Healthcare-associated infections in a newly opened intensive care unit

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Abstract

Background. Healthcare-associated infections (HAIs) are common complications in ICU patients due to high invasive device utilization rates. The aim of the study was to analyse the epidemiology of ventilator-associated pneumonias (VAPs), blood stream infections (BSIs), urinary tract infections (UTIs) and surgical site infections (SSIs) in a newly opened medical-surgical intensive care unit.

Methods. Based on the CDC criteria, the Infection Control Team detected and recorded VAP, BSI, UTI and SSI cases over a 12-month period following the opening of a new ICU.

Results. HAIs were diagnosed in 44 out of 168 patients (26%). The ventilator utilization was 72%. The incidence density of VAP was 15.5/1000 ventilator days. The central line utilization was 100%. The BSI rate was 5/1000 catheter-line days. The urinary catheter utilization was 95%. The UTI rate was 1.9/1000 catheterization days. SSIs occurred in 8 out of 60 surgical patients (13%). The most common isolates were Gram-negative bacteria.

Conclusions. The incidence of VAP was found to be higher than the mean rates reported from the USA and Western Europe yet similar to those in the developing countries. BSI and UTI rates were comparable to those given in NNIS and HELICS reports. Effective prevention strategies should be introduced in order to reduce high VAP rates.

Key words: intensive care, healthcare-associated infections; healthcare-associated infections, aetiological factors; healthcare-associated infections, incidence density

Healthcare-associated infections (HAIs) affect 5–20% of patients treated in the hospital setting [1] and pose significant problems for institutions providing healthcare services as they prolong hospital stays of patients and increase treatment costs. Elimination of healthcare-associated infections is infeasible. They have been and still are inseparable elements of long-term and increasingly invasive therapy. Patients of multi-profile intensive care units (ICUs) are at particular risk of acquiring healthcare-associated infections. Infections are diagnosed in 45–60% of ICU patients; 1/4 of them are healthcare-associated infections [1]. In Poland, due to the specificity of ICU therapy attributable to primarily severe conditions of patients, immunosuppression, invasive monitoring, mechanical ventilation or parenteral feeding and despite a relatively low percentage of patients treated in ICUs (5–7%), healthcare-associated infections are 5–10 times more frequently observed than in other hospital wards and departments [1]. The ICU bacterial flora is characterised by high antibiotic resistance and the ability to colonise quickly the environment and personnel. Within 3–7 days of a ICU stay, 96% of patients are colonised by the strains typical of a given unit [1]. For many years, it has been emphasised that active surveillance of infections is essential to improve the safety of patients and to reduce huge expenditures connected with their treatment [1–3].

The aim of the present study was to analyse the incidence rates of healthcare-associated infections in the newly opened intensive care unit.
METHODS

The study encompassed all patients treated in the seven-bed ICU of the Teaching Hospital, Medical University of Silesia in Zabrze during the first 12 months of its functioning. The ICU is interdisciplinary; it predominantly admits patients due to respiratory failure yet the percentage of “surgical” patients is also high. The Unit consists of one five-bed room and two single-bed rooms. Intubation tubes enabling subglottic secretion aspiration and closed suction systems (a maximum utilisation time — 72 h) are used. Oral hygiene is carried out twice a day using appropriate solutions. In some cases, selective decontamination of the gastrointestinal tract is performed. The number of nurses is 4 during day shifts and 3 during night shifts. The majority of nurses have never worked in the intensive care unit. The uniforms of the entire personnel are changed on a daily basis and their designs are in accordance with the recommendations – short sleeves required. The personnel undergo cyclic training regarding hygiene and hand disinfection practices. The monitoring of utilisation of hand disinfectants reveals that in some periods this utilisation is lower than it should be.

The observations were carried out within the System of Active Surveillance of Infections according to the guidelines of the Polish Society of Hospital Infections (PSHIs). The Infection Control Team (ICT) identified and recorded bloodstream infections (BSIs), ventilator-associated pneumonias (VAPs), urinary tract infections (UTIs) and surgical site infections (SSIs) following the definitions of the Centre for Disease Control and Prevention/ National Healthcare Safety Network (CDC/NHSN) [4]. The data was collected using a questionnaire filled in daily with the number of patients being hospitalised, new admissions, patients mechanically ventilated on a given day (or only intubated), patients with intravenous line and urinary catheters. The healthcare-associated infection charts were completed electronically and verified by the ICT. In each infection case, the material for microbiological testing was collected to identify the aetiological factor. Drug-susceptibility was examined following the recommendations of the European Committee on Antimicrobial Susceptibility Testing (EUCAST). Antibiotic dosing was tailored according to the actual MIC of a given antibiotic. The number and quality of infections were analysed using the following epidemiological measures: prevalence of ICU infections over the study period, incidence density for individual infections (recommended by the CDC) in relation to device utilization ratios (DURs), infection-attributable mortality rates as well as types and distribution of aetiological factors.

RESULTS

During the observation period, 168 patients were treated in the ICU (2137 person-days). Prior to admission, 88.5% of patients stayed in other hospital wards, including other ICUs. The mortality rate in the study period was 33%. The average percentage of bed utilization was 80%. The ventilator utilisation ratio (VUR), i.e. the number of ventilator days per the total number of person-days, was 0.72 (72% of mechanically ventilated patients). The ratio of intravenous catheter utilization, calculated in a similar way, was 1, and of urinary catheters — 0.95. Healthcare-associated infections (n = 47) were observed in 44 patients (26.2% of all treated individuals). It is not always necessary to isolate a pathogen in order to diagnose a healthcare-associated infection; however, during the study period the factor responsible for infection was identified in each case. The mortality rate in the group of patients with infections was 45.4%. The incidence density ratio (number of hospital infections per 1000 person-days) was 22. Acinetobacter baumannii was found responsible for 38.8% of infection cases (Table 1). The most common infection was ventilator-associated pneumonia (Table 2). The first symptoms of VAP were observed on average after 11 days of artificial ventilation (the range 7–16 days, median — 12 days). The aetiological factor was identified collecting the material with a bronchofibroscope (invasive method). BSIs were detected after 14 days (median) of catheterization. Catheter-associated sepsis developed in 11 patients. The number of patients admitted after surgery or operated on during the ICU stay was 60 (35.7% of all hospitalised patients). The hospital-acquired infection incidence was higher amongst “surgical” patients — 31 of them developed infections, i.e. 52% of all surgical patients and 70% of all the infected individuals. The dominating clinical form of infection in these patients was VAP. Eight of them (13%) had surgical site infections. In two cases, deep infections were observed; one patient had abdominal infection while the other had metastatic abscesses.

DISCUSSION

The study findings demonstrate that the percentage of patients with hospital infections was comparable with the data from other Polish ICUs, i.e. 24–36%, albeit higher than in the Western European countries and USA [2, 3, 5–7, 9]. The incidence of infections was not affected by the fact that the unit and equipment were new. According to the environmental study performed prior to admission of the first patient, colonization with multi-resistant Acinetobacter baumannii was detected occurring in other hospital wards. Our study has not taken into account the number of patients who acquired hospital infections by direct contact with other patients. Literature data indicates that only 15% of nosocomial infections spread by direct contact resulting from negligence of isolation procedures [10]. The key risk factors of infections include the severity of patient’s
state, his/her endogenous bacterial flora and invasiveness of procedures, i.e. factors that are difficult to modify [10].

The epidemiological data obtained diverge from the expected indices reported in the Hospital in Europe Link for Infection Control through Surveillance (HELICS) and the American National Nosocomial Infections Surveillance (NNIS) System Report [6, 7, 9] (Fig. 1). The ICU under study is a part of the teaching hospital where students, residents and physicians of other specialities are continuously trained. According to the NNIS report, in university multi-profile ICUs with a substantial percentage of surgical patients, the incidence of infections is significantly higher compared to the wards where trainings was not organized [9]. In our centre, similarly to other university centres in Poland, high indices of invasive procedures are noteworthy [2, 3, 5]. In Poland, 80% of patients treated in ICUs are mechanically ventilated whereas in France, Germany, Spain and USA the average percentage is 40% [5–7, 9]. This discrepancy evidences the severity of patients’ conditions in our ICUs. The differences are also likely to be associated with the criteria of procedure assessment, which result in lower numbers of patients mechanically ventilated outside ICUs compared to other countries. In our centre, the ventilator utilization ratio is 72%, which corresponds to 90 percentiles of the NNIS programme [9]. This high frequency of mechanical ventilation is related to increased VAP incidence. VAP incidence density per 1000 mechanical ventilation days in the present study was 15.5, i.e. higher than in the USA (5.7 for a similar profile of patients) and in the majority of European countries [5–7, 9]. According to the HELICS report, this ratio ranges from 5.3 in the centres with the percentage of intubated patients lower than 30% to 10.8 in the centres with over 60% of intubated patients. A comparably high VAP ratio was observed in the Wrocław centre (16) as well as in ICUs in Austria (16.2) and Holland (14.2) [5, 7]. In Germany, thanks to the introduction of the Krankenhaus Infektions Surveillance System (KiSS), the incidence of VAP was reduced by 24% during three years [11]. The alarming VAP incidence in the ICU studied can be only partially explained by a high percentage of ventilator utilisation and the unit’s profile. The data obtained strongly suggests the necessity to introduce appropriate measures aimed at proper use of VAP prevention procedures, to organize more frequent suitable personnel training and to consider non-invasive mechanical ventilations in some cases. The multi-centre study has demonstrated that the risk of hospital-acquired pneumonia amongst critically ill surgical patients is high, even higher than the risk of SSIs [12–14].

### Table 1. Pathogens causing infections in ICU patients

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>VAP</th>
<th>BSI</th>
<th>UTI</th>
<th>SSI</th>
<th>Total n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acinetobacter baumannii</td>
<td>10</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>18 (38.3)</td>
</tr>
<tr>
<td>Klebsiella pneumoniae</td>
<td>7</td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>12 (25.5)</td>
</tr>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>3 (6.38)</td>
</tr>
<tr>
<td>Escherichia coli</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>3 (6.38)</td>
</tr>
<tr>
<td>Enterobacter sp.</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2 (4.25)</td>
</tr>
<tr>
<td>Proteus mirabilis</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1 (2.12)</td>
</tr>
<tr>
<td>MRSA</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2 (4.25)</td>
</tr>
<tr>
<td>MRCNS</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3 (6.38)</td>
</tr>
<tr>
<td>Enterococcus faecium</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2 (4.25)</td>
</tr>
<tr>
<td>Enterococcus faecalis</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1 (2.12)</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>11</td>
<td>4</td>
<td>8</td>
<td>47 (100%)</td>
</tr>
</tbody>
</table>

All abbreviations explained in the text

### Table 2. Incidence density of infections in relation to device utilisation ratios

<table>
<thead>
<tr>
<th>Infection</th>
<th>n (%)</th>
<th>Device utilisation ratio</th>
<th>Incidence density</th>
<th>Number of deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>VAP</td>
<td>24 (51.0)</td>
<td>0.72</td>
<td>15.5/1000 ventilator days</td>
<td>13</td>
</tr>
<tr>
<td>BSI</td>
<td>11 (23.4)</td>
<td>1</td>
<td>5/1000 intravenous catheter days</td>
<td>4</td>
</tr>
<tr>
<td>UTI</td>
<td>4 (8.5)</td>
<td>0.95</td>
<td>1.9/1000 urinary catheter days</td>
<td>0</td>
</tr>
<tr>
<td>SSI</td>
<td>8 (17%)</td>
<td>60 patients after surgery</td>
<td>The above ratio is not used in SSI analysis</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>47 (100%)</td>
<td></td>
<td></td>
<td>20</td>
</tr>
</tbody>
</table>

All abbreviations explained in the text
constituted almost half of all the surgical patients of the ICU. Our study confirms these findings: amongst 31 cases of infections detected in surgical patients, VAP was found in 52% of individuals.

The SSI incidence rate is 3% [1, 9, 15]. Our results present the prevalence only in patients admitted to the ICU; the majority of them with two or three NNIS risk factors (high ASA scores, infected surgical site, long duration of surgery). Patients were transferred from various hospitals and the symptoms of SSI were mainly detected on admission. The surveillance of SSIs seems to be one of the most difficult challenges of the ICU as it requires efficient cooperation with the personnel of surgical wards. Blood stream infections were observed in 5/1000 catheter-days at 100% procedure utilization whereas the American and European mean was 4 at 60% procedure utilization [6, 7, 9]. The highest BSI ratio (7.4) was observed in trauma and burn units [9]. The effective method for BSI prevention is to follow the standards and the definitions applied. Therefore, the current goal is to standardize definitions and epidemiological indices to increase the reliability of comparisons.

**CONCLUSION**

The new facility and equipment does not affect the incidence of healthcare-associated infections. Considering an alarmingly high incidence rate of VAPs, decisive action should be undertaken in order to reduce the number of infections and improve the safety of patients.

**References:**


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