National Nosocomial Infections Surveillance (NNIS) System Report, Data Summary from January 1990-May 1999, Issued June 1999

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 1990 through May 1999 and updates previously published data.[1-7]

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.[8-10] 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 and Prevention (CDC) definitions that include laboratory and clinical criteria.[9]

In January 1999, the hospital-wide component was eliminated from the NNIS system. This was done for several reasons. The hospital-wide component required considerable time and resources in most hospitals, particularly those that have a large and high-risk patient population, resulting in inaccurate and inadequate case-finding. More important, the hospital-wide component did not yield rates that were meaningful for national comparison purposes because they were not risk-adjusted.

*See Appendix C.

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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, as well as 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 g, 1001 to 1500 g, 1501 to 2500 g, and >2500 g).

Surgical patient surveillance component

ICPs select from the NNIS operative procedure list those procedures they wish to follow 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,[11] duration of operation, and American Society of Anesthesiology (ASA) score.[12] Using a composite index for predicting the risk of SSI after surgery, ICPs can calculate rates by the number of risk factors present.[7]

The time periods for the data contained in this report vary depending on the table. Data from the 1980s are no longer included in any table. Each table represents NNIS data from one of the surveillance components. There are no data solely from the hospital-wide component in this report.

Table 1. Pooled means and percentiles of the distribution of device-associated infection rates, by type of ICU, ICU component, January 1992-May 1999

Urinary catheter-associated UTI rate*

Type of ICU	No. of units	Urinary catheter-days	Pooled mean	Percentile				
				10%	25%	50% (median)	75%	90%
Coronary	105	345,618	6.8	1.1	3.3	5.9	10.0	13.7
Cardiothoracic	48	350,359	3.3	0.6	1.5	2.7	4.2	5.4
Medical	124	746,926	7.6	2.1	4.2	7.0	9.1	12.0
Medical/surgical								
Major teaching	71	339,039	6.8	2.1	4.4	6.5	9.8	11.0
All others	140	874,163	4.5	1.2	2.2	4.4	6.0	8.1
Neurosurgical	46	194,474	8.4	2.9	4.9	8.1	10.0	14.7
Pediatric	65	177,945	5.2	0.0	2.6	4.9	7.2	11.0
Surgical	146	1,017,283	5.6	1.2	3.2	5.0	7.9	9.2
Trauma	21	128,958	7.7	2.7	4.3	7.7	9.5	11.1
Burn	17	32,723	10.1	–	–	–	–	–
Respiratory	7	28,699	6.4	–	–	–	–	–

Central line-associated BSI rate†

Type of ICU	No. of units	Central line-days	Pooled mean	Percentile				
				10%	25%	50% (median)	75%	90%
Coronary	106	216,837	4.9	0.0	1.8	4.1	6.5	8.9
Cardiothoracic	48	324,182	2.9	0.4	1.4	2.3	3.6	5.2
Medical	124	531,300	6.1	2.2	3.8	5.4	7.3	9.8
Medical/surgical								
Major teaching	72	238,446	6.0	1.5	3.5	5.7	7.6	9.3
All others	138	532,464	4.1	1.1	2.2	4.0	5.6	7.2
Neurosurgical	45	104,285	5.6	1.8	3.0	4.5	8.4	9.2
Pediatric	67	248,610	7.9	1.4	4.5	6.9	9.6	12.3
Surgical	146	819,268	5.6	1.4	2.6	5.0	7.0	9.3
Trauma	21	94,185	7.3	0.0	2.6	6.4	8.6	9.3
Burn	17	25,660	12.2	–	–	–	–	–
Respiratory	7	15,732	4.3	–	–	–	–	–

Ventilator-associated pneumonia rate‡

Type of ICU	No. of units	Ventilator-days	Pooled mean	Percentile				
				10%	25%	50% (median)	75%	90%
Coronary	101	144,455	9.4	0.0	3.4	6.8	12.0	16.5
Cardioghoracic	48	193,159	11.5	2.6	5.6	11.0	14.1	20.1
Medical	121	505,023	8.2	1.9	4.2	7.3	10.6	15.3
Medical/surgical								
Major teaching	71	191,053	12.4	3.6	6.9	10.3	14.4	18.2
All others	138	419,304	10.3	3.6	6.3	9.4	12.6	15.6
Neurosurgical	45	91,508	17.1	3.1	7.6	12.7	18.7	23.6
Pediatric	66	256,919	5.7	0.1	1.9	4.6	7.9	11.8
Surgical	146	569,271	14.6	5.6	8.4	12.3	16.4	25.6
Trauma	21	83,690	16.9	6.4	10.9	14.7	21.2	27.2
Burn	17	19,378	19.9	–	–	–	–	–
Respiratory	7	22,913	5.3	–	–	–	–	–

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

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

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

Tables 1 and 2 from the ICU component update previously published device-associated rates and device utilization (DU) ratios by type of ICU.[1-5] 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.

Table 2. Pooled means and percentiles of the distribution of device utilization ratios, by type of ICU, ICU component, January 1992-May 1999

Urinary catheter utilization*

Type of ICU	No. of units	Patient-days	Pooled mean	Percentile				
				10%	25%	50% (median)	75%	90%
Coronary	107	770,739	0.45	0.22	0.35	0.46	0.56	0.66
Cardiothoracic	48	406,648	0.86	0.72	0.83	0.90	0.95	0.96
Medical	127	1,055,251	0.71	0.47	0.62	0.73	0.82	0.88
Medical/surgical								
Major teaching	72	432,959	0.78	0.54	0.70	0.80	0.84	0.89
All others	141	1,204,728	0.73	0.52	0.62	0.74	0.82	0.88
Neurosurgical	46	245,244	0.79	0.53	0.68	0.81	0.90	0.93
Pediatric	70	550,661	0.32	0.13	0.20	0.29	0.40	0.48
Surgical	146	1,221,149	0.83	0.65	0.77	0.85	0.91	0.95
Trauma	21	148,606	0.87	0.64	0.73	0.90	0.93	0.96
Burn	17	59,578	0.55	–	–	–	–	–
Respiratory	7	45,886	0.63	–	–	–	–	–

Central line utilization†

Type of ICU	No. of units	Patient-days	Pooled mean	Percentile				
				10%	25%	50% (median)	75%	90%
Coronary	108	770,739	0.28	0.13	0.18	0.26	0.35	0.50
Cardiothoracic	48	406,648	0.80	0.62	0.74	0.84	0.87	0.95
Medical	126	1,055,251	0.50	0.29	0.36	0.48	0.61	0.72
Medical/surgical								
Major teaching	72	432,959	0.55	0.37	0.42	0.56	0.66	0.74
All others	141	1,204,728	0.44	0.21	0.31	0.44	0.55	0.65
Neurosurgical	46	245,244	0.43	0.24	0.37	0.46	0.55	0.61
Pediatric	70	550,661	0.45	0.25	0.34	0.44	0.56	0.65
Surgical	146	1,221,149	0.67	0.49	0.57	0.68	0.77	0.88
Trauma	21	148,606	0.63	0.39	0.50	0.62	0.68	0.76
Burn	17	59,578	0.43	–	–	–	–	–
Respiratory	7	45,886	0.34	–	–	–	–	–

Ventilator utilization‡

Type of ICU	No. of units	Patient-days	Pooled mean	Percentile				
				10%	25%	50% (median)	75%	90%
Coronary	106	770,739	0.19	0.07	0.11	0.17	0.26	0.32
Cardiothoracic	48	406,648	0.48	0.32	0.38	0.50	0.55	0.64
Medical	126	1,055,251	0.48	0.23	0.32	0.45	0.58	0.68
Medical/surgical								
Major teaching	72	432,959	0.44	0.26	0.34	0.44	0.54	0.62
All others	141	1,204,728	0.35	0.18	0.24	0.34	0.41	0.51
Neurosurgical	46	245,244	0.37	0.21	0.28	0.39	0.46	0.58
Pediatric	70	550,661	0.47	0.21	0.33	0.43	0.51	0.58
Surgical	146	1,221,149	0.47	0.24	0.35	0.47	0.55	0.65
Trauma	21	148,606	0.56	0.35	0.43	0.59	0.64	0.71
Burn	17	59,578	0.33	–	–	–	–	–
Respiratory	7	45,886	0.50	–	–	–	–	–

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

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

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

Although the number of units reporting data from the burn and respiratory ICUs is still insufficient to provide percentile distributions of the rates or ratios, for the first time data are presented for trauma ICUs. In addition, the data for combined medical/surgical ICUs have been split into 2 groups by type of hospital: "major teaching" and "all other." 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.

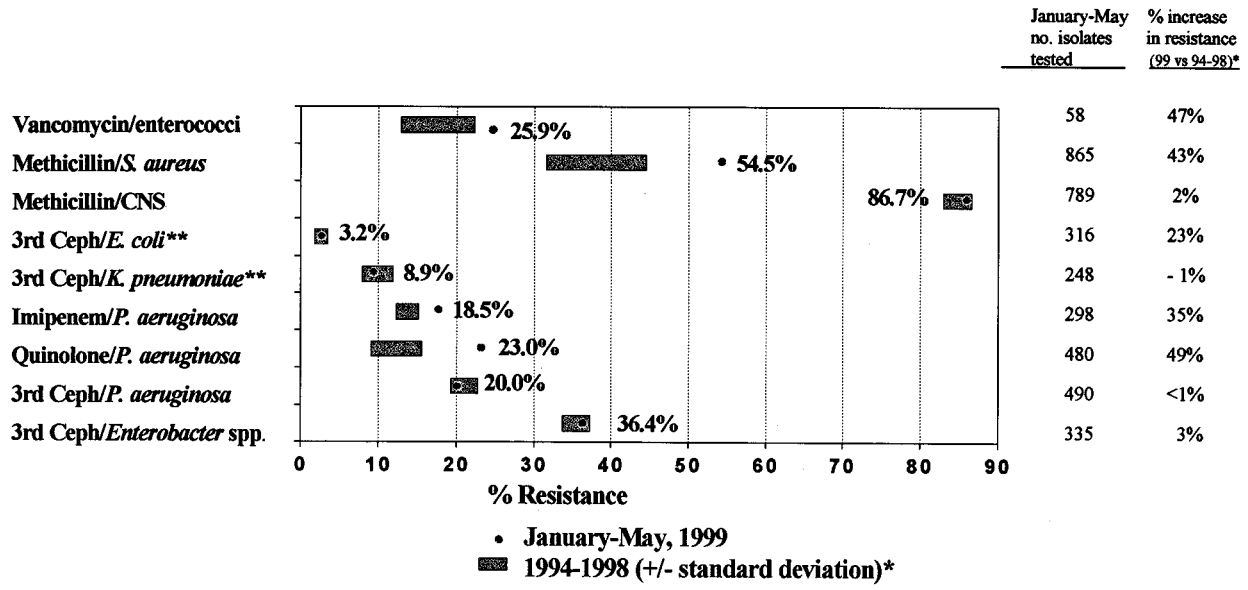

Fig 1. Selected antimicrobial-resistant pathogens associated with nosocomial infections in ICU patients, comparison of resistance rates from January-May 1999 with 1994-1998. Notes: *CNS,* coagulase-negative staphylococci; *3rd Ceph,* resistance to third-generation cephalosporins (either ceftriaxone, cefotaxime, or ceftazidime); *Quinolone,* resistance to either ciprofloxacin or ofloxacin. *Percentage increase in resistance rate of current year (January-May 1999) compared with mean rate of resistance during previous 5 years (1994-1998). **"Resistance" for *E coli* or *K pneumoniae* is the rate of nonsusceptibility of these organisms to either 3rd Ceph group or aztreonam.

Table 3. Distribution of the most common pathogens isolated from bloodstream infections, by type of ICU,* January 1992-May 1999

	Type of ICU																			
	Burn		Coronary care		Cardio-thoracic		Medical		Medical/ surgical		Neuro-surgical		Pediatric		General surgery		Trauma		Total	
Pathogen	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Enterobacter spp	54	11.2	44	2.9	65	6.2	132	3.1	173	3.6	36	4.1	163	6.8	330	5.8	86	10.4	1083	4.9
E coli	16	3.3	43	2.8	21	2.0	92	2.1	96	2.0	23	2.6	72	3.0	127	2.2	24	2.9	514	2.3
K pneumoniae	16	3.3	33	2.2	23	2.2	167	3.9	110	2.3	27	3.1	103	4.3	228	4.0	28	3.4	735	3.4
P aeruginosa	46	9.5	31	2.1	27	2.6	157	3.6	160	3.4	32	3.7	116	4.9	237	4.1	35	4.3	841	3.8
S aureus	85	17.6	352	23.2	95	9.0	600	14.0	582	12.2	115	13.1	232	9.7	597	10.4	100	12.1	2758	12.6
CNS	67	13.9	561	37.0	448	42.7	1530	35.7	1954	40.9	391	44.6	902	37.7	2071	36.1	257	31.1	8181	37.3
Enterococcus spp	75	15.5	154	10.2	150	14.3	706	16.5	552	11.5	99	11.3	257	10.7	876	15.3	98	11.9	2967	13.5
C albicans	21	4.4	40	2.6	46	4.4	269	6.3	283	5.9	26	3.0	121	5.1	259	4.5	25	3.0	1090	5.0
All other pathogens	103	21.3	257	17.0	174	16.6	634	14.8	870	18.2	127	14.5	426	17.8	1010	17.6	173	20.9	3774	17.2
Total	483	100.0	1515	100.0	1049	100.0	4287	100.0	4780	100.0	876	100.0	2392	100.0	5735	100.0	826	100.0	21943	100.0

CNS, Coagulase-negative staphylococci.
*Includes all ICU infections reported from hospitals performing either the ICU or hospital-wide surveillance components during the time period.

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. 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.[5] 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.

Tables 3 through 5 update the distribution of the most common pathogens isolated from the 3 most frequently

Table 4. Distribution of the most common pathogens isolated from pneumonia, by type of ICU,* January 1992-May 1999

	Type of ICU																			
	Burn		Coronary care		Cardio-thoracic		Medical		Medical/ surgical		Neuro-surgical		Pediatric		General surgery		Trauma		Total	
Pathogen	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Enterobacter spp	51	8.0	207	9.8	375	13.1	512	8.6	1022	10.6	257	10.5	182	9.8	1557	12.8	281	13.4	4444	11.2
E coli	21	3.4	88	4.2	139	4.8	211	3.5	402	4.1	112	4.6	66	3.6	593	4.9	93	4.4	1725	4.3
K pneumoniae	34	5.3	176	8.4	169	5.9	461	7.7	720	7.4	182	7.5	99	5.4	878	7.2	146	7.0	2865	7.2
H influenzae	42	6.6	65	3.1	165	5.8	87	1.5	340	3.5	181	7.4	171	9.3	532	4.4	155	7.4	1738	4.3
P aeruginosa	137	21.5	314	14.9	375	13.1	1264	21.2	1507	15.5	294	12.1	414	22.4	2087	17.2	360	17.1	6752	17.0
S aureus	157	24.7	425	20.2	326	11.3	1273	21.4	1750	18.0	527	21.6	303	16.4	2065	17.0	379	18.1	7205	18.1
Enterococcus spp	12	1.9	37	1.8	66	2.3	102	1.7	177	1.8	32	1.3	17	0.9	215	1.8	24	1.1	682	1.7
C albicans	18	2.8	133	6.3	180	6.3	298	5.0	592	6.1	104	4.3	37	2.0	468	3.9	32	1.5	1862	4.7
All other pathogens	164	25.8	658	31.3	1073	37.4	1752	29.4	3197	33.0	749	30.7	559	30.2	3759	30.9	626	29.9	12537	31.5
Total	636	100.0	2103	100.0	2868	100.0	5960	100.0	9707	100.0	2438	100.0	1848	100.0	12154	100.0	2096	100.0	39810	100.0

*Includes all ICU infections reported from hospitals performing either the ICU or hospital-wide surveillance components during the time period.

Table 5. Distribution of the most common pathogens isolated from urinary tract infections, by type of ICU,* January 1992-May 1999

	Type of ICU																			
	Burn		Coronary care		Cardio-thoracic		Medical		Medical/ surgical		Neuro-surgical		Pediatric		General surgery		Trauma		Total	
Pathogen	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Enterobacter spp	29	6.7	120	3.9	78	5.9	284	4.1	328	4.3	101	5.1	126	9.5	417	6.2	77	6.5	1560	5.1
E coli	59	13.7	805	26.0	165	12.5	947	13.7	1378	17.9	557	28.3	255	19.2	988	14.6	239	20.1	5393	17.5
K pneumoniae	20	4.7	242	7.8	81	6.1	435	6.3	404	5.3	155	7.9	91	6.8	410	6.1	53	4.5	1891	6.2
P aeruginosa	86	20.0	202	6.5	166	12.6	668	9.7	786	10.2	215	10.9	190	14.3	891	13.1	161	13.5	3365	11.0
S aureus	11	2.6	72	2.3	8	0.6	121	1.8	123	1.6	38	1.9	18	1.3	86	1.3	20	1.7	497	1.6
CNS	9	2.1	100	3.2	21	1.6	159	2.3	245	3.2	74	3.8	57	4.3	131	1.9	42	3.5	838	2.7
Enterococcus spp	78	18.1	443	14.3	113	8.5	977	14.2	1083	14.1	235	11.9	128	9.6	985	14.5	184	15.5	4226	13.8
C albicans	36	8.4	315	10.2	277	21.0	1437	20.8	1211	15.7	159	8.1	186	14.0	1106	16.3	129	10.8	4856	15.8
All other pathogens	102	23.7	798	25.8	412	31.2	1866	27.1	2135	27.7	434	22.1	280	21.0	1764	26.0	284	23.9	8075	26.3
Total	430	100.0	3097	100.0	1321	100.0	6894	100.0	7693	100.0	1968	100.0	1331	100.0	6778	100.0	1189	100.0	30701	100.0

CNS, Coagulase-negative staphylococci.
*Includes all ICU infections reported from hospitals performing either the ICU or hospital-wide surveillance components during the time period.

occurring infection sites in the ICU—bloodstream infection, pneumonia, and urinary tract infection—in different types of ICU. The differences in pathogens by the type of ICU for the same infection site suggest that ICU type may serve as an indirect marker of case mix. Site distributions of infections for coronary care, medical, and pediatric ICUs have been published elsewhere.[13-15]

Fig 1 shows the rates of antimicrobial resistance among selected pathogens identified from ICU patients with nosocomial infections. For each antimicrobial/pathogen pair, the pooled mean rate of resistance for January-May 1999 is displayed. Next to or overlapping this point is the average rate of resistance (±1 standard deviation) during the previous 5 years (shaded bars). Finally, the number of isolates tested from January–May 1999 and the percentage increase in the resistance rate during this time period in 1999 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 US hospitals

Table 6. Pooled means and percentiles of the distribution of device-associated infection rates, by birth weight category, HRN component, January 1990-May 1999

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	121	344,999	12.2	4.9	7.3	12.0	16.3	19.7
1001-1500 g	120	163,124	7.6	1.3	3.8	6.7	11.0	15.7
1501-2500 g	122	138,766	5.0	0.0	1.5	3.9	7.1	10.8
>2500 g	124	200,852	4.5	0.0	1.2	3.7	6.3	9.6
Ventilator-associated pneumonia rate†								
				Percentile				
Birth weight category	No. of HRNs	Ventilator-days	Pooled mean	10%	25%	50% (median)	75%	90%
≤1000 g	121	369,155	4.9	0.0	1.6	4.0	7.6	10.7
1001-1500 g	118	116,936	3.9	0.0	0.0	2.5	6.3	9.6
1501-2500 g	117	91,341	3.5	0.0	0.0	2.0	4.3	8.0
>2500 g	118	135,352	2.8	0.0	0.0	1.0	3.7	6.2

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

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

Table 7. Pooled means and percentiles of the distribution of device-utilization ratios, by birth weight category, HRN component, January 1990-May 1999

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	123	865,182	0.40	0.18	0.28	0.36	0.52	0.65
1001-1500 g	123	611,965	0.27	0.09	0.14	0.23	0.38	0.51
1501-2500 g	129	680,354	0.20	0.05	0.09	0.16	0.28	0.46
>2500 g	129	653,471	0.31	0.07	0.12	0.23	0.38	0.52
Ventilator utilization ratio†								
				Percentile				
Birth weight category	No. of HRNs	Patient-days	Pooled mean	10%	25%	50% (median)	75%	90%
≤1000 g	123	865,182	0.43	0.24	0.32	0.40	0.52	0.65
1001-1500 g	123	611,965	0.19	0.07	0.10	0.15	0.27	0.38
1501-2500 g	129	680,354	0.13	0.03	0.06	0.10	0.17	0.32
>2500 g	129	653,471	0.21	0.05	0.08	0.14	0.25	0.37

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

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

remains a concern. Of note, the proportion of *Staphylococcus aureus* isolates that were resistant to methicillin, oxacillin, or nafcillin (MRSA) continues to rise and is more than 50% for the first time ever. In addition, the rate of resistant enterococci (VRE) has not slowed, and about one quarter of all enterococcal infections are now resistant to vancomycin. 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 6 and 7 from the HRN component update the previously published device-associated rates and DU ratios in each of 4 birth weight categories.[1-4,6] For the HRN component, device-days consist of the total number of ventilator-days and umbilical 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. Percent distributions of infections by major site of noso-

Table 8. Surgical site infection rates,* by operative procedure and risk index category, surgical patient component, 1992-1998

Operative procedure category		Duration cut point (h)	Risk index category	N	Rate
CARD	Cardiac surgery	5	0	1021	0.59
CBGB	CABG-chest and donor site	5	0	1098	0.73
CBGC	CABG-chest only	4	0,1	6210	2.62
OCVS	Other cardiovascular surg	2	0,1	5313	0.77
ORES	Other respiratory system	2	0,1,2,3	1352	2.74
THOR	Thoracic surgery	3	0	936	0.43
BILI	Liver/pancreas	4	0	309	3.24
OGIT	Other digestive surgery	3	0,1	2290	3.23
SB	Small bowel surgery	3	0	823	5.59
XLAP	Laparotomy	2	0	3733	1.69
NEPH	Nephrectomy	4	0,1,2,3	2046	1.22
OGU	Other genitourinary surgery	2	0	8946	0.44
PRST	Prostatectomy	4	0	1648	0.91
HN	Head and neck	7	0	442	2.94
OENT	Other ENT	2	0,1	2474	0.24
HER	Herniorrhaphy	2	0	7251	0.79
MAST	Mastectomy	3	0,1	11178	2.07
CRAN	Craniotomy	4	0	2054	0.58
ONS	Other nervous system	4	0,1,2,3	1648	1.76
VSHN	Ventricular shunt	2	0	1549	3.68
CSEC	Cesarean section	1	0	59921	3.27
HYST	Abdominal hysterectomy	2	0	17590	1.50
OOB	Other obstetric procedures	1	0,1,2,3	793	0.50
VHYS	Vaginal hysterectomy	2	0	7959	1.08
AMP	Limb amputation	1	0,1,2,3	5991	4.29
FUSN	Spinal fusion	4	0	12306	1.23
FX	Open reduction fracture	2	0	8474	0.64
HPRO	Hip prosthesis	2	0	9841	0.78
KPRO	Knee prosthesis	2	0	13721	0.87
LAM	Laminectomy	2	0	18951	0.85
OMS	Other musculoskeletal	3	0	9493	0.65
OPRO	Other prosthesis	3	0,1,2,3	1396	0.64
OBL	Other hem/lymph system	3	0,1,2,3	844	2.01
OES	Other endocrine system	3	0	1364	0.15
OEYE	Other eye	2	0,1,2,3	437	0.69
OSKN	Other integumentary system	2	0,1,2,3	5501	1.38
SKGR	Skin graft	3	0,1	1872	1.44
SPLE	Splenectomy	3	0,1,2,3	1016	2.85
TP	Organ transplant	7	0,1	2077	5.39
VS	Vascular surgery	3	0	3579	0.98

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.

comial infection and pathogens by major site, as well as other HRN analyses, have been published.[16]

Tables 8 and 9 from the Surgical Patient component update the last published rates.[1] Table 8 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 were combined into a new category 2,3. Thus the number of risk index categories in the tables will differ depending on the operation.

The duration of operation cut points has changed for the following operations from the previously published report[1] (old→new number of hours shown in parenthesis): nephrectomy (3→4); head and neck (5→7); other ear, nose, or throat (3→2); mastectomy (2→3); craniotomy (5→4); other nervous system (3→4); skin graft (2→3); and splenectomy (2→3).

Risk index category	N	Rate	Risk index category	N	Rate	Risk index category	N	Rate
1	13285	1.69	2,3	4010	2.84	–	–	–
1	113169	3.46	2	22942	5.82	3	57	17.54
2,3	2420	4.05		–	–	–	–	–
2	1660	1.69	3	69	5.80	–	–	–
	–	–		–	–	–	–	–
1	2876	1.29	2,3	1048	3.24	–	–	–
1,2,3	1094	7.04		–	–	–	–	–
2,3	432	8.10		–	–	–	–	–
1	1876	7.52	2	1010	9.80	3	183	14.75
1	4125	3.15	2	2181	5.36	3	363	7.99
	–	–		–	–	–	–	–
1	4016	1.17	2,3	983	2.95	–	–	–
1,2,3	1306	2.68		–	–	–	–	–
1	595	5.71	2,3	280	13.93	–	–	–
2,3	272	2.94		–	–	–	–	–
1	3982	1.86	2,3	901	3.44	–	–	–
2,3	403	3.97		–	–	–	–	–
1,2,3	8112	1.75		–	–	–	–	–
	–	–		–	–	–	–	–
1,2,3	3573	5.12		–	–	–	–	–
1	19920	4.74	2,3	1641	8.65	–	–	–
1	9504	2.47	2,3	2012	6.11	–	–	–
	–	–		–	–	–	–	–
1,2,3	3937	1.47		–	–	–	–	–
	–	–		–	–	–	–	–
1	7206	3.07	2,3	1979	7.23	–	–	–
1	12709	1.33	2,3	2931	2.59	–	–	–
1	17638	1.55	2,3	5120	2.07	–	–	–
1	17101	1.22	2,3	4928	2.03	–	–	–
1	14064	1.38	2,3	4122	2.57	–	–	–
1	6680	0.93	2,3	1788	2.07	–	–	–
	–	–		–	–	–	–	–
	–	–		–	–	–	–	–
1,2,3	1046	0.96		–	–	–	–	–
	–	–		–	–	–	–	–
	–	–		–	–	–	–	–
2,3	806	4.47		–	–	–	–	–
	–	–		–	–	–	–	–
2,3	5711	6.99		–	–	–	–	–
1	30595	1.79	2,3	12515	5.05	–	–	–

For a hospital to be represented in Table 9, it must have reported sufficient data, that is, at least 30 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 10 lists 4 operations in which the use of a laparoscope has been incorporated into the SSI risk index. Laparoscopes and endoscopes are being used with increasing frequency to perform operations. A scope was used most frequently on the following procedures: cholecystectomy (64%), appendectomy (19%), vaginal hysterectomy (15%), other operations on ear, nose, or throat (14%), other genitourinary operations (10%), gastric surgery (8%), exploratory laparotomy (7%), other musculoskeletal operations (7%), thoracic (7%), herniorrhaphy (4%), and colon surgery (3%). A scope was used to perform the other remaining operative procedures less

Table 9. Percentiles of the distributuion of surgical site infection rates,* by operative procedure and risk index category,† surgical patient component, 1992-1998

Operative procedure category		Risk index category	No. Hospitals	Pooled mean rate	Percentile				
					10%	25%	50% (median)	75%	90%
CARD	Cardiac surgery	1	71	1.69	0.00	0.00	1.28	2.06	3.46
CARD	Cardiac surgery	2,3	45	2.84	0.00	0.00	2.01	3.96	6.57
CBGB	CABG-chest and donor site	1	123	3.46	1.09	1.92	2.95	4.29	6.70
CBGB	CABG-chest and donor site	2	107	5.82	1.30	3.09	5.43	7.80	10.82
CBGC	CABG-chest only	0,1	52	2.62	0.00	0.00	1.33	3.38	4.43
CBGC	CABG-chest only	2,3	29	4.05	0.00	0.00	1.81	3.61	6.16
OCVS	Other cardiovascular surgery	0,1	27	0.77	0.00	0.00	0.00	1.38	2.97
THOR	Thoracic surgery	1	31	1.29	0.00	0.00	0.00	2.01	2.77
OGIT	Other digestive tract surgery	0,1	21	3.23	0.00	1.41	2.38	5.05	7.36
SB	Small bowel surgery	1	24	7.52	2.49	4.17	6.38	10.42	16.80
XLAP	Laparotomy	0	30	1.69	0.00	0.00	1.43	2.40	4.55
XLAP	Laparotomy	1	37	3.15	0.00	0.23	2.60	3.98	6.69
XLAP	Laparotomy	2	25	5.36	0.00	1.25	4.04	7.84	9.80
NEPH	Nephrectomy	0,1,2,3	24	1.22	0.00	0.00	0.00	1.92	4.01
OGU	Other genitourinary	0	28	0.44	0.00	0.00	0.25	1.04	1.45
OGU	Other genitourinary	1	25	1.17	0.00	0.11	0.64	2.08	3.30
PRST	Prostatectomy	0	23	0.91	0.00	0.00	0.00	1.05	3.09
HER	Herniorrhaphy	0	40	0.79	0.00	0.00	0.24	1.45	2.33
HER	Herniorrhaphy	1	39	1.86	0.00	0.00	1.10	2.94	3.85
MAST	Mastectomy	0,1	48	2.07	0.00	0.00	0.86	2.42	3.42
CRAN	Craniotomy	0	26	0.58	0.00	0.00	0.00	1.34	2.38
CRAN	Craniotomy	1,2,3	51	1.75	0.00	0.00	0.92	2.36	3.23
VSHN	Ventricular shunt	1,2,3	30	5.12	0.00	1.15	3.84	6.16	9.76
CSEC	Cesarean section	0	96	3.27	0.00	1.21	2.59	5.69	9.12
CSEC	Cesarean section	1	87	4.74	0.00	1.56	3.38	7.16	9.77
CSEC	Cesarean section	2,3	22	8.65	0.00	4.27	6.60	13.07	18.08
HYST	Abdominal hysterectomy	0	66	1.50	0.00	0.00	1.16	2.33	4.23
HYST	Abdominal hysterectomy	1	63	2.47	0.00	0.00	1.55	2.79	4.71
HYST	Abdominal hysterectomy	2,3	29	6.11	0.00	2.74	4.71	9.42	11.61
VHYS	Vaginal hysterectomy	0	33	1.08	0.00	0.00	0.52	1.62	3.93
VHYS	Vaginal hysterectomy	1,2,3	34	1.47	0.00	0.00	1.15	1.95	4.23
AMP	Limb amputation	0,1,2,3	36	4.29	0.00	1.57	3.25	5.37	8.39
FUSN	Spinal fusion	0	57	1.23	0.00	0.00	0.47	1.45	2.56
FUSN	Spinal fusion	1	55	3.07	0.00	0.00	2.08	4.02	6.36
FUSN	Spinal fusion	2,3	26	7.23	0.00	4.67	7.02	9.60	13.46
FX	Open reduction fracture	1	60	1.33	0.00	0.00	0.90	1.64	2.37
HPRO	Hip prosthesis	0	91	0.78	0.00	0.00	0.00	1.09	2.81
HPRO	Hip prosthesis	1	119	1.55	0.00	0.00	1.04	2.35	3.85
HPRO	Hip prosthesis	2,3	73	2.07	0.00	0.00	1.06	3.80	6.29
KPRO	Knee prosthesis	0	91	0.87	0.00	0.00	0.31	1.59	2.80
KPRO	Knee prosthesis	1	111	1.22	0.00	0.00	0.93	1.91	3.24
KPRO	Knee prosthesis	2,3	68	2.03	0.00	0.00	1.47	3.45	5.56
LAM	Laminectomy	0	83	0.85	0.00	0.00	0.47	1.13	2.66
LAM	Laminectomy	1	77	1.38	0.00	0.00	1.01	2.37	3.38
LAM	Laminectomy	2,3	51	2.57	0.00	0.00	2.41	3.57	6.90
OMS	Other musculoskeletal	0	34	0.65	0.00	0.00	0.45	0.83	0.96
OMS	Other musculoskeletal	1	32	0.93	0.00	0.00	0.00	1.23	1.88
OSKN	Other integumentary system	0,1,2,3	26	1.38	0.00	0.00	0.95	1.49	2.39
VS	Vascular surgery	0	47	0.98	0.00	0.00	0.00	1.68	3.94
VS	Vascular surgery	1	83	1.79	0.00	0.71	1.38	2.25	3.50
VS	Vascular surgery	2,3	77	5.05	0.00	2.87	4.65	7.2	9.18
FX	Open reduction fracture	2,3	35	2.59	0.00	0.00	2.80	4.40	7.50

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, internal mammary artery used for bypass graft).

*Per 100 operations.

†Includes only those procedure-risk categories for which at least 20 hospitals have reported at least 30 operations.

Table 10. Surgical site infection rates,* by selected operative procedure and modified risk index category incorporating laparoscope use,† surgical patient component, 1992-1998

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	17095	0.49	0	15471	0.69	1	7417	2.04	2	2492	3.49	3	318	6.60
COLO Colon surgery	3	M	288	0.69	0	6812	4.32	1	11856	6.24	2	5267	9.55	3	718	12.95
APPY Appendectomy	1	0-Yes	893	0.56	0-No	3866	1.37	1	4957	3.17	2,3	2121	5.85	–	–	–
GAST Gastric surgery	3	0-Yes	203	0.49	0-No	1144	2.71	1	2416	5.13	2,3	1184	10.73	–	–	–

*Per 100 operations.
†This table uses a new modified risk index that incorporates the influence of laparoscope on SSI rates. The influence of scope on SSI rates was different across the four procedures:
For cholecystectomy and colon surgery, when the operation was done laparoscopically, 1 was subtracted from the number of risk factors (ASA score ≥3; duration of surgery >75th percentile; or contaminated or dirty wound class) in the NNIS risk index. For example, when two 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 minus 1 or "M."
For appendectomy and gastric surgery, 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" which means laparoscope was used and "0-No" when laparoscope was not used. Since there was no difference in the rates when 2 or 3 risk factors were present, the rates for categories 2 and 3 were combined into a single 2,3 category.

Table 11. Surgical site infection rates* after coronary artery bypass graft (CBGB) procedure, by risk index category and specific site, surgical patient component, January 1992-December 1997

	Risk index category							
	0		1		2		3	
Infection site	No. SSIs	Rate	No. SSIs	Rate	No. SSIs	Rate	No. SSIs	Rate
Donor site	4	0.36	1798	1.59	644	2.81	2	3.51
Superficial incisional	4	0.36	1453	1.28	504	2.20	2	3.51
Deep incisional	0	0.00	345	0.30	140	0.61	0	0.00
Chest	4	0.36	2120	1.87	692	3.02	8	14.04
Superficial incisional	3	0.27	892	0.79	285	1.24	2	3.51
Deep incisional	0	0.00	560	0.49	185	0.81	3	5.26
Organ/space	1	0.09	668	0.59	222	0.97	3	5.26
Total	8	0.73	3918	3.46	1336	5.82	10	17.54

*Per 100 operations.
Denominators for the risk categories are as follows:
Category 0 = 1098
Category 1 = 113169
Category 2 = 22942
Category 3 = 57

than 2% of the time. For 4 operations, the SSI rate was significantly different when a scope was used. When other risk factors were controlled, cholecystectomy, colon surgery, gastric surgery, and appendectomy had lower SSI rates when a scope was used. However, there were some differences among these operations. For cholecystectomy and colon surgery, the influence of scope use was captured by subtracting one from the number of risk factors (ASA score ≥3, duration of surgery >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 surgery, the use of a scope was only important if the patient had no other risk factors. Therefore, we split the index value of zero 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 11 displays SSI rates by specific site after coronary artery bypass graft (CBGB) operations in which

incisions are made at both the chest and the donor vessel harvest sites.

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.[8-10] You should also refer to Appendices A and B for further instructions. Appendix A discusses the calculation of infection rates and DU ratios for the ICU or HRN surveillance components. Appendix B 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.

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APPENDIX A.

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 upon 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, 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; five on day 2; two on day 3; five on day 4; three on day 5; four on day 6; and four 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 BSI rate per 1000 central line-days =

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

Calculation of Device Utilization (DU) Ratio

Steps 1,2,4: Same as 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 B for interpretation of the percentiles of the rates/ratios.

APPENDIX B.

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 whether 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 due to infrequent and/or short duration of device use.

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. 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 C.

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