Ventilator-associated pneumonia in adults in developing countries: a systematic review

Yaseen Arabi,*, Nehad Al-Shirawi, Ziad Memish, Antonio Anzueto

Background: Ventilator-associated pneumonia (VAP) is a leading cause of death in hospitalized patients, but there has been no systematic analysis of the incidence, microbiology, and outcome of VAP in developing countries or of the interventions most applicable in that setting.

Methods: We reviewed MEDLINE (January 1966—April 2007) and bibliographies of the retrieved articles for all observational or interventional studies that examined the incidence, microbiology, outcome, and prevention of VAP in ventilated adults in developing countries. We evaluated the rates of VAP using the National Healthcare Safety Network (NHSN) definitions and the impact of VAP on the intensive care unit (ICU) length of stay (LOS) and mortality, and the impact of interventions used to reduce VAP rates.

Results: The rates of VAP varied from 10 to 41.7 per 1000 ventilator-days and were generally higher than NHSN benchmark rates. Gram-negative bacilli were the most common pathogens (41—92%), followed by Gram-positive cocci (6—58%). VAP was associated with a crude mortality that ranged from 16% to 94% and with increased ICU LOS. Only a small number of VAP intervention studies were performed; these found that staff education programs, implementation of hand hygiene, and VAP prevention practice guidelines, and/or implementation of sedation protocol were associated with a significant reduction in VAP rates. Only one interventional study was a randomized controlled trial comparing two technologies, the rest were sequential observational. This study compared a heat and moisture exchanger (HME) to a heated humidifying system (HHS) and found no difference in VAP rates.

Conclusions: Based on the existing literature, the rate of VAP in developing countries is higher than NHSN benchmark rates and is associated with a significant impact on patient outcome. Only a few studies reported successful interventions to reduce VAP. There is a clear need for additional
**Introduction**

Ventilator-associated pneumonia (VAP) is a leading cause of morbidity and mortality in intensive care unit (ICU) patients.\(^1\)\(^-\)\(^4\) Several countries have reported mortality rates ranging from 24% to 76%.\(^5\)\(^,\)\(^6\) As a result, prevention of VAP has become a focus of patient safety initiatives. Prevention of nosocomial infections, including VAP, was identified as a priority area for national action by the Institute of Medicine.\(^7\)

Similarly, the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) has included prevention of healthcare-associated infections, including VAP, in its 2006 National Patient Safety Goals and recommended to manage sentinel events all identified cases of unanticipated death or major permanent loss of function associated with a healthcare-associated infection, including VAP.\(^8\) The prevention of VAP is a component of the Surgical Care Improvement Project (SCIP).\(^9\) VAP prevention is one of the six components of the ‘100K Lives’ campaign and a key component of the ‘Protecting 5 Million Lives from Harm’ campaign launched by the Institute for Healthcare Improvement (IHI).\(^10\),\(^11\) The IHI has promoted VAP prevention and safety of patients on mechanical ventilation by implementing a set of interventions known as the ‘ventilator bundle’.\(^12\) This bundle includes four components: (1) elevation of the head of the bed to between 30 and 45 degrees, (2) daily interruption of sedation and daily assessment of readiness to extubate, (3) peptic ulcer disease prophylaxis, and (4) deep vein thrombosis prophylaxis.

In contrast, VAP has received little attention in developing countries until recently.\(^13\) The purpose of this review was to evaluate the incidence, microbiology, and outcome of VAP in developing countries and to identify if any of the preventive interventions described before have been applied to reduce VAP rates in these regions of the world.

**Methods**

**Search strategy**

We conducted a MEDLINE search including all publications from January 1966 to April 2007, to identify all studies that investigated VAP in developing countries as identified by the World Bank.\(^14\) We used a combination of MeSH terms ('Ventilators, Mechanical' [MeSH] OR 'Respiration, Artificial' [MeSH] OR 'Hospitals' [MeSH]) AND ('Pneumonia' [MeSH] OR 'Infection' [MeSH] OR 'Respiratory Tract Infections' [MeSH]) AND 'Developing Countries' [MeSH]. Reference lists of key reviews were also searched for additional studies. We also conducted a manual search using the following terms: 'nosocomial', 'ventilator', 'pneumonia', 'developing countries', and 'infection'. Citations were limited to in vivo human studies, full articles, and those publications in the English language. Neither unpublished data nor abstracts were included.

**Inclusion criteria**

We included all studies (observational and interventional, prospective and retrospective) from developing countries that: (1) used the US Centers for Disease Control and Prevention (CDC) National Healthcare Safety Network (NHSN) definitions\(^15\) (previously known as the National Nosocomial Infections Surveillance (NNIS)), (2) examined mechanically ventilated adult patients in the ICU, and (3) examined the epidemiology, microbiology, outcome, or prevention of VAP. In the case of multiple studies addressing the same subject and coming from the same hospital of the same country, we used only the latest data.

**Study identification**

The titles and abstracts generated by the initial search were reviewed by two authors (YA and NS) to identify potential studies that met the inclusion criteria. In all instances where the abstract title indicated that the article might be relevant, the full article was obtained. The same two authors reviewed the full text of these articles and applied the inclusion criteria independently. We resolved differences by discussion and consultation with a third author (ZM) in the event that agreement could not be reached. The reviewers were not blinded to the authors or the institutions where the studies were conducted.

**Data abstraction and outcome measures**

For each study, the following data were abstracted: country of study, study design, type of population, and number of patients. We evaluated the following outcome measures:

1. The VAP rate expressed as episodes per 1000 ventilator-days as per the CDC NHSN definitions,\(^1\),\(^15\)
2. The microbiology of VAP.
3. The impact of VAP on duration of mechanical ventilation, ICU length of stay (LOS), or mortality.
4. For intervention studies, we documented the type of intervention and impact on VAP rate or surrogate markers for VAP prevention.

**Data analysis**

Descriptive statistics were used as appropriate. Comparative statistics are presented as reported by authors.

**Results**

**Epidemiology**

We identified 22 studies that reported VAP rate using the CDC NHSN definition (Table 1);\(^16\)\(^-\)\(^35\); single country studies were...
most commonly from the Middle East (n = 10), followed by South America (n = 5) then Southeast Asia (n = 3). There were international studies that included developed and developing countries but reported pooled mean and not individual country rates. The VAP rate (per 1000 ventilator-days) ranged from as low as 10 per 1000 ventilator-days in Thailand25,26 and Colombia28 to a high of 41.7 per 1000 ventilator-days in a study on oncology ICU patients from Brazil.17 Figure 1 shows the VAP rates in medical-surgical ICUs compared with the pooled mean rate and 25—75 percentile rates of VAP in the US medical-surgical ICUs as per the CDC NHSN.15

### Microbiology

The microbiology of VAP was reported in 22 studies (Table 2). Gram-negative bacilli were responsible for the majority of VAP episodes (41—92%). Overall, *Pseudomonas aeruginosa* was the most common isolated Gram-negative organism (9—52%),16,18,20—22,27—29,33,36—41 followed by *Acinetobacter spp* (0—36%).24,25,30,42,43 Gram-positive cocci were responsible for 6—58% of the isolates. *Candida spp* accounted for between 0 and 7% of VAP episodes, although not all studies reported the percentage of *Candida spp* isolates.

### Association of VAP and outcome

Fifteen studies examined mortality of patients with VAP in developing countries, and five studies reported ICU LOS (Table 3). The crude VAP mortality rate ranged from 16% to 94% compared to 0.2% to 51% in non-VAP patients. ICU LOS of VAP patients ranged from 8 to 24 days compared to 2.5 to 13 days in non-VAP patients. Pawar et al. studied 25 VAP patients in a cardiac-surgical ICU in India41 and found that VAP was associated with increased ICU LOS by 10 days and higher mortality than patients without VAP (16 vs. 0.2%; p < 0.0002). Kanafani studied 70 patients admitted to a medical-surgical ICU in Lebanon24 and found that ICU LOS

### Table 1 Ventilator-associated pneumonia (VAP) rates in developing countries

<table>
<thead>
<tr>
<th>Study [Ref.]</th>
<th>Year</th>
<th>Country</th>
<th>VAP ratea</th>
<th>Type of ICU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elatrous16</td>
<td>1996</td>
<td>Tunisia</td>
<td>40</td>
<td>Medical</td>
</tr>
<tr>
<td>Velasco17</td>
<td>1997</td>
<td>Brazil</td>
<td>41.7</td>
<td>Oncology ICU</td>
</tr>
<tr>
<td>Barsic18</td>
<td>1999</td>
<td>Croatia</td>
<td>28—37</td>
<td>NA</td>
</tr>
<tr>
<td>Khuri-Bulos19</td>
<td>1999</td>
<td>Jordan</td>
<td>19.1</td>
<td>Medical-surgical</td>
</tr>
<tr>
<td>Memish20</td>
<td>2000</td>
<td>Saudi Arabia</td>
<td>16.8</td>
<td>Medical-surgical</td>
</tr>
<tr>
<td>Memish21</td>
<td>2001</td>
<td>Saudi Arabia</td>
<td>13.3</td>
<td>Medical-surgical</td>
</tr>
<tr>
<td>Simsek22</td>
<td>2001</td>
<td>Turkey</td>
<td>16.4</td>
<td>Cardiac-surgical</td>
</tr>
<tr>
<td>Jamulitrat23</td>
<td>2002</td>
<td>Thailand</td>
<td>32</td>
<td>NA</td>
</tr>
<tr>
<td>Kanafani24</td>
<td>2003</td>
<td>Lebanon</td>
<td>30</td>
<td>Medical-surgical</td>
</tr>
<tr>
<td>Thongpiyapoom25</td>
<td>2004</td>
<td>Thailand</td>
<td>10.8</td>
<td>Medical-surgical</td>
</tr>
<tr>
<td>Jamulitrat26</td>
<td>2004</td>
<td>Thailand</td>
<td>10.8</td>
<td>Medical-surgical</td>
</tr>
<tr>
<td>Noor27</td>
<td>2005</td>
<td>Pakistan</td>
<td>26</td>
<td>Medical surgical</td>
</tr>
<tr>
<td>Moreno28</td>
<td>2006</td>
<td>Colombia</td>
<td>10</td>
<td>Medical-surgical</td>
</tr>
<tr>
<td>Inan29</td>
<td>2006</td>
<td>Turkey</td>
<td>20.8</td>
<td>Medical-surgical</td>
</tr>
<tr>
<td>Ertugrul30</td>
<td>2006</td>
<td>Turkey</td>
<td>28.7</td>
<td>Surgical</td>
</tr>
<tr>
<td>Ramirez Barba31</td>
<td>2006</td>
<td>Mexico</td>
<td>21.8</td>
<td>Medical-surgical</td>
</tr>
<tr>
<td>Rosenthal32</td>
<td>2006</td>
<td>Argentina</td>
<td>35.5</td>
<td>Medical-surgical and CCU</td>
</tr>
<tr>
<td>Rosenthal33</td>
<td>2006</td>
<td>Eight countriesb</td>
<td>24.1 (10—52.7)</td>
<td>Medical-surgical, CCU</td>
</tr>
<tr>
<td>Jaimes34</td>
<td>2007</td>
<td>Colombia</td>
<td>29</td>
<td>3 ICUs: surgical/trauma, medical, cardiovascular</td>
</tr>
<tr>
<td>Leblebicioglu35</td>
<td>2007</td>
<td>Turkey</td>
<td>26.5</td>
<td>13 ICUs, 12 hospitals</td>
</tr>
</tbody>
</table>

ICU, intensive care unit; NA, not available; HME, heat and moisture exchanger; HHS, heated humidifying system; CCU, coronary care unit.

a Episodes per 1000 ventilator-days.
b The eight countries were: Argentina, Brazil, Colombia, India, Mexico, Morocco, Peru, and Turkey.

Figure 1 Ventilator-associated pneumonia (VAP) rates in medical-surgical intensive care units (ICUs) in several developing countries. The solid line represents the pooled mean rate of VAP from the US Centers for Disease Control and Prevention (CDC), according to the National Healthcare Safety Network medical-surgical ICUs and the shaded area represents the 25—75 percentile rate.
increased from a mean of 11 days in patients without VAP to 24 days in patients with VAP \( p = 0.013 \). The mortality was 39\% for VAP patients vs. 30\% for non-VAP patients, but the difference was not statistically significant. A study by Rosenthal from a medical-surgical ICU in Argentina reported an attributable mortality of 35\% and 10 attributable extra days of hospitalization associated with VAP.\(^{44}\) Other studies also found similar results.\(^{28,30,37–39}\)

**Intervention studies to prevent VAP in developing countries**

Eight studies described VAP prevention studies\(^{21,32,45–50}\) and are summarized in Table 4. The study design of all was of pre-/post-intervention comparison except for one study, which was a randomized controlled trial. The non-randomized design reflects that these studies were examining non-technologic infection control interventions, while the randomized trial compared different similar and equivalent technologies. Berg et al. examined the effectiveness of specific infection control interventions in a teaching hospital in Guatemala City.\(^{45}\) After 3 months of prospective surveillance, the investigators implemented targeted interventions including modification of respiratory tract care, an educational program focused on respiratory intervention, and general interventions (i.e., aseptic techniques). As a result of intervention, the frequency of hand washing increased from 5\% to 63\% \( (p < 0.001) \) and the VAP rate dropped from 113 to 40 per 1000 ventilator-days \( (p = 0.001) \). Rosenthal et al. monitored the compliance with hand hygiene during routine patient care in two ICUs in Buenos Aires, Argentina, before and during implementation of a hand hygiene education, training, and performance feedback program. Compliance improved from 23.1\% to 64.5\% \( (p < 0.0001) \). During the same period, VAP rates decreased from 47.6 to 27.9 per 1000 ventilator-days \( (p < 0.001) \). Another study by the same authors\(^{32}\) examined all adult patients who received mechanical ventilation for at least 24 hours in four level III adult ICUs in two Argentine hospitals. The VAP rate was determined during a period of active surveillance without an infection control program (phase 1) and was compared with the VAP rate after implementation of an infection control program that included educational and surveillance feedback components (phase 2). The investigators found that the rates of VAP were significantly lower in phase 2 than in phase 1 (51.28 vs. 35.50 episodes of VAP per 1000 ventilator-days, \( p < 0.003 \)). Salahuddin et al. conducted a pre- and post-intervention study in a university hospital in Pakistan to assess whether an educational program focusing on preventive practices for VAP could reduce the incidence. Evidence-based guidelines for preventive practices (including practice guidelines on hand hygiene, protective clothing, semi-recumbent positioning, avoidance of gastric distention, the use of non-invasive ventilation, proper levels of sedation, and oral hygiene with chlorhexidine oral rinse) were developed and disseminated to the ICU staff. VAP infection rates reduced by 51\%, from 13.2 in the pre-intervention period to 6.5 per 1000 ventilator-days in the post-intervention period (mean difference 6.7; 95\% CI 2.9–10.4, \( p = 0.02 \)). Khatib et al. conducted a pre- and post-intervention study in Lebanon to examine the effectiveness of warning labels attached permanently to the ventilators on improving the practice of hand
washing and the use of gloves by respiratory care practitioners in the ICU. After placing the “wash hands, use gloves” labels, the rates of hand washing and use of gloves were significantly higher during the second period when labels were attached to the ventilators, as compared to the rates during the first period: hand washing, 92% vs. 46% \((p < 0.05)\); use of gloves, 92% vs. 43% \((p < 0.05)\). The study did not examine the effect of this intervention on the VAP rate.

Memish et al. conducted a prospective randomized study in a tertiary care ICU in Saudi Arabia comparing the incidence of

### Table 3  The association of VAP with ICU LOS and mortality in developing countries

<table>
<thead>
<tr>
<th>Study [Ref.]</th>
<th>Year</th>
<th>Country</th>
<th>Type of ICU</th>
<th>Total No. of patients</th>
<th>No. of patients with VAP</th>
<th>ICU LOS (days)</th>
<th>Mortality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>VAP Non-VAP</td>
<td>VAP Non-VAP</td>
</tr>
<tr>
<td>Elatrous16</td>
<td>1996</td>
<td>Tunisia</td>
<td>Medical</td>
<td>73</td>
<td>28</td>
<td>20</td>
<td>13</td>
</tr>
<tr>
<td>Stebbings37</td>
<td>1999</td>
<td>Singapore</td>
<td>Medical</td>
<td>136</td>
<td>12</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Simsek22</td>
<td>2001</td>
<td>Turkey</td>
<td>Cardiac-surgical</td>
<td>1716</td>
<td>36</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Memish21</td>
<td>2001</td>
<td>Saudi Arabia</td>
<td>Medical-surgical</td>
<td>243</td>
<td>33</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Mukhopadhyay39</td>
<td>2003</td>
<td>India</td>
<td>Surgical</td>
<td>241</td>
<td>121</td>
<td>14</td>
<td>4a</td>
</tr>
<tr>
<td>Pawar41</td>
<td>2003</td>
<td>India</td>
<td>Cardiac-surgical</td>
<td>952</td>
<td>25</td>
<td>24</td>
<td>11a</td>
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<tr>
<td>Kanafar24</td>
<td>2003</td>
<td>Lebanon</td>
<td>Medical-surgical</td>
<td>70</td>
<td>40</td>
<td>8</td>
<td>2.5a</td>
</tr>
<tr>
<td>Rosenthal44</td>
<td>2003</td>
<td>Argentina</td>
<td>Medical-surgical</td>
<td>213</td>
<td>32</td>
<td>22</td>
<td>12</td>
</tr>
<tr>
<td>Erbay38</td>
<td>2004</td>
<td>Turkey</td>
<td>Medical-surgical</td>
<td>97b</td>
<td>37</td>
<td>8</td>
<td>2.5a</td>
</tr>
<tr>
<td>Noor27</td>
<td>2005</td>
<td>Pakistan</td>
<td>NA</td>
<td>250</td>
<td>70</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Sallam36</td>
<td>2005</td>
<td>Egypt</td>
<td>Medical-surgical-cardiac</td>
<td>400</td>
<td>11</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Luna42</td>
<td>2006</td>
<td>Argentina</td>
<td>NA</td>
<td>508</td>
<td>76</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Moreno28</td>
<td>2006</td>
<td>Columbia</td>
<td>Medical-surgical</td>
<td>2172</td>
<td>86</td>
<td>NA</td>
<td>NA</td>
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<tr>
<td>Ertugrul30</td>
<td>2006</td>
<td>Turkey</td>
<td>Surgical</td>
<td>100</td>
<td>28</td>
<td>NA</td>
<td>NA</td>
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<tr>
<td>Rosenthal33</td>
<td>2006</td>
<td>8 countries</td>
<td>Medical-surgical-cardiac</td>
<td>21 069</td>
<td>1277</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

VAP, ventilator-associated pneumonia; ICU, intensive care unit; LOS, length of stay; NA, not available.

\(a\) Statistically significant \((p < 0.05)\).

\(b\) Case–control study (number of controls = 60).

### Table 4  Interventions aiming at VAP reduction in developing countries

<table>
<thead>
<tr>
<th>Study/year [Ref.]</th>
<th>Country</th>
<th>Study design</th>
<th>Intervention</th>
<th>Outcome measurement</th>
<th>VAP rate per 1000 ventilator-days</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Berg (1995)45</td>
<td>Guatemala</td>
<td>Pre-/post-intervention</td>
<td>Targeted Interventions and education Hand washing and glove use</td>
<td>VAP rate per 1000 ventilator-days</td>
<td>113</td>
<td>40</td>
</tr>
<tr>
<td>Khatib (1999)46</td>
<td>Lebanon</td>
<td>Pre-/post-intervention</td>
<td>Use of HME vs. HHS</td>
<td>VAP rate per 1000 ventilator-days</td>
<td>15.7</td>
<td>13.3</td>
</tr>
<tr>
<td>Memish (2001)21</td>
<td>Saudi Arabia</td>
<td>Prospective randomized comparative</td>
<td></td>
<td>VAP rate per 1000 ventilator-days</td>
<td>13.2</td>
<td>6.5</td>
</tr>
<tr>
<td>Salahuddin (2004)47</td>
<td>Pakistan</td>
<td>Pre-/post-intervention</td>
<td>Staff education program</td>
<td>VAP rate per 1000 ventilator-days</td>
<td>47.6</td>
<td>27.9</td>
</tr>
<tr>
<td>Rosenthal (2005)48</td>
<td>Argentina</td>
<td>Pre-/post-intervention</td>
<td>Hand hygiene training and feedback program Educational program on VAP prevention</td>
<td>VAP rate per 1000 ventilator-days</td>
<td>40.5</td>
<td>24</td>
</tr>
<tr>
<td>Danachaijir (2005)49</td>
<td>Thailand</td>
<td>Pre-/post-intervention</td>
<td>Hand hygiene, proper handling of respiratory secretions/educational sessions</td>
<td>VAP rate per 1000 ventilator-days</td>
<td>51.3</td>
<td>35.5</td>
</tr>
<tr>
<td>Rosenthal (2006)32</td>
<td>Argentina</td>
<td>Pre-/post-intervention</td>
<td>Sedation protocol and educational program about sedation</td>
<td>VAP rate per 100 patients</td>
<td>28</td>
<td>11</td>
</tr>
<tr>
<td>Arabi50</td>
<td>Saudi Arabia</td>
<td>Pre-/post-intervention</td>
<td></td>
<td>VAP rate per 100 patients</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

VAP, ventilator-associated pneumonia; NA, not available; HME, heat and moisture exchanger; HHS, heated humidifying system.
VAP using the heat and moisture exchanger (HME) vs. the heated humidifying system (HHS). They found that there was no significant difference in the incidence of VAP between the two systems. In the same ICU in Saudi Arabia, Arabi et al. conducted a prospective, four-pronged, observational study describing a quality improvement initiative that employs two types of controlled comparisons: a ‘before and after’ comparison related to intense education of ICU clinicians and nurses about sedation and analgesia in the ICU, and a comparison of protocolized versus non-protocolized sedation practice. Patients were assigned alternatively to receive sedation by a goal-directed protocol using the Riker sedation–agitation scale (SAS) or by standard practice. A multifaceted multidisciplinary educational program was initiated including the use of point of use reminders, directed educational efforts, and opinion leaders. This included several lectures and in-services and the routine availability of at least one member of this group to answer questions. The investigators demonstrated significant reductions in the use of analgesics and sedatives after 3 months of implementing the protocol. This was associated with a reduction in the VAP rate from 28 to 11 per 100 patients (p = 0.002).

Discussion

Our review demonstrates great variability in the reported incidence and mortality rates of VAP in different developing countries. The VAP incidence ranged from 10 to 41.7 per 1000 ventilator-days. Furthermore, we found that only few prospective prevention interventional studies were performed. The VAP incidence ranged from 1 to 4.7 per 1000 ventilator-days in different developing countries. This variation is probably related to several factors, including differences in patient populations (medical, surgical, vs. combined ICUs), differences in infection control and critical care practices, and variability in data collection methods as well as variability in the definition of VAP. The VAP incidence was lower in surgical ICUs compared to medical-surgical ICUs. However, this finding is not universal, as some medical-surgical ICUs had a low incidence rate. This may be explained by variation in surveillance methods and different infection control practices in different developing countries. It is worth noting that these rates were from developing countries that have surveillance programs and thus have reasonable healthcare infrastructures. The VAP rates may be even higher in countries that do not have such facilities. In addition, lack of appropriate surveillance data may make the application of infection control measures and assessing their outcome very difficult.

In comparison, the CDC NHSN hospitals report a mean VAP rate in US medical-surgical ICUs of 3.6 per 1000 ventilator-days, in neurosurgical ICUs of 7.0 per 1000 ventilator-days, and in trauma ICUs of 10.2 per 1000 ventilator-days. A multicenter study from 16 Canadian ICUs reported a mean VAP rate of 14.8 per 1000 ventilator-days. In Europe, reported VAP ranged from 9.4 to 1000 ventilator-days in France. In Germany, 24 per 1000 ventilator days in Germany, according to 35 and 46 per 1000 ventilator days in Italy. Thus, even in the developed countries, considerable inter-country variation exists, but it appears that in several developing countries, VAP rates are higher than the reported rates from the USA, Canada, and some European countries.

Data on microbiology of VAP in developing countries showed that Gram-negative bacilli were the predominant organisms. This is similar to findings reported in North American and European studies. Pooled data collected from 24 Western studies showed that Gram-negative bacilli represented 58%, Staphylococcus aureus 20%, and other Gram-positive organisms 14%, of VAP pathogens.

Our results revealed that mortality associated with VAP is high in developing countries. Several studies demonstrated higher mortality in VAP patients compared to those without VAP, although some studies did not find a statistically significant difference in mortality between VAP and non-VAP patients. These findings are consistent with the crude mortality of VAP that has been reported in developed countries to range from 24% to 76% and attributable mortality from 20% to 30%.

Several studies have shown that simple, cost-effective measures can result in significant reduction in the incidence of VAP in developing countries. Simple measures, e.g., hand washing, proper handling of respiratory tract secretions, and the use of gloves by health workers can reduce VAP rates if they are re-enforced by training and programs. In addition, all these measures are readily available and can be implemented at a low cost in countries with limited healthcare resources.

Conclusion

This review has addressed the incidence, microbiology, and outcome of VAP in developing countries. In these countries, VAP is a serious problem that is associated with high mortality rates and increase in ICU LOS, which may represent an additional burden on the scarce resources in developing countries. Further studies are needed to investigate additional VAP prevention intervention in these settings. This review illustrates the need for wide-scale initiatives for VAP prevention in developing countries similar to those in developed countries.

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Conflict of interest: No conflict of interest to declare.

References


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