	1940	1.75	2,3	1370	4.53		—	—
	—	—		—	—		—	—
2,3	1673	14.52		—	—		—	—
1	64,404	1.73	2,3	25,856	4.42		—	—

category. For example, because the SSI rates for cardiac operation with 2 or 3 risk factors were similar, the data were combined into a new category 2,3. Thus, the number of risk index categories in the tables will differ depending on the operation. For coronary artery bypass graft with chest and vessel donor site incision operations and gastric operation, rates for risk categories 2 and 3 are now reported separately. However, for 2 other operations, fewer risk categories are reported, ie, prostatectomy changed from category 1 and 2,3 to a combined 1,2,3 category, and splenectomy changed from 0 and 1,2,3 to a combined single 0,1,2,3 category.

The duration of operation cut points have changed from the last published report[1] for 3 operations: limb amputation, which changed from 1 to 2 hours; other digestive system, from 3 to 2 hours; and splenectomy, 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.

Table 6. Percentiles of the distribution of SSI rates,* by operative procedure and risk index category,† Surgical Patient component, January 1992 through June 2003

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	0.44	1.14	1.74	2.79
CARD	Cardiac	2,3	85	2.21	0	0	1.28	3.01	4.93
CBGB	CABG-chest and donor	0	30	1.18	0	0	0.88	2.20	3.23
CBGB	CABG-chest and donor	1	182	3.45	1.41	2.19	3.28	4.30	6.11
CBGB	CABG-chest and donor	2	173	5.51	2.27	3.68	5.42	7.66	10.00
CBGC	CABG-chest only	1	105	2.20	0	0	1.59	3.32	4.07
CBGC	CABG-chest only	2,3	61	3.88	0	1.12	2.76	4.54	7.07
OCVS	Other cardiovascular	0,1	33	0.57	0	0	0	0.67	1.97
OCVS	Other cardiovascular	2	21	1.29	0	0	0	1.63	2.37
THOR	Thoracic	0	21	0.36	0	0	0	0	0.88
THOR	Thoracic	1	36	1.02	0	0	0	1.49	2.73
THOR	Thoracic	2,3	21	2.48	0	0	1.45	3.57	5.89
APPY	Appendectomy	0-Yes	21	0.73	0	0	0	0.80	1.62
APPY	Appendectomy	0-No	47	1.33	0	0	1.08	2.08	3.53
APPY	Appendectomy	1	58	2.77	0	1.36	2.36	4.00	5.78
APPY	Appendectomy	2	36	4.76	0	0	2.94	5.41	7.77
CHOL	Cholecystectomy	M	86	0.44	0	0	0	0.51	1.17
CHOL	Cholecystectomy	0	90	0.68	0	0	0.39	1.15	2.44
CHOL	Cholecystectomy	1	73	1.76	0	0	1.38	3.25	5.22
CHOL	Cholecystectomy	2	46	3.28	0	0.30	3.21	4.65	6.83
COLO	Colon	0	94	4.00	0	2.00	3.51	4.94	6.42
COLO	Colon	1	102	5.64	2.22	3.59	5.18	6.94	8.55
COLO	Colon	2	81	8.55	3.85	5.65	8.99	11.62	17.19
COLO	Colon	3	27	11.53	1.84	7.65	13.19	16.33	23.41
GAST	Gastric	0-No	28	2.63	0	0	2.22	4.48	6.76
GAST	Gastric	1	47	4.83	0.49	2.05	4.20	8.07	9.41
GAST	Gastric	2	30	8.82	1.69	4.34	8.06	13.66	22.22
OGIT	Other digestive	0,1	25	2.67	0	0.34	2.00	3.46	6.87
SB	Small bowel	0	24	5.17	0	1.49	4.48	6.38	10.13
SB	Small bowel	1	34	7.49	2.2	4.23	7.02	8.44	12.35
SB	Small bowel	2,3	27	9.23	5.11	6.39	8.11	13.23	16.67
XLAP	Laparotomy	0	37	1.76	0	0	1.36	2.23	3.20
XLAP	Laparotomy	1	42	3.11	0	1.19	2.41	4.03	6.73
XLAP	Laparotomy	2	33	4.82	0	1.87	3.53	6.37	10.28
NEPH	Nephrectomy	0,1,2,3	28	1.11	0	0	0.85	2.33	4.98
OGU	Other genitourinary	0	32	0.37	0	0	0.15	0.60	1.33
OGU	Other genitourinary	1	29	0.90	0	0	0.55	1.89	2.36
PRST	Prostatectomy	0	30	0.81	0	0	0	0.83	2.11
PRST	Prostatectomy	1,2,3	24	2.20	0	0	1.04	3.85	4.68
HER	Herniorrhaphy	0	48	0.79	0	0	0.54	1.77	2.42
HER	Herniorrhaphy	1	52	2.08	0	0.66	1.82	3.19	5.88
HER	Herniorrhaphy	2,3	26	4.40	0	0	3.70	5.16	6.33
MAST	Mastectomy	0	58	1.81	0	0	0.73	1.59	3.09
MAST	Mastectomy	1	52	2.20	0	0.56	2.16	3.33	6.43
CRAN	Craniotomy	0	40	0.86	0	0	0	1.61	2.61
CRAN	Craniotomy	1	63	1.65	0	0	1.03	2.25	4.13
CRAN	Craniotomy	2,3	45	2.32	0	0	1.04	2.97	5.32
ONS	Other nervous system	0,1,2,3	20	1.51	0	0	0	1.82	2.41
VSHN	Ventricular shunt	0	29	4.22	0	0	2.56	4.38	6.33
VSHN	Ventricular shunt	1,2,3	41	5.39	0	1.49	3.51	6.46	8.19
CSEC	Cesarean section	0	128	2.82	0.49	1.30	2.15	4.55	6.76
CSEC	Cesarean section	1	116	4.21	0.25	1.37	3.18	5.41	8.10
CSEC	Cesarean section	2,3	48	7.65	0	3.09	5.45	10.34	13.27
HYST	Abdominal hysterectomy	0	103	1.37	0	0	0.95	2.39	3.37
HYST	Abdominal hysterectomy	1	98	2.28	0	0.70	1.72	3.19	4.65
HYST	Abdominal hysterectomy	2,3	51	5.34	0	2.23	4.55	8.33	10.23
VHYS	Vaginal hysterectomy	0,1,2,3	68	1.22	0	0.29	0.90	1.68	3.36

Table 6. (continued)

Operative procedure category		Risk index category	No. hospitals	Pooled mean rate	Percentile				
					10%	25%	50% (median)	75%	90%
AMP	Limb amputation	0,1,2,3	39	3.62	0	1.57	2.94	5.31	7.71
FUSN	Spinal fusion	0	107	1.10	0	0	0.86	1.51	2.48
FUSN	Spinal fusion	1	111	2.76	0	0.71	2.21	3.54	4.90
FUSN	Spinal fusion	2,3	71	6.30	0	2.16	4.39	8.00	11.57
FX	Open reduction of fracture	0	68	0.77	0	0	0.25	1.12	1.91
FX	Open reduction of fracture	1	75	1.38	0	0	1.02	1.65	2.52
FX	Open reduction of fracture	2	46	2.68	0	0.14	2.73	3.94	5.64
HPRO	Hip prosthesis	0	153	0.88	0	0	0.54	1.24	2.34
HPRO	Hip prosthesis	1	185	1.61	0	0.08	1.24	2.18	3.67
HPRO	Hip prosthesis	2,3	147	2.49	0	0.85	2.05	3.70	6.13
KPRO	Knee Prosthesis	0	149	0.87	0	0	0.65	1.30	2.24
KPRO	Knee Prosthesis	1	175	1.26	0	0.20	1.12	1.95	3.09
KPRO	Knee Prosthesis	2,3	144	2.22	0	0	1.90	3.42	5.93
LAM	Laminectomy	0	131	0.92	0	0	0.64	1.37	2.60
LAM	Laminectomy	1	134	1.39	0	0.49	1.30	1.98	2.93
LAM	Laminectomy	2,3	108	2.49	0	1.10	2.09	3.53	5.49
OMS	Other musculoskeletal	0	41	0.61	0	0	0.36	0.84	1.30
OMS	Other musculoskeletal	1	42	0.94	0	0	0.63	1.39	2.40
OMS	Other musculoskeletal	2,3	22	1.72	0	0	1.19	2.90	3.97
OPRO	Other prosthesis	0,1,2,3	29	0.66	0	0	0	0.70	2.16
OSKN	Other integumentary system	0,1,2,3	29	1.29	0	0.36	1.07	1.83	2.73
SPLE	Splenectomy	0,1,2,3	20	2.93	0	0	3.26	4.55	6.04
VS	Vascular	0	67	0.91	0	0	0	1.71	3.03
VS	Vascular	1	106	1.73	0	0.78	1.54	2.54	3.79
VS	Vascular	2,3	100	4.42	0.99	2.88	4.76	6.60	8.61

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.

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 operation, 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 appendectomy and gastric operation, the use of 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 2003) 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] 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. Finally, antimicrobial agents with similar spectrum or clinical indications were grouped in

Table 7. SSI rates,* by selected operative procedure and modified risk index category incorporating laparoscope use,† Surgical Patient component, January 1992 through June 2003

Operative procedure category	Duration cut point (h)	Risk index category	N	Rate	Risk index category	N	Rate
CHOL Cholecystectomy	2	M	31,762	0.44	0	25,771	0.68
COLO Colon	3	M	666	2.55	0	17,356	4.00
APPY Appendectomy	1	0-Yes	2604	0.73	0-No	7668	1.33
GAST Gastric	3	0-Yes	494	1.01	0-No	2701	2.63

*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 are 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 operation, 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 2 groups: 0–Yes (laparoscope used) and 0–No (laparoscope not used).

Table 8. SSI rates* after coronary artery bypass graft (CBGB) operation, by risk index category and specific site, Surgical Patient component, January 1992 through June 2003

Risk index category	0		1		2		3	
Infection site	No. SSIs	Rate	No. SSIs	Rate	No. SSIs	Rate	No. SSIs	Rate
Leg (donor site)	18	0.73	5016	1.47	1829	2.52	5	2.33
Superficial incisional	13	0.53	3882	1.14	1428	1.96	5	2.33
Deep incisional	5	0.20	1134	0.33	401	0.55	0	0.00
Chest	11	0.45	6721	1.98	2176	2.99	17	7.91
Superficial incisional	6	0.24	2497	0.73	827	1.14	4	1.86
Deep incisional	2	0.08	1902	0.56	552	0.76	8	3.72
Organ/space	3	0.12	2322	0.68	797	1.10	5	2.33
Total	29	1.18	11,737	3.45	4005	5.51	22	10.23

*per 100 operations.

Denominators for the risk categories are as follows:
Category 0 = 2458
Category 1 = 340,225
Category 2 = 72,723
Category 3 = 215

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, respiratory, and trauma ICUs reporting usage data is insufficient to include in 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 nonduplicate 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

Risk index category	N	Rate	Risk index category	N	Rate	Risk index category	N	Rate
1	11,992	1.76	2	4206	3.28	3	462	5.63
1	29,716	5.64	2	12,330	8.55	3	1743	11.53
1	10,009	2.77	2	3470	4.76	3	412	7.04
1	5526	4.83	2	2484	8.82	3	163	13.50

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 2003

Non-ICU Inpatient Areas (n = 73)			**Percentile**				
Antimicrobial agent	**No. DDD***	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
Penicillin group	99,152	9.0	1.3	3.0	5.6	9.8	15.0
Ampicillin group	733,483	66.7	34.5	48.2	62.5	81.0	102.4
Antipseudomonal penicillins	214,946	19.6	2.8	7.8	18.3	29.7	47.9
Antistaphylococcal penicillins	164,761	15.0	2.7	4.3	11.7	18.3	26.9
First-generation cephalosporins	881,165	80.2	45.6	59.4	76.0	106.3	125.1
Second-generation cephalosporins	426,785	38.8	12.7	22.4	33.1	50.2	64.1
Third-generation cephalosporins	1,029,646	93.7	36.9	53.8	80.3	124.5	150.3
Carbapenem group	65,203	5.9	0.4	1.5	4.7	8.7	14.8
Aztreonam	28,745	2.6	0.1	0.7	1.6	3.7	6.3
Fluoroquinolones	750,958	68.3	24.8	40.6	61.7	109.4	177.0
Trimethoprim/sulfamethoxazole	501,584	45.6	3.0	17.0	26.5	40.6	74.9
Vancomycin (oral)	31,168	2.8	0.1	0.5	1.3	2.4	4.2
Vancomycin (parenteral)	329,052	29.9	13.1	17.1	24.4	39.9	62.5
Coronary care unit (n = 32)			**Percentile**				
Antimicrobial agent	**No. DDD***	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
Penicillin group	810	6.2	0	0.3	2.1	9.4	22.0
Ampicillin group	5004	38.4	10.4	19.0	35.0	64.3	87.6
Antipseudomonal penicillins	3975	30.5	0	3.4	21.9	46.4	60.0
Antistaphylococcal penicillins	2300	17.7	0	3.5	11.8	32.9	49.2
First-generation cephalosporins	6798	52.2	9.0	27.7	36.5	54.4	104.9
Second-generation cephalosporins	4376	33.6	2.5	9.2	22.5	34.5	53.9
Third-generation cephalosporins	16,213	124.4	32.9	48.3	122.1	143.4	187.1
Carbapenem group	1114	8.6	0	0.2	6.1	12.1	26.7
Aztreonam	718	5.5	0	0	1.9	10.8	14.9
Fluoroquinolones	9011	69.2	9.7	17.2	38.1	86.2	136.7
Trimethoprim/sulfamethoxazole	4480	34.4	0	7.0	16.2	32.6	106.4
Vancomycin (oral)	482	3.7	0	0	0	1.3	7.0
Vancomycin (parenteral)	6537	50.2	11.2	19.8	36.9	81.0	105.9
Cardiothoracic ICU (n = 21)			**Percentile**				
Antimicrobial agent	**No. DDD***	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
Penicillin group	411	4.5	0	0	1.4	4.0	8.3
Ampicillin group	2804	31.0	3.2	6.8	26.6	37.0	48.8
Antipseudomonal penicillins	2320	25.6	1.1	8.8	16.0	36.1	48.6
Antistaphylococcal penicillins	1474	16.3	0	0	6.5	19.7	27.5
First-generation cephalosporins	25,754	284.6	36.5	210.0	258.7	465.4	697.9

Table 9. (continued)

Cardiothoracic ICU (n = 21)			**Percentile**				
Antimicrobial agent	**No. DDD***	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
Second-generation cephalosporins	7900	87.3	3.4	8.9	25.4	81.2	493.3
Third-generation cephalosporins	11,077	122.4	20.4	35.7	84.8	132.2	201.5
Carbapenem group	1596	17.6	0	1.6	12.4	18.9	49.4
Aztreonam	694	7.7	0	0.2	1.0	5.3	7.8
Fluoroquinolones	5266	58.2	6.2	12.1	42.0	82.3	121.6
Trimethoprim/sulfamethoxazole	1200	13.3	0	0	7.6	13.9	37.9
Vancomycin (oral)	484	5.3	0	0	0	0.9	10.7
Vancomycin (parenteral)	11,464	126.7	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	998	8.5	—	—	—	—	—
Ampicillin group	6403	54.8	—	—	—	—	—
Antipseudomonal penicillins	3704	31.7	—	—	—	—	—
Antistaphylococcal penicillins	1485	12.7	—	—	—	—	—
First-generation cephalosporins	5431	46.5	—	—	—	—	—
Second-generation cephalosporins	3848	32.9	—	—	—	—	—
Third-generation cephalosporins	34,213	292.9	—	—	—	—	—
Carbapenem group	1759	15.1	—	—	—	—	—
Aztreonam	881	7.5	—	—	—	—	—
Fluoroquinolones	15,274	130.8	—	—	—	—	—
Trimethoprim/sulfamethoxazole	4051	34.7	—	—	—	—	—
Vancomycin (oral)	489	4.2	—	—	—	—	—
Vancomycin (parenteral)	9913	84.9	—	—	—	—	—
Medical ICU (n = 35)			**Percentile**				
Antimicrobial agent	**No. DDD***	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
Penicillin group	1596	8.5	0	1.5	5.6	10.2	20.4
Ampicillin group	17,224	91.5	37.6	56.2	74.4	96.9	127.8
Antipseudomonal penicillins	13,832	73.4	13.0	27.5	66.2	112.9	170.8
Antistaphylococcal penicillins	6547	34.8	0	3.8	20.4	39.2	58.5
First-generation cephalosporins	6610	35.1	10.7	20.2	30.5	40.5	70.3
Second-generation cephalosporins	6504	34.5	2.1	7.2	26.5	56.1	69.0
Third-generation cephalosporins	61,756	327.9	92.2	108.8	194.1	321.6	386.1
Carbapenem group	6550	34.8	0	7.9	23.9	37.2	98.3
Aztreonam	1734	9.2	0	1.1	5.7	13.4	17.6
Fluoroquinolones	24,301	129.0	29.5	56.8	86.5	146.3	256.8
Trimethoprim/sulfamethoxazole	13,179	70.0	1.9	14.6	29.8	58.7	123.0
Vancomycin (oral)	340	1.8	0	0	0.7	1.8	6.7
Vancomycin (parenteral)	23,603	125.3	42.9	55.7	75.2	153.4	219.5
Medical-Surgical ICU (n = 60)			**Percentile**				
Antimicrobial agent	**No. DDD***	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
Penicillin group	2671	6.4	0	0.5	1.9	6.5	22.2
Ampicillin group	32,405	77.7	15.3	31.9	70.0	116.6	139.7
Antipseudomonal penicillins	32,952	79.0	20.0	37.5	67.6	94.3	130.4
Antistaphylococcal penicillins	8578	20.6	0.5	4.1	11.8	22.6	42.0
First-generation cephalosporins	45,628	109.3	23.8	56.6	81.6	132.4	215.5
Second-generation cephalosporins	19,662	47.1	4.6	11.5	31.9	53.2	104.8
Third-generation cephalosporins	91,700	219.7	81.9	116.3	197.6	261.0	332.1

Table 9. (continued)

Medical-Surgical ICU (n = 60)			Percentile				
Antimicrobial agent	No. DDD*	Pooled mean	10%	25%	50% (median)	75%	90%
Carbapenem group	13,136	31.5	3.3	7.3	23.8	40.7	54.2
Aztreonam	4243	10.2	0	1.8	6.4	14.5	24.6
Fluoroquinolones	64,492	154.5	30.2	59.8	122.9	242.8	296.0
Trimethoprim/sulfamethoxazole	18,248	43.7	0	10.3	18.2	44.0	95.5
Vancomycin (oral)	2,367	5.7	0	0	2.0	5.4	10.1
Vancomycin (parenteral)	33,915	81.3	31.6	51.7	66.6	122.0	136.3

Neurosurgical ICU (n = 11)			Percentile				
Antimicrobial agent	No. DDD*	Pooled mean	10%	25%	50% (median)	75%	90%
Penicillin group	351	6.3	—	—	—	—	—
Ampicillin group	2665	48.2	—	—	—	—	—
Antipseudomonal penicillins	2514	45.4	—	—	—	—	—
Antistaphylococcal penicillins	3289	59.4	—	—	—	—	—
First-generation cephalosporins	6711	121.2	—	—	—	—	—
Second-generation cephalosporins	1163	21.0	—	—	—	—	—
Third-generation cephalosporins	11,721	211.8	—	—	—	—	—
Carbapenem group	1538	27.8	—	—	—	—	—
Aztreonam	82	1.5	—	—	—	—	—
Fluoroquinolones	3825	69.1	—	—	—	—	—
Trimethoprim/sulfamethoxazole	2399	43.3	—	—	—	—	—
Vancomycin (oral)	74	1.3	—	—	—	—	—
Vancomycin (parenteral)	5374	97.1	—	—	—	—	—

Surgical ICU (n = 37)			Percentile				
Antimicrobial agent	No. DDD*	Pooled mean	10%	25%	50% (median)	75%	90%
Penicillin group	3495	13.7	0	0.9	3.7	9.4	21.1
Ampicillin group	23,055	90.4	24.8	50.6	81.3	138.1	157.7
Antipseudomonal penicillins	14,189	55.6	11.0	31.0	57.5	80.8	105.7
Antistaphylococcal penicillins	6304	24.7	0.8	5.0	13.5	35.6	55.3
First-generation cephalosporins	48,295	189.3	59.4	101.2	161.1	365.5	496.1
Second-generation cephalosporins	11,304	44.3	3.7	27.0	47.5	70.9	97.6
Third-generation cephalosporins	48,851	191.5	53.6	100.2	142.0	173.5	222.8
Carbapenem group	11,169	43.8	0.3	10.3	19.9	51.9	71.5
Aztreonam	1711	6.7	0.3	3.0	6.8	12.1	19.3
Fluoroquinolones	34,072	133.6	34.2	64.7	84.6	107.0	244.1
Trimethoprim/sulfamethoxazole	13,353	52.3	4.7	12.8	17.9	33.3	92.3
Vancomycin (oral)	1160	4.5	0	0	1.2	3.1	11.3
Vancomycin (parenteral)	40,570	159.0	51.6	71.5	99.1	131.3	188.7

Pediatric ICU (n = 16)			Percentile				
Antimicrobial Agent	No. DDD*	Pooled mean	10%	25%	50% (median)	75%	90%
Penicillin group	304	6.0	—	—	—	—	—
Ampicillin group	2190	43.5	—	—	—	—	—
Antipseudomonal penicillins	604	12.0	—	—	—	—	—
Antistaphylococcal penicillins	1356	27.0	—	—	—	—	—
First-generation cephalosporins	2430	48.3	—	—	—	—	—
Second-generation cephalosporins	1745	34.7	—	—	—	—	—
Third-generation cephalosporins	10,740	213.6	—	—	—	—	—
Carbapenem group	404	8.0	—	—	—	—	—
Aztreonam	90	1.8	—	—	—	—	—

Table 9. (continued)

Pediatric ICU (n = 16)			Percentile				
Antimicrobial agent	**No. DDD***	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
Fluoroquinolones	457	9.1	—	—	—	—	—
Trimethoprim/sulfamethoxazole	685	13.6	—	—	—	—	—
Vancomycin (oral)	160	3.2	—	—	—	—	—
Vancomycin (parenteral)	3177	63.2	—	—	—	—	—

*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.

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

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 2003

All ICUs combined				Percentile				
Antimicrobial-resistant pathogen	**No. units**	**No. tested**	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
MRSA	154	19,791	51.6	20.0	31.2	46.3	60.4	67.6
Methicillin-resistant CNS	140	12,034	76.0	56.6	69.5	76.0	82.6	89.8
Vancomycin-resistant *Enterococcus* spp	137	12,482	12.7	0	4.0	13.4	24.6	37.5
Ciprofloxacin/ofloxacin-resistant *Pseudomonas aeruginosa*	129	11,884	35.8	8.1	17.4	29.6	41.5	55.2
Levofloxacin-resistant *P aeruginosa*	64	4409	37.1	7.7	16.8	29.1	41.7	48.9
Imipenem-resistant *P aeruginosa*	118	10,427	19.4	3.8	8.2	13.4	26.8	40.0
Ceftazidime-resistant *P aeruginosa*	125	11,214	13.8	0	5.0	10.3	16.3	25.0
Piperacillin-resistant *P aeruginosa*	113	10,140	17.2	2.7	6.6	14.3	18.8	31.6
Cef3-resistant *Enterobacter* spp	108	4504	26.6	9.1	18.2	24.4	36.4	47.4
Carbapenem-resistant *Enterobacter* spp	89	3868	0.7	0	0	0	0	3.9
Cef3-resistant *Klebsiella pneumoniae*	114	6558	5.8	0	0	1.6	8.0	20.7
Cef3-resistant *Escherichia coli*	137	10,719	1.2	0	0	0	2.3	6.7
Quinolone-resistant *E coli*	133	10,524	6.2	0	0	2.5	7.1	14.3
Penicillin-resistant pneumococci	44	1141	20.1	0	5.6	15.2	25.8	52.4
Cefotaxime/ceftriaxone-resistant pneumococci	32	716	8.4	0	0	4.4	11.3	29.4

Non-ICU inpatient areas				Percentile				
Antimicrobial-resistant pathogen	**No. units**	**No. tested**	**Pooled mean**	**10%**	**25%**	**50% (median)**	**75%**	**90%**
MRSA	55	33,405	42.0	24.5	31.0	43.8	52.5	58.5
Methicillin-resistant CNS	52	19,635	64.3	52.2	57.1	65.5	71.0	75.6
Vancomycin-resistant *Enterococcus* spp	54	26,825	11.5	1.9	3.5	6.7	12.8	18.6
Ciprofloxacin/ofloxacin-resistant *Pseudomonas aeruginosa*	54	18,108	27.2	12.9	20.5	27.5	36.8	42.9
Levofloxacin-resistant *P aeruginosa*	28	6979	29.4	14.2	20.5	28.0	34.0	44.7
Imipenem-resistant *P aeruginosa*	52	14,051	12.4	5.2	6.6	9.5	14.4	20.6
Ceftazidime-resistant *P aeruginosa*	52	16,428	8.5	1.9	3.8	6.8	11.3	14.1
Piperacillin-resistant *P aeruginosa*	51	13,995	11.5	3.4	6.3	9.5	14.0	18.3
Cef3-resistant *Enterobacter* spp	49	6143	20.3	5.4	13.2	20.0	25.6	28.6
Carbapenem-resistant *Enterobacter* spp	45	4685	1.0	0	0	0	1.0	2.9
Cef3-resistant *Klebsiella pneumoniae*	54	11,702	5.5	0	0	1.4	4.4	10.8
Cef3-resistant *Escherichia coli*	54	33,670	1.3	0	0	0.6	1.5	3.3
Quinolone-resistant *E coli*	55	33,636	6.1	0.4	1.6	2.9	6.0	14.6
Penicillin-resistant pneumococci	39	3159	18.8	2.3	5.9	12.0	20.0	36.7
Cefotaxime/ceftriaxone-resistant pneumococci	31	1805	8.1	0	1.2	5.6	12.7	16.6

Table 10. (continued)

Outpatient areas				Percentile				
Antimicrobial-resistant pathogen	No. units	No. tested	Pooled mean	10%	25%	50% (median)	75%	90%
MRSA	49	27,979	25.9	14.9	18.8	24.3	30.8	46.1
Methicillin-resistant CNS	47	13,449	48.7	38.5	42.8	48.1	56.4	61.2
Vancomycin-resistant *Enterococcus* spp	46	20,251	4.6	0.5	1.3	3.7	5.9	7.4
Ciprofloxacin/ofloxacin-resistant *Pseudomonas aeruginosa*	46	12,700	23.1	12.2	17.0	23.7	30.6	39.0
Levofloxacin-resistant *P aeruginosa*	22	4514	23.5	12.5	15.1	19.1	28.6	36.8
Imipenem-resistant *P aeruginosa*	45	9642	7.5	2.1	4.1	6.0	9.1	13.0
Ceftazidime-resistant *P aeruginosa*	45	11,203	4.7	0	2.3	3.8	6.2	7.9
Piperacillin-resistant *P aeruginosa*	41	9345	6.0	0	2.6	4.5	6.0	10.9
Cef3-resistant *Enterobacter* spp	43	4855	9.6	2.3	5.2	10.4	14.5	17.9
Carbapenem-resistant *Enterobacter* spp	39	3141	0.6	0	0	0	0	2.4
Cef3-resistant *Klebsiella pneumoniae*	45	13,127	1.8	0	0	0.9	1.8	5.9
Cef3-resistant *Escherichia coli*	49	77,672	0.4	0	0	0.2	0.7	1.2
Quinolone-resistant *E coli*	48	74,609	2.7	0.2	0.9	2.0	2.9	7.2
Penicillin-resistant pneumococci	40	3862	17.9	2.0	5.6	10.3	21.0	28.8
Cefotaxime/ceftriaxone-resistant pneumococci	35	2526	5.7	0	0	1.6	8.7	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:

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

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 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	12×10^6 U
		Procaine penicillin G	2.4×10^6 U
		Penicillin G benzathine	1.2×10^6 U
		Penicillin V	1 g
	Ampicillin group	Ampicillin (parenteral)	4 g
		Ampicillin (oral)	2 g
		Ampicillin/sulbactam	6 g
		Amoxicillin (oral)	1.5 g
		Amoxicillin/clavulanic acid (oral)	1.5 g
	Antistaphylococcal penicillins (Methicillin group)	Nafcillin	4 g
		Oxacillin	4 g
		Dicloxacillin (oral)	2 g
	Antipseudomonal penicillins	Piperacillin	18 g
		Piperacillin/tazobactam	13.5 g
		Ticarcillin	18 g
		Ticarcillin/clavulanic acid	12.4 g
	First-generation cephalosporins	Cefazolin	3 g
		Cephalothin	4 g
		Cefadroxil (oral)	2 g
		Cephalexin (oral)	2 g
	Second-generation cephalosporins	Cefotetan	2 g
		Cefmetazole	4 g
		Cefoxitin	4 g
		Cefuroxime	3 g
		Cefuroxime axetil (oral)	1 g
		Cefaclor (oral)	1 g
		Cefprozil (oral)	1 g
	Third-generation cephalosporins	Cefotaxime	3 g
		Ceftazidime	3 g
		Ceftizoxime	3 g
		Ceftriaxone	1 g
		Cefixime (oral)	0.4 g
		Cefipime	4 g
	Carbapenems	Meropenem	3 g
		Imipenem cilastatin	2 g
Other β-lactams		Aztreonam	4 g
Glycopeptides		Vancomycin (parenteral)	2 g
		Vancomycin (oral)	1 g
Fluoroquinolones		Ciprofloxacin (parenteral)	0.8 g
		Ciprofloxacin (oral)	1.5 g
		Ofloxacin (parenteral)	0.8 g
		Ofloxacin (oral)	0.8 g
		Levofloxacin (parenteral)	0.5 g

Appendix A. (continued)

Class	Group	Antimicrobial agent	DDD
		Levofloxacin (oral)	0.2 g
		Trovafloxacin (parenteral)	0.2 g
		Trovafloxacin (oral)	0.2 g
		Sparfloxacin (oral)	0.2 g
		Norfloxacin (oral)	0.8 g
		Lomefloxacin	0.4 g
Trimethoprim/ Sulfamethoxazole		Trimethoprim component (oral)	0.32 g
		Trimethoprim compound (parenteral)	0.84 g

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.

Appendix B.

HOW TO CALCULATE A DEVICE-ASSOCIATED INFECTION RATE AND DU 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 birth-weight 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 that 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: A total of 5 patients on the first day of the month had 1 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: Central line-associated bloodstream infection rate per 1000 central line-days =

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

Calculation of DU Ratio

Steps 1, 2, and 4: Same as that for device-associated infection rates, plus determine the number of patient-days that 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*: A total of 10 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; 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 DU 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 a result of 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 DU 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. Because 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 to lower the ventilator-associated pneumonia rate in the unit.

Appendix D.

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