

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

A report from the NNIS System\*

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

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.<sup>5-7</sup> The components may be used singly or simultaneously, but once selected, they must be used for a minimum of 1 calendar month. All infections are categorized into major and specific infection sites using standard CDC definitions that include laboratory and clinical criteria.<sup>6</sup>

## ADULT AND PEDIATRIC ICU SURVEILLANCE COMPONENT

Infection control professionals (ICPs) collect data on all sites of nosocomial infection in patients located in

ICUs, as well as ICU-specific denominator data. Site-specific infection rates can be calculated by using as a denominator the number of patients at risk, patient-days, and days of indwelling urinary catheterization, central vascular cannulation (central line), or ventilation.

## HRN SURVEILLANCE COMPONENT

ICPs collect data on all sites of nosocomial infection in patients located in HRN, and HRN-specific denominator data. Site-specific infection rates can be calculated by using as a denominator the number of patients at risk, patient-days, and days of umbilical catheter/central line use or ventilation for each of 4 birth-weight categories ( $\leq 1000$  gm, 1001-1500 gm, 1501-2500 gm, and  $\geq 2500$  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,<sup>8</sup> duration of operation, and American Society of Anesthesiology (ASA) score.<sup>9</sup> Using a composite index for predicting the risk of SSI after operation, ICPs can calculate rates by the number of risk factors present.<sup>4</sup>

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

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\*See [Appendix D](#).

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

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

UTI, Urinary tract infection; BSI, bloodstream infection.

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

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

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

to construct tables comprised of data from fewer and more recent years only (January 2002 through June 2004; Tables 1-4). However for the surgical patient component, we had to use all the data from January

1992 through June 2004, because the numbers of operations in each procedure-risk-stratum was too small to produce stable rates when only more recent years' data were used (Tables 5-8). Similarly, Tables 9

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

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

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

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

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

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

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

vice utilization (DU) ratios by type of ICU.<sup>1,2</sup> As noted above, data from a shorter, more recent time period is presented which differs from previous reports. In general, the device-associated urinary tract and

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

| Umbilical and central line-associated BSI rate* |             |                   |             | Percentile |     |              |      |      |
|---|-------------|-------------------|-------------|------------|-----|--------------|------|------|
| Birth-weight category                           | No. of HRNs | Central line-days | Pooled mean | 10%        | 25% | 50% (median) | 75%  | 90%  |
| ≤ 1000 g  | 104         | 204,468           | 9.1         | 1.6        | 5.4 | 8.5          | 11.6 | 16.1 |
| 1001-1500 g                                     | 98          | 95,254            | 5.4         | 0.0        | 1.8 | 4.0          | 7.4  | 12.2 |
| 1501-2500 g                                     | 97          | 79,904            | 4.1         | 0.0        | 0.0 | 3.2          | 6.5  | 8.9  |
| >2500 g   | 94          | 97,202            | 3.5         | 0.0        | 0.0 | 1.9          | 4.1  | 7.4  |

| Ventilator-associated pneumonia rate† |             |                 |             | Percentile |     |              |     |     |
|---------------------------------------|-------------|-----------------|-------------|------------|-----|--------------|-----|-----|
| Birth-weight category                 | No. of HRNs | Ventilator-days | Pooled mean | 10%        | 25% | 50% (median) | 75% | 90% |
| ≤ 1000 g                              | 102         | 204,117         | 3.5         | 0.0        | 0.0 | 2.4          | 5.8 | 8.5 |
| 1001-1500 g                           | 91          | 50,204          | 2.4         | 0.0        | 0.0 | 0.0          | 3.2 | 8.0 |
| 1501-2500 g                           | 86          | 39,957          | 1.9         | 0.0        | 0.0 | 0.0          | 1.5 | 6.1 |
| >2500 g                               | 90          | 55,038          | 1.4         | 0.0        | 0.0 | 0.0          | 0.9 | 3.2 |

BSI, Bloodstream infection.

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

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

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

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

| Ventilator utilization ratio† |             |              |             | Percentile |      |              |      |      |
|-------------------------------|-------------|--------------|-------------|------------|------|--------------|------|------|
| Birth-weight category         | No. of HRNs | Patient-days | Pooled mean | 10%        | 25%  | 50% (median) | 75%  | 90%  |
| ≤ 1000 g                      | 105         | 489,195      | 0.43        | 0.22       | 0.32 | 0.43         | 0.53 | 0.63 |
| 1001-1500 g                   | 104         | 319,316      | 0.16        | 0.05       | 0.09 | 0.15         | 0.20 | 0.35 |
| 1501-2500 g                   | 103         | 388,630      | 0.10        | 0.03       | 0.05 | 0.07         | 0.16 | 0.27 |
| >2500 g                       | 103         | 335,430      | 0.17        | 0.04       | 0.06 | 0.11         | 0.21 | 0.33 |

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

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

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

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

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

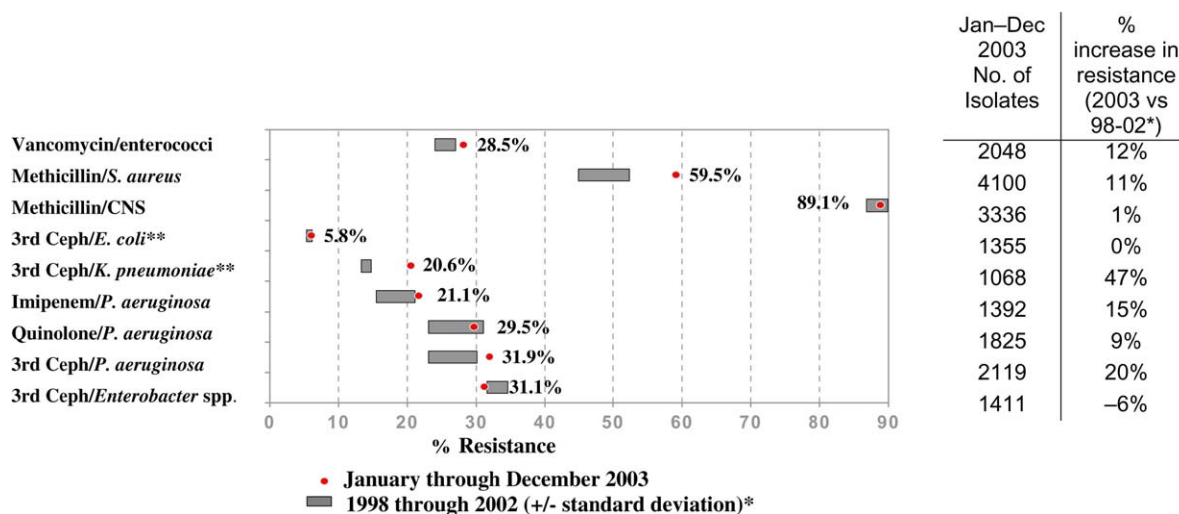
| Operative procedure category    | Duration cut point (h) | Risk index category | Risk index |      | Risk index |         | Risk index |      | Risk index |       |   |           |
|---------------------------------|------------------------|---------------------|------------|------|------------|---------|------------|------|------------|-------|---|-----------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

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

\*Per 100 operations.

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

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



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

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

Site distributions of infections for coronary care, medical, pediatric, and combined medical-surgical ICUs have been published elsewhere.<sup>10-13</sup>

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

adjusted and comparisons of these rates between hospitals should be made with caution.

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

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



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

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

Continued on next page

Table 6. (Continued)

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

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

\*Per 100 operations.

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

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

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

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



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

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

\*Per 100 operations.

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

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

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

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

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

\*Per 100 operations.

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

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

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

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

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

Continued on next page

**Table 9.** (Continued)

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

Continued on next page

**Table 9.** (Continued)

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

| Pediatric ICU (n = 16)           |          |             | Percentile |     |              |     |     |
|----------------------------------|----------|-------------|------------|-----|--------------|-----|-----|
| Antimicrobial agent              | No. DDD* | Pooled mean | 10%        | 25% | 50% (median) | 75% | 90% |
| Penicillin group                 | 2162     | 41.6        | —          | —   | —            | —   | —   |
| Ampicillin group                 | 4818     | 92.7        | —          | —   | —            | —   | —   |
| Antipseudomonal penicillins      | 575      | 11.1        | —          | —   | —            | —   | —   |
| Antistaphylococcal penicillins   | 1829     | 35.2        | —          | —   | —            | —   | —   |
| First-generation cephalosporins  | 2531     | 48.7        | —          | —   | —            | —   | —   |
| Second-generation cephalosporins | 1690     | 32.5        | —          | —   | —            | —   | —   |
| Third-generation cephalosporins  | 7564     | 145.6       | —          | —   | —            | —   | —   |
| Carbapenem group                 | 421      | 8.1         | —          | —   | —            | —   | —   |
| Aztreonam                        | 90       | 1.7         | —          | —   | —            | —   | —   |
| Fluoroquinolones                 | 668      | 12.8        | —          | —   | —            | —   | —   |
| Trimethoprim/sulfamethoxazole    | 908      | 17.5        | —          | —   | —            | —   | —   |
| Vancomycin (oral)                | 160      | 3.1         | —          | —   | —            | —   | —   |
| Vancomycin (parenteral)          | 3329     | 64.1        | —          | —   | —            | —   | —   |

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

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

the table. The number of neurosurgical and pediatric ICUs and hematology/oncology/transplant wards is insufficient to provide percentile distributions; only pooled mean usage rates are displayed. Table 10 shows ICARE/AUR resistance data for selected antimicrobial-resistant bacteria on the basis of reported antimicrobial susceptibility test results on all non-duplicate clinical isolates processed by the laboratory during each study month. A duplicate isolate was defined as an isolate of the same species of bacteria with the same antimicrobial susceptibility pattern in the same patient in the same month, regardless of the site of isolation. All isolates, whether responsible for hospital-acquired or community-acquired infection or for colonization, were reported to ICARE/AUR by participating hospitals. Hospitals used National Committee for Clinical Laboratory Standards interpretive standards for minimum inhibitory concentration, or zone diameter testing standards to report numbers of susceptible, intermediate, or resistant organisms. A minimum of 10 isolates

must be tested in a hospital area for resistance rates to be calculated for that area. Resistance data have been combined for all ICU types because detailed analysis demonstrated that, in general, resistance rates (percent prevalence) did not differ by type of ICU. Also, these data show that for most antimicrobial-resistant bacteria, resistance rates are highest in the ICU areas, followed by non-ICU inpatient areas, with lowest rates in the outpatient areas.

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

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

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

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

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

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

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

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

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

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

Continued on next page



**Appendix A.** (Continued)

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

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

**Appendix B.**

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

#### Calculation of Device-associated Infection Rate

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

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

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

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

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

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

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

*Example:*

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

## Calculation of DU Ratio

**Steps 1,2,4:** Same as that for device-associated infection rates, plus determine the number of patient-days which is used as the denominator of the DU ratio. Patient-days are the total number of days that patients are in the ICU (or HRN) during the selected time period.

*Example:* Ten patients were in the unit on the first day of the month; 12 on day 2; 11 on day 3; 13 on day 4; 10 on day 5; 6 on day 6; and 10 on day 7; and so on. If we counted the patients in the unit from days 1 through 7, we would add 10 + 12 + 11 + 13 + 10 + 6 + 10 for a total of 72 patient-days for the first week of the month. If we continued for the entire month, the number of patient-days for the month is simply the sum of the daily counts.

**Step 5:** Calculate the DU ratio with the following formula:

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

With the number of device-days and patient-days from the examples above,  $\text{DU} = 28/72 = 0.39$  or 39% of patient-days were also central line-days for the first week of the month.

**Step 6:** Examine the size of the denominator for your hospital's rate or ratio. Rates or ratios may not be good estimates of the true rate or ratio for your hospital if the denominator is small, ie, <50 device-days or patient-days.

**Step 7:** Compare your hospital's ICU/HRN rates or ratios with those found in the tables of this report. Refer to [Appendix C](#) for interpretation of the percentiles of the rates/ratios.

## Appendix C.

### INTERPRETATION OF PERCENTILES OF INFECTION RATES OR DEVICE UTILIZATION RATIOS

**Step 1:** Evaluate the rate (ratio) you have calculated for your hospital and confirm that the variables in the rate (both numerator and denominator) are identical to the rates (ratios) in the table.

**Step 2:** Examine the percentiles in each of the tables and look for the 50th percentile (or median). At the 50th percentile, 50% of the hospitals have lower rates (ratios) than the median and 50% have higher rates (ratios).

**Step 3:** Determine if your hospital's rate (ratio) is above or below this median.

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

**Step 4:** If it is above the median, determine whether the rate (ratio) is above the 75th percentile. At the 75th percentile, 75% of the hospitals had lower rates (ratios) and 25% of the hospital had higher rates (ratios).

**Step 5:** If the rate (ratio) is above the 75th percentile, determine whether it is above the 90th percentile. If it is, then the rate (ratio) is a high outlier which *may* indicate a problem.

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

**Step 6:** If it is below the median, determine whether the rate (ratio) is below the 25th percentile. At the 25th percentile, 25% of the hospitals had lower rates (ratios) and 75% of the hospitals had higher rates (ratios).

**Step 7:** If the rate (ratio) is below the 25th percentile, determine whether it is below the 10th percentile. If the rate is, then it is a low outlier which may be due to underreporting of infections. If the ratio is below the 10th percentile, it is a low outlier and may be a result of infrequent DU, short duration of DU, or both.

**Note:** Device-associated infection rates and device utilization ratios should be examined together so that preventive measures may be appropriately targeted. For example, you find that the ventilator-associated pneumonia rate for a certain type of ICU is consistently above the 90th percentile and the ventilator utilization ratio is routinely between the 75th and 90th percentile. Since the ventilator is a significant risk factor for pneumonia, you may want to target your efforts on reducing the use of ventilators or limiting the duration with which they are used on patients in order to lower the ventilator-associated pneumonia rate in the unit.

## Appendix D

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