Nosocomial Infections in Pediatric Intensive Care Units in the United States

Michael J. Richards, MB, BS, FRACP; Jonathan R. Edwards, MS; David H. Culver, PhD; Robert P. Gaynes, MD; and the National Nosocomial Infections Surveillance System

ABSTRACT. Objectives. To describe the epidemiology of nosocomial infections in pediatric intensive care units (ICUs) in the United States.

Background. Patient and ICU characteristics in pediatric ICUs suggest the pattern of nosocomial infections experienced may differ from that seen in adult ICUs.

Methods. Data were collected between January 1992 and December 1997 from 61 pediatric ICUs in the United States using the standard surveillance protocols and nosocomial infection site definitions of the National Nosocomial Infections Surveillance System’s ICU surveillance component.

Results. Data on 110,709 patients with 6,290 nosocomial infections were analyzed. Primary bloodstream infections (28%), pneumonia (21%), and urinary tract infections (15%) were most frequent and were almost always associated with the use of an invasive device. Primary bloodstream infections and surgical site infections were reported more frequently in infants aged 2 months or less as compared with older children. Urinary tract infections were reported more frequently in children >5 years old compared with younger children. Coagulase-negative staphylococci (38%) were the most common bloodstream isolates, and aerobic Gram-negative bacilli were reported in 25% of primary bloodstream infections. Pseudomonas aeruginosa (22%) was the most common species reported from pneumonia and Escherichia coli (19%), from urinary tract infections. Enterobacter spp. were isolated with increasing frequency from pneumonia and were the most common Gram-negative isolates from bloodstream infections. Device-associated infection rates for bloodstream infections, pneumonia, and urinary tract infections did not correlate with length of stay, the number of hospital beds, or season.

Conclusions. In pediatric ICUs, bloodstream infections were the most common nosocomial infection. The distribution of infection sites and pathogens differed with age and from that reported from adult ICUs. Device-associated infection rates were the best rates currently available for comparisons between units, because they were not associated with length of stay, the number of beds in the hospital, or season. Pediatrics 1999;103(4). URL: http://www.pediatrics.org/cgi/content/full/103/4/e39; intensive care units, pediatrics, epidemiology, cross infection, risk factors, bacteremia, pneumonia, urinary tract infections.

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**Fig 1.** Site distribution of nosocomial infections in pediatric intensive care units, by age. BSI indicates bloodstream infection; UTI, urinary tract infection; PNE, pneumonia; LRI, lower respiratory infection other than pneumonia; SSI, surgical site infection; EENT, eye, ear, nose, or throat infection; GI, gastrointestinal infection; SST, skin or soft tissue infection; CVS, cardiovascular infection; OTHR, other infection.

**TABLE 1.** Specific Infection Site Distribution in Pediatric Intensive Care Unit Patients (NNIS 1992–1997)

<table>
<thead>
<tr>
<th>Infection</th>
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<tbody>
<tr>
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<tr>
<td>Bloodstream infections</td>
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<tr>
<td>Laboratory confirmed bloodstream infections</td>
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<tr>
<td>Clinical sepsis</td>
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<tr>
<td>Pneumonia</td>
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<tr>
<td>Urinary tract infections</td>
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<tr>
<td>Symptomatic UTI</td>
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<tr>
<td>Asymptomatic UTI</td>
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<tr>
<td>Other</td>
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<tr>
<td>Surgical site infections</td>
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<tr>
<td>Skin</td>
</tr>
<tr>
<td>Intraabdominal abscess</td>
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<tr>
<td>Soft tissue</td>
</tr>
<tr>
<td>Mediastinitis</td>
</tr>
<tr>
<td>Meningitis</td>
</tr>
<tr>
<td>Other</td>
</tr>
<tr>
<td>Eye, ear, nose, and throat infections</td>
</tr>
<tr>
<td>Sinusitis</td>
</tr>
<tr>
<td>Ear</td>
</tr>
<tr>
<td>Conjunctivitis</td>
</tr>
<tr>
<td>Other eye infections</td>
</tr>
<tr>
<td>Upper respiratory tract infection</td>
</tr>
<tr>
<td>Oral</td>
</tr>
<tr>
<td>Cardiovascular infections</td>
</tr>
<tr>
<td>Vascular</td>
</tr>
<tr>
<td>Endocarditis</td>
</tr>
</tbody>
</table>

Abbreviations: NNIS, National Nosocomial Infections Surveillance (System); UTI, urinary tract infection.
The results show that the incidence of nosocomial infections in PICUs was higher among children younger than 5 years of age, with a peak in those aged 2 months or less. The distribution of major infection sites differed by age group, with bloodstream infections occurring more frequently in older children and urinary tract infections in younger children. The median length of stay for infected children was 4.8 days in 1992 compared to 4.3 days in 1997.

Distribution of Nosocomial Infections by Site

The distribution of infections was examined by the major site of infection. Three major infection sites represented 64% of all reported infections: bloodstream infections, pneumonia, and urinary tract infections. The distribution of nosocomial infections by age showed a peak in children aged 2 months to 5 years for bloodstream infections, followed by pneumonia and urinary tract infections. The proportion of infections due to bloodborne pathogens was higher in children younger than 5 years compared to older children. UTIs accounted for a smaller percentage of infections in those children.

The table below shows the commonly reported pathogens from patients in pediatric intensive care units, by site (NNIS 1992–1997).

### Table 2: Commonly Reported Pathogens From Patients in Pediatric Intensive Care Units, by Site (NNIS 1992–1997)

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Bloodstream Infection % (n = 1887)</th>
<th>Pneumonia % (n = 1459)</th>
<th>Urinary Tract Infection % (n = 1045)</th>
<th>Lower Respiratory Tract Infection % (n = 935)</th>
<th>Surgical Site Infection % (n = 544)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coagulase-negative staphylococci</td>
<td>37.8</td>
<td>0.9</td>
<td>4.3</td>
<td>1.5</td>
<td>14.0</td>
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<tr>
<td>Enterococcus</td>
<td>11.2</td>
<td>1.0</td>
<td>10.0</td>
<td>1.2</td>
<td>8.1</td>
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<tr>
<td>Staphylococcus aureus</td>
<td>9.3</td>
<td>16.9*</td>
<td>1.5</td>
<td>18.8</td>
<td>20.2†</td>
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<tr>
<td>Enterobacter spp.</td>
<td>6.2</td>
<td>9.3†</td>
<td>10.3</td>
<td>12.2</td>
<td>8.1</td>
</tr>
<tr>
<td>Candida albicans</td>
<td>5.5‡</td>
<td>14.3§†</td>
<td>3.6</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>4.9</td>
<td>21.8</td>
<td>13.1‡</td>
<td>15.1</td>
<td>14.5‡</td>
</tr>
<tr>
<td>Klebsiella pneumoniae</td>
<td>4.1</td>
<td>5.3</td>
<td>7.3</td>
<td>3.5</td>
<td>3.7</td>
</tr>
<tr>
<td>Other Candida</td>
<td>3.4*</td>
<td>0.4</td>
<td>6.2</td>
<td>1.1</td>
<td>2.0</td>
</tr>
<tr>
<td>Escherichia coli</td>
<td>2.9</td>
<td>3.6</td>
<td>19‡†</td>
<td>3.2</td>
<td>5.1</td>
</tr>
<tr>
<td>Acinetobacter spp.</td>
<td>2.0</td>
<td>3.1</td>
<td>0.4</td>
<td>3.1</td>
<td>0.7</td>
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<tr>
<td>Serratia marcescens</td>
<td>2.0</td>
<td>3.6</td>
<td>1.2</td>
<td>3.6</td>
<td>2.8</td>
</tr>
<tr>
<td>Streptococcus pneumoniae</td>
<td>0.6</td>
<td>3.4</td>
<td>0</td>
<td>2.6</td>
<td>0.6</td>
</tr>
<tr>
<td>Citrobacter</td>
<td>0.5</td>
<td>0.5</td>
<td>4.3</td>
<td>1.1</td>
<td>1.8</td>
</tr>
<tr>
<td>Candida glabrata</td>
<td>0.4*</td>
<td>0</td>
<td>0.6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other fungi</td>
<td>0.2*</td>
<td>0.7</td>
<td>1.6</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Group B streptococcus</td>
<td>0.1</td>
<td>0.2</td>
<td>0.1</td>
<td>0</td>
<td>0.4</td>
</tr>
<tr>
<td>Haemophilus influenzae</td>
<td>0.1</td>
<td>10.2</td>
<td>0</td>
<td>5.8</td>
<td>0.9</td>
</tr>
<tr>
<td>Aspergillus</td>
<td>0.1</td>
<td>0.5</td>
<td>0</td>
<td>0.1</td>
<td>0.7</td>
</tr>
<tr>
<td>Viruses</td>
<td>0.1</td>
<td>2.5†</td>
<td>0.2</td>
<td>10.1</td>
<td>0</td>
</tr>
</tbody>
</table>

Abbreviation: NNIS, National Nosocomial Infections Surveillance (System).

* Reports of fungi from bloodstream infections and S aureus from pneumonia were more common in children >5 years than younger children (P < .001).
† Reports of Enterobacter spp and viruses from pneumonia and S aureus from wound infections were more common in children 2 months and younger than in older children (P < .001).
‡ Reports of E coli from urinary tract infections and P aeruginosa from surgical site infections were more common in children >2 months (P < .02) than in neonates.
§ Reports of C albicans from urinary tract infections were more common in children >12 years than in younger children (P < .002).
¶ Pathogens associated with use of an invasive device (see text).
ceding surgical site infections in the PICU. The most frequent types of preceding surgical procedure were chest surgery, including cardiovascular surgery (41%); gastrointestinal surgery (24%); neurosurgery (13%); transplant surgery (8%); orthopedic surgery (5%); vascular surgery (3%); and head and neck surgery (3%).

The distribution of specific sites of infection within selected common major infection sites (Table 1) was similar across the age groups, with a few exceptions. Of infections of the eyes, ears, nose, and throat, ear infections and conjunctivitis were more frequent in children 5 years and younger than older children: (87/311 [28.0%] vs 15/115 [13.0%], P < .001, and 60/311 [19.3%] vs 8/115 [7.0%], P < .001, respectively), whereas sinusitis was more frequently reported in children >5 years compared with younger children (61/115 [53.0%] vs 52/311[16.7%], P < .001). Of surgical site infections, intraabdominal infections were more frequent in children >2 months than in younger children (79/330 [23.9%] vs 8/116 [6.9%, P < .001), and mediastinitis was more common in children 5 years or younger than in older children (44/341 [12.9%] vs 3/105 [2.9%, P = .001). Twenty-two episodes of nosocomial endocarditis were reported, 18 in patients <1 year of age. Twelve episodes of necrotizing enterocolitis were reported, all in children <1 year of age.

Each of the three major sites of nosocomial infection, bloodstream infection, pneumonia, and UTI, was strongly associated with use of an invasive device. Of bloodstream infections, 91% were in patients with a central intravenous line present. Of episodes of nosocomial pneumonia, 95% were in patients on mechanical ventilation. Of nosocomial UTIs, 77% were in patients with urinary tract catheters.

Pathogen Distributions Among Nosocomial Infections

Primary Bloodstream Infections

Coagulase-negative staphylococci (38%) were the most common pathogens reported (Table 2). Gram-negative aerobic bacilli were reported frequently (25% of all isolates for all species); Enterobacter spp. was the most commonly reported species.

Nosocomial Pneumonia

Sixty-seven percent of reported isolates were Gram-negative aerobic bacilli. Pseudomonas aeruginosa (22%) was the most frequently reported isolate, followed by Staphylococcus aureus (17%). Of 36 viral isolates reported from children with nosocomial pneumonia, 27 (75%) were respiratory syncytial virus. Of 94 viral isolates reported from children with nosocomial lower respiratory tract infections other than pneumonia, 77 (82%) were respiratory syncytial virus.

UTIs

Fifty-seven percent of reported isolates were aerobic Gram-negative bacilli. Escherichia coli was the most frequently reported isolate (19%). Twenty-three percent of reported isolates were fungi, most frequently Candida albicans (14%).

Surgical Site Infections

The pathogens reported from surgical site infections differed according to the type of procedure. P aeruginosa (16%) was the most common pathogen reported after gastrointestinal tract surgery, followed by S aureus (10%). S aureus (34%) was the most common pathogen reported after chest and cardiovascular surgery, followed by coagulase-negative staphylococci (18%). Coagulase-negative staphylococci (23%) were the most common pathogens reported after neurosurgery, followed by S aureus (19%).

Other Specific Sites

Of 190 pathogens reported from 194 episodes of nosocomial gastroenteritis, 99 (52%) were reported as Gram-positive anaerobes, presumably Clostridium difficile. Eighty-four (44%) were viruses. Of these, 62 (74%) were rotaviruses and 11 (13%) enteroviruses. Of 62 pathogens reported from 113 episodes of nosocomial sinusitis, 33 (53%) were Gram-negative aerobic bacilli and the most frequent of these were P aeruginosa (18%) and Enterobacter spp. (13%). Sixteen percent of pathogens were S aureus. Of 89 pathogens reported from 51 episodes of nosocomial meningitis or ventriculitis, 36 (40%) were coagulase-negative staphylococci, 10 (11%) were S aureus, and 36 (40%) were aerobic Gram-negative bacilli. Of 27 pathogens reported from 22 episodes of nosocomial endocarditis, 7 (26%) were coagulase-negative staphylococci, 6 (22%) were S aureus, 6 (22%) enterococci, and 4 (15%) aerobic Gram-negative bacilli.

Changes in the Pathogen Distribution With Use of Invasive Devices

We noted a difference in the pathogen distribution in patients with device-associated infections compared with patients with infections when an invasive device was not present. Fungal bloodstream infections were more commonly reported in primary bloodstream infections associated with central lines than in noncentral line-associated bloodstream infections (173/1710 [10.1%] vs 8/176 [4.5%, P = .008, respectively). Viral pneumonia was less commonly reported in pneumonia associated with mechanical ventilation than nonventilator-associated pneumonia (27/1379 [2.0%] vs 9/80 [11.3%, P < .001, respectively). P aeruginosa and C albicans UTIs were more commonly reported in UTIs associated with urinary catheters than in noncatheter-associated UTIs (115/800 [14.4%] vs 22/245 [9.0%, P = .02, 133/800 [16.6%] vs 16/245 [6.5%, P < .001, respectively).

Temporal Changes in Pathogen Distribution

We examined changes in the frequency of pathogens from all infection sites during the 6 years. Enterobacter spp. was more frequently reported in later years, increasing from 7% to 12% of reported pathogens (χ² value for linear trend, P < .001). This change was most marked in respiratory infections, ie, the frequency of reports of Enterobacter spp. from pneumonia increased in the 6-year period from 7.4% to 13% (χ² test for trend, P = .02). For bloodstream infection isolates, P aeruginosa was reported more
frequently later in the 6-year period (3.0% to 7.4%, \( P = .02 \)). \( S. aureus \) was more frequently reported in earlier years, decreasing from 16% to 10% of all pathogens in all infection sites (\( P = .001 \)).

Nosocomial Infection Rates and Device Utilization

The mean overall patient nosocomial infection rate was 6.1 infections per 100 patients, and the mean infection rate per 1000 patient days was 14.1. However, these overall rates were strongly correlated with other measures, ie, with length of stay (\( r = 0.45, P = .0002 \)) and central line, ventilator, and urinary catheter use (\( r = 0.65, 0.56, 0.40; P = .0001, .0001, .001 \), respectively). After we controlled for device exposure by calculating device-associated infection rates, central line-associated bloodstream infections, ventilator-associated pneumonia, and catheter-associated UTIs did not correlate with length of stay (\( r = 0.11, −0.04, −0.005; P = .39, .77, .97 \), respectively), with associated-device utilization (\( r = −0.01, 0.09, −0.09; P = .92, .48, .47 \), respectively), or hospital size by number of beds (\( r = 0.07, 0.12, 0.07; P = .59, .37, .58 \), respectively, for each device). On univariate analysis we found a weak, negative association between rates of catheter-associated UTIs with ICU size (\( r = −0.31, P < .02 \)) but no such association for ventilator-associated pneumonia or line-associated bloodstream infections (\( r = −0.19, 0.19; P = .08, .08 \), respectively). The distribution of the device-associated rates is shown in Figs 2, 3, and 4. The distribution of each of the three device-associated rates in the PICUs in pediatric as compared with nonpediatric hospitals did not differ.

We used linear regression modeling to further assess potential associations with the three device-associated infection rates and total number of hospital beds, rates of associated device utilization, ICU bedsize, and the average length of stay in the ICU. There was no significant association between the device-associated infection rates and any of these variables with the exception of ICU bedsize. We found a negative association with ICU bedsize for both catheter-associated UTI and ventilator-associated pneumonia rates (\( P < .002 \)). We examined the three nosocomial device-associated infection rates for the four 3-month seasons. Controlling for length of ICU stay, year of infection, hospital size, and ICU size, we found no seasonal variation.

Use of Invasive Devices

Device utilization varied greatly between the PICUs (Table 3). Urinary catheter utilization was the lowest among the three devices.

DISCUSSION

Our analysis suggests that the epidemiology of nosocomial infections in PICUs differs from that seen in other critical care areas. The distribution of infection sites lies between what we have previously reported in neonatal ICUs and adult medical ICUs. First, primary bloodstream infections were the most common sites of infection, followed by pneumonia and UTIs. In adult medical ICUs, UTIs were most frequently reported. In neonatal ICUs, bloodstream infections were even more frequent than in pediatric units. We saw a transition between the two patterns with age, although bloodstream infections remained the most frequent nosocomial infections in adolescents. This distribution may in part reflect lower rates of urinary catheter use in PICUs; the pooled mean rate of urinary catheter utilization in PICUs was 0.32, as compared with 0.69 in medical ICUs. Surgical site infections, particularly skin infections and mediastinitis, were more frequent in neonates, reflecting early surgery for congenital defects. Nosocomial lower respiratory tract infections not classified as pneumonia were reported more frequently in PICUs (12% vs 4.4%), and cardiovascular infections, usually phlebitis, less frequently (1.9% vs 4.2% of major sites of infection) than in adult medical ICUs. Also, sinusitis was reported predominantly in older children.

The distribution of pathogens in PICUs differed from that we have observed in adults, and within the PICUs and changed with age. In primary nosocomial bacteremia, Gram-negative bacteria were more frequently reported in PICUs than in adult medical ICUs (25% vs 17%). \( Enterobacter \) spp. was the most common Gram-negative species reported in PICU patients with primary bacteremia and cardiovascular infections. Others have suggested that enterococci are infrequent bloodstream pathogens in pediatric settings, but enterococci were reported more frequently than \( S. aureus \). In nosocomial respiratory infections, \( Enterobacter \) spp. was reported more frequently in neonates. Viral infections were reported
as important pediatric nosocomial respiratory pathogens, but are rarely reported as adult ICU nosocomial pathogens. Others have noted that viruses are less frequent as nosocomial pathogens in PICUs than in other areas of pediatric hospitals. This may, in part, explain the lack of seasonal variation in device-associated infection rates. Fungal pathogens were reported more commonly in bloodstream infections in school-aged children, but much less frequently in UTIs than we have recently reported in adult medical ICUs (23% vs 39%). These differences in pathogen distribution seem likely to be, in part, an effect of age but also to reflect other patient-related factors, including underlying medical and surgical conditions, previous hospital stay, and antibiotic exposure.

*Enterobacter* spp. was reported with increasing frequency throughout the 6 years examined, particularly in respiratory tract infections and were the most frequently reported Gram-negative pathogens after *P. aeruginosa* in surgical site infections and eye, ear, nose, and throat infections. Individual institutions have reported nosocomial outbreaks of *E. cloacae* in neonatal and pediatric ICUs and increased *Enterobacter* spp. bacteremia in pediatric patients. Enterobacter organisms are intrinsically resistant to first-generation cephalosporins and their prominence in these units may reflect selective pressure of these frequently used agents. Emergence in adults of broadly resistant *Enterobacter* spp. through high level production of chromosomal β-lactamase seems to develop in individual patients through mutation rather than crossinfection. In adults, this has been associated with previous therapy with a third-generation cephalosporin rather than with an aminoglycoside or extended-spectrum penicillin.

We noted a mean overall patient infection rate of 6.1%. Brown et al. reported 7% of patients admitted to a PICU developed an ICU-acquired infection, in a study using NNIS definitions and methods. In previous studies in other ICU types, overall nosocomial infection rates were confounded by average length of stay and rates of device utilization. However, device-associated infection rates in PICUs were not confounded by these factors or by the hospital bed-size. We noted slightly lower rates of catheter-associated UTIs and ventilator-associated pneumonia rates in larger PICUs although the significance of this finding for purposes of comparing rates is not clear. This may reflect differences in intrinsic risk factors including differences in the severity of illness in patients using these urinary catheters or ventilators, differences in the duration of urinary catheterization in patients after, for example, surgical procedures, or differences in reporting. We observed a considerable variation in these rates that our current NNIS data collection does not explain. More detailed surveillance to investigate other risk factors, both intrinsic to the patient and relating to the ICU environment and procedures, may explain these variations but involves a further burden of data collection.

Differences in nosocomial infection rates according to the type of ICU have been previously de-
reported that children under 2 years of age have the
was higher (pooled mean, 7.3 vs 3.1). Others have
(pooled mean, 5.9 vs 9.1 and 5.9 vs 9.5), and the
central line-associated bloodstream infection rate
was higher (pooled mean, 7.3 vs 3.1). Others have
reported that children under 2 years of age have the
highest nosocomial infection rates in PICUs with up
to 25% of children in this group infected.3 Our data
show the distribution of infection sites differed with
age. Thus, differences in the age distribution among
PICUs may explain some differences between noso-
comial infection rates in different PICUs.

Device utilization in PICUs was comparable to that
in adult medical ICUs,8 apart from lower rates of
urinary catheter utilization. Within PICUs, we found
considerable variation in rates of device utilization.
High ventilator utilization ratios may reflect severity
of illness that may explain, in part, some of the
variation. Also, there may be step-down facilities in
certain institutions, allowing earlier discharge from
the PICU, reducing nondevice-days, and increasing
the utilization ratio.

These surveillance data have several limitations.
These ICUs were generally in large hospitals with
academic departments and may not be representa-
tive of smaller institutions. Pulmonary infection in
the ICU often is particularly difficult to differenti-
te from noninfective pulmonary infiltrates and the
microbiology reported from sputum cultures may be
contaminated by upper respiratory tract flora. Viral
infections were underreported because appropriate
cultures were not always performed. Data reported
here may reflect underreporting of infections at sites
other than the three most frequent sites, as noted in
a recent evaluation study of NNIS hospitals.18 We
reported the types of surgery preceding surgical site
infections, but lack denominator data on the number
and details of these procedures to evaluate the risk
of infection after the procedure. For that information
to be most useful, surgical site infection data collection
should not be restricted to the ICU. We did not
collect denominator data on risk factors apart from
device use, which limits comparison of rates between
units.

CONCLUSIONS

In PICUs, the distribution of infection sites and of
pathogens lay between that reported in neonatal
ICUs and adult ICUs, and changed with the age of
the patients. Device-associated infection rates were
the best available rates for comparisons between
units because they were not confounded by length of
stay, total number of hospital beds, or differences in
the associated device utilization.

REFERENCES
1. Pollack MM, Yeh TS, Ruttiman UE, et al. Evaluation of pediatric inten-
S30–S33
Surveillance System. Description of surveillance methods. Am J Infect
Control. 1991;19:35–38
CG, ed. Hospital Epidemiology and Infection Control. Baltimore, MD: Wil-
liams and Wilkins; 1995;A3
neonates in high risk nurseries in the United States. Pediatrics. 1996;98:
357–361
4684 hospital-acquired infections in pediatric patients. Pediatr Infect Dis
J. 1989;8:668–675
11. Wang CC, Chu M, Ho L, Hwang R. Analysis of plasid pattern in
pediatric intensive care unit outbreaks of nosocomial infection due to
12. Andersen J, Asmabar BL, Dujan MI. Increasing Enterobacter bacteraemia
features and emergence of antibiotic resistance during therapy. Ann Intem
14. Weisscher M, Schumacher H, Kolmos HJ. Resistance characteristics of
blood culture isolates of Enterobacter cloacae with special reference to
beta lactamases and relation to preceding antimicrobial therapy. APAMIS.
1991;91:1855–1915
16. Roberts JA, Fussekk EN, Khan MB. Bacterial adherence to urethral
17. Werbel RF, Thompson RL, Landry SM, et al. Hospital acquired infec-
tion in intensive care unit patients: An overview with an emphasis on
comial infections in intensive care unit patients to the National Nosoco-
mail Infections Surveillance (NNIS) System. Infect Control Hosp Epi-
demiol. 1998;19:308–316
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