Introduction

Pneumonia is the leading cause of deaths among under-five children globally [1,2], with an estimated 1.4 million out of the total 7.6 million deaths in this population in 2010 [3]. In the critical care medicine the case-fatality is even higher [4]. A number of initiatives leading to improvement in the...
nutritional status and rate of exclusive breast-feeding, case management practices including better access to antibiotics, care-seeking behaviour and referral practices, along with reductions in the indoor air-pollutions and housing overcrowding have contributed to reductions in the global burden of deaths from pneumonia [5,6,7], the United Nations Millennium Development Goal 4 (MDG 4) that aims to reduce child mortality by two-thirds by 2015 still remains in dream. Preventive strategies and appropriate and prompt management of pneumonia are integral part of the strategy to reduce the mortality from pneumonia [8]. Appropriate antimicrobial therapy requires evidence base, most importantly the etiology in particular patient population and their antimicrobial susceptibility. Pneumonia is frequently caused by a varieties of viruses, bacteria, fungus or mycobacterium tuberculosis [9,10]; however, their isolation and identification in resource poor settings is not only expensive but also very intriguing. Moreover, the etiology varies by age groups, nutritional status, geographical locations and settings in which they occur [9,11,12]. In most reported studies, the organisms were isolated from blood, sputum, throat swab or nasopharyngeal swab [9,13,14], which either did not reflect the actual incidence or isolation of the causative organism; isolation of organisms from tracheal aspirates is more likely representative of the actual pathogens [15,16,17]. However, there is limited data on isolation of bacterial pathogens from tracheal aspirates in mechanically ventilated children admitted to ICU with pneumonia, especially from developing countries. Therefore, we aimed at evaluating the bacterial isolations from tracheal aspirates in mechanically ventilated children admitted to intensive care unit (ICU) of the Dhaka Hospital of International Centre for Diarroheal Disease Research, Bangladesh (icddr,b) with community acquired pneumonia.

**Methods**

**Study design:**
This is a retrospective analysis of data excerpted from electronic medical records system of the “Dhaka Hospital” (named SHEBA) of icddr,b. We collected data of all children of both sex, aged 0-59 months, who were admitted to the ICU of the hospital between August 2009 and July 2013 and required mechanical ventilation, and also had their tracheal aspirate collected for bacteriological culture. The indication of ventilation was respiratory failure, defined by severe respiratory distress and severe hypoxemia (arterial oxygen saturation < 90% at sea level) despite receiving non-invasive continuous positive airway pressure (such as by bubble CPAP) and/or severe hypercarbia (Ph < 7.2 and PCO₂ > 60 mm of water). Tracheal aspirates were sent for bacterial culture and antimicrobial susceptibility testing of the isolates within an hour of intubation and ventilation. Collection of samples was made directly in a sterile, closed vacuum container using aseptic techniques inserting a tracheal aspiration probe up to carina. The containers were sealed by the physicians and sent to the microbiology laboratory at icddr,b for the further processing.

**Procedure of isolation:**
The tracheal aspirates specimens were seeded in BACTEC™ Peds Plus culture media, which contains resins for neutralization of antibiotics. Then they were placed into BACTEC™ FX in which the microorganisms, if present in the samples, metabolize nutrients in the BACTEC culture vial and release CO₂ into the medium or utilize the oxygen in the medium. The instrument monitors the fluorescence of the vial sensor that is activated when CO₂ is produced or O₂ is utilized. Analysis of the rate and amount of CO₂ produced or O₂ utilized enables the instrument to determine if the vial is positive; i.e., the presumptive presence of viable organisms [18].

**Diagnosis of pneumonia and Clinical care:**
Pneumonia diagnosis was done following the World Health Organization (WHO) criteria for under-five children [19]; the study children were managed in accordance with the protocolized guidelines of the hospital that is based on local and global evidence [9,20,21]

**Data analysis:**
Clinical and laboratory data were collected and entered onto a personal computer using Statistical Package for Social Sciences (SPSS), Windows (Version 17.0; Chicago, IL) and Epi Info (Version 1.0.3, USD, Stone Mountain, GA). The variables analyzed include demographic data, presence of diarrhea (three or more abnormally loose or watery stools in previous 24 hours) [20], severe malnutrition (weight for length z score of <-3 of the median of the WHO reference or nutritional edema) [20], results of tracheal aspirates, the bacterial isolates and their antimicrobial susceptibility with multi drug resistant bacteria (if the bacteria is >30% resistant to any antibiotics).

**Results:**
Among 836 admitted pneumonia children in the ICU, we identified 35 children who had their tracheal aspirate assayed for bacterial culture and antimicrobial susceptibility tests. Out of these children 34 (97%) had bacterial isolates: 12 (35%) had single isolates (Table 1) and the rest 22 (65%) had poly-microbial growths (Table 2), and there were a total of 60 isolates (Table 3).

**Table 1.** Single bacterial isolates from tracheal aspirates of under-five children mechanically-ventilated for pneumonia.

<table>
<thead>
<tr>
<th>Bacteria</th>
<th>n (%)</th>
</tr>
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<tbody>
<tr>
<td><em>Klebsella</em> species</td>
<td>4 (33)</td>
</tr>
<tr>
<td><em>Escherichia coli</em></td>
<td>4 (33)</td>
</tr>
<tr>
<td><em>Enterococcus</em> species</td>
<td>1 (8)</td>
</tr>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td>2 (17)</td>
</tr>
<tr>
<td>Coagulase negative <em>Staphylococcus</em></td>
<td>1 (8)</td>
</tr>
</tbody>
</table>

Figures represent n (%), unless specified

Median age (inter-quartile range) of the study children was 7.5 (5.0, 12.0) months. Male and female distribution was almost equal 18 and 17, 10 children of available 29 data (35%) were
non-breast-fed, and 27 children of available 30 data (90%) were vaccinated. Diarrhea and severe malnutrition was present in 31/34 (91%) and 21/34 (62%) children respectively.

**Table 2.** Multiple bacterial isolates from tracheal aspirates of under-five children mechanically-ventilated for pneumonia.

<table>
<thead>
<tr>
<th>Organism</th>
<th>n (%)</th>
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</thead>
<tbody>
<tr>
<td>Klebsella species</td>
<td>10 (45)</td>
</tr>
<tr>
<td>Escherichia coli</td>
<td>7 (32)</td>
</tr>
<tr>
<td>Acinetobacter species</td>
<td>8 (36)</td>
</tr>
<tr>
<td>Streptococcus species</td>
<td>8 (36)</td>
</tr>
<tr>
<td>Enterococcus species</td>
<td>5 (23)</td>
</tr>
<tr>
<td>Staphylococcus aureus</td>
<td>2 (9)</td>
</tr>
<tr>
<td>Pseudomonas species</td>
<td>3 (14)</td>
</tr>
<tr>
<td>Coagulase negative Staphylococcus</td>
<td>2 (9)</td>
</tr>
<tr>
<td>Proteus species</td>
<td>2 (9)</td>
</tr>
<tr>
<td>Staphylococcus hemolyticus</td>
<td>1 (4)</td>
</tr>
</tbody>
</table>

Forty-four of the 60 (73%) isolates were gram negatives - 14 (23%) were Klebsella species, 11 (18%) were Escherichia coli, 8 (13%) were Acinetobacter species and 4 (7%) were Pseudomonas species. Among the gram positives, 8 (13%) were Streptococcus species and 4 (7%) were Staphylococcus aureus (Table 3).

The antimicrobial susceptibility of the isolates are provided in Table 3; it can be seen that, the susceptibility of the gram-negatives, with the exception of Klebsella, to ampicillin, cotrimoxazole, gentamycin, ciprofloxacin, azithromycin, and ceftriaxone ranged from 0- 54%, and that to ceftazime and amikacin ranged from 12-80%. The susceptibility of Klebsella species, Escherichia coli, Acinetobacter species and Pseudomonas species to imipenem and meropenem ranged from 25 – 90%. The susceptibility of the gram positives to these drugs ranged from 0-100% (Table 3).

The predominance of gram negatives from tracheal aspirates of our study children is a new finding. Our isolated bacterial agents significantly differ from the common bacterial etiology of pneumonia in this age group of children [24,25]. High proportion of children with severe malnutrition (62%), a common co-morbidity of pneumonia and diarrhea in developing countries may be a factor that explains our observation- the etiology of pneumonia in under-five children is different in such children compared to those without severe malnutrition [9,27]. Our isolated bacterial agents significantly differ from the common bacterial etiology of pneumonia in this age group of children [24,25]. High proportion of children with severe malnutrition (62%), a common co-morbidity of pneumonia and diarrhea in developing countries may be a factor that explains our observation - the etiology of pneumonia in under-five children is different in such children compared to those without severe malnutrition [9,27].
agents are common in ventilation-associated pneumonia (VAP) or in nosocomial pneumonia [28,29]; however, we collected tracheal aspirates from children with community acquired pneumonia and we collected the sample immediately following their intubation and ventilation. The remote chance of the possibility of nosocomial infection in our study population could not be ruled out since the median duration of hospital stay of those children, before intubation and ventilation, was 5.0 (inter-quartile range 1-24) days.

With the exception of Klebsiella species, all of the gram-negatives were frequently resistant to all commonly used antibiotics such as ampicillin, gentamycin, trimethoprim-sulfamethoxazole, ciprofloxacin, and ceftriaxone. The susceptibility of these isolates to ceftazidime and amikacin were a bit better but still very low. Our findings underscores the importance of considering carbapenem such as imipenem or meropenem as first-line therapy for pneumonic children who develop respiratory failure- the historical and local susceptibility pattern of the most of the gram negatives to these two drugs are still very encouraging [29].

In conclusion, the results of our data suggest that tracheal aspirate was highly sensitive for bacterial pneumonia in under-five children who required mechanical ventilation. Gram negative and multi-drug resistant bacteria were the predominant essential etiology of pneumonia in under-five ventilated children especially in children with diarrhea which underscores the importance of initiation of intravenous carbapenem drugs in such population to reduce potential ramiﬁcation. However, long term prospective studies with greater sample may provide more robust information.

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References:


