INTRODUCTION: Hospital infections are important because of increased risk of mortality and morbidity and their economic burden countries especially like India, most commonly seen in intensive care units (ICUs). We aimed to document the characteristics of patients at an ICU of Northern India, obtain bacteriologic samples, and determine the distribution of the isolated microorganisms. MATERIAL/METHODS: The study was conducted in the ICU of an anesthesiology and Surgery department. The characteristics of 200 patients treated there for a period of over two years were documented. The distribution of bacteriologic samples and isolated microorganisms and susceptibilities were investigated. The emerging hospital infections were determined using surveillance methods that were based on clinical and laboratory data. RESULTS: Intoxication was the most common cause of hospitalization, followed by respiratory insufficiency due to severe pneumonia and/or chronic obstructive respiratory disease, then trauma, postoperative conditions, and cerebrovascular problems. Cultures were most commonly obtained from patients with respiratory insufficiency and trauma. According to clinical specimens, the most commonly isolated microorganisms were E. coli (60.86%) in urine, S. aureus (53.84%) in blood, P. aeruginosa (26.22%) in tracheal aspirates, and Acinetobacter spp. (50.00%) in wounds. Considering all specimens, MRSA (24.00%) was the most common microorganism. CONCLUSIONS: Hospital infections causes serious problem in an ICU setting. Surveillance studies comprise the basis for treatment of ICU infections. KEYWORDS: intensive care unit, hospital infection, bacteriological culture.
MATERIAL AND METHODS: The admitted patients for treated in the Intensive Care Units (ICUs) of the anesthesiology and Surgery department of the Lord Buddha Koshi Medical College & Associated Hospital, Saharsa (B. N. Mandal University, Madhepura) between June 2012 and June 2014.

Selection of the Patients: The hospitalized patients in the ICU, by the anesthesiology and surgery departments. Patients who were treated for less than 48 hours in the ICU were excluded. Routine microbiological screening from tracheal aspirate, urine, and the surgical field was performed in selected patients.

A blood culture was done if there was clinical suspicion of systemic inflammation. Cerebrospinal fluid (CSF) was obtained when there was fever of unknown origin or clinical suspicion of meningitis. A Medical Officer dealing with infection control followed the patients included in the study by using surveillance methods based on patient and laboratory data. Definitions were used according to the “Centers for Disease Control and Prevention (CDC)” criteria.

DEFINITIONS:
Bacteremia: Positive blood cultures were evaluated for primary or secondary infection following exclusion of contamination. Bacteremia was considered if the infection was not secondary to another focus.

Pneumonia: This was considered when significant growth was observed on transtracheal aspiration and/or blood cultures of patients with clinically or radiologically suspected pneumonia.

Surgical wound Infections: Significant growth with at least one infection sign or symptoms.

Urinary tract Infections: Urinary tract infection was diagnosed when a urine specimen contained ≥102 colonies/ml in the presence of symptoms such as fever, hypothermia, lethargy, or ≥105 colonies/ml without any symptoms.

Microbiological Methods: Bacteriologic samples and microorganisms isolated were investigated at the Clinical Microbiology Laboratory of the Lord Buddha Koshi Medical College & Associated Hospital, Saharsa. Conventional methods (Standard precautions to be taken as per guidelines of Center for Disease control & Prevention) were used to identify bacteria.

Antibiotic susceptibility tests were determined by the Kirby-Bauer disc diffusion method while maintaining the required standardization conditions given by CLSI. Plates were incubated at 37°C in an aerobic environment for 24 hours. The results of antibiotic sensitivity were interpreted on the basis of diameters of growth inhibition zones according to CLSI suggestions.

Statistical Analysis: Data analysis was performed using Chi-square and Kruskal-Wallis tests were used for comparisons. A p value p<0.05 was considered as Statistically Significant.

RESULTS: The study was conducted in the ICU of an anesthesiology and Surgery department of the Lord Buddha Koshi Medical College & Associated Hospital, Saharsa. During the Two-years period, 200 patients were included in the study. The mean age was 44.3±21.5 (range: 5–65) years. Etiologies were as follows: 57 (28.5%) intoxication, 47(23.5%) respiratory insufficiency due to chronic obstructive pulmonary disease (COPD) or severe pneumonia, 42 (20.5%) trauma, 27(13.5%) postoperative, 16 (8%) cerebrovascular accident (CVA), and 11 (5.5%) other causes.

The mean hospitalization period of the patients was 3.7±3.1 days for intoxication patients, 11.3±2.3 for patients with COPD or severe pneumonia, 19.2±17.8 for trauma patients, 14.5±12.5 for
postoperative patients, 7.8±3.3 for CVA patients, and 9.8±10.2 days for other etiologies. The mean hospitalization periods showed significant differences between groups (Kruskal-Wallis p=0.0001).

Three hundred and thirty urine, 340 blood stream, 260 tracheal aspirate, 12 catheter, 10 pleural fluid, 38 wound, and 10 CSF specimens, making a total of 1000 bacteriologic samples, were sent to our clinical Microbiology laboratory of the Lord Buddha Koshi Medical College & Associated Hospital, Saharsa. The number of samples obtained from respiratory insufficiency and trauma patients was greater than from the other groups. The distribution of the samples according to patient groups is shown in Table 1.

| Sample               | Intoxication | COPD | Trauma  | Postoperative | CVA | Other | Total |
|----------------------|--------------|------|---------|---------------|-----|-------|-------|
|                      | n      | %    | n      | %    | n      | %    | n      | %    | n      | %    |
| Urine                | 21     | 6.4  | 80     | 24.3 | 85     | 25.7 | 60     | 18.2 | 77     | 23.2 | 7     | 21    | 330   | 100   |
| Blood                | 6      | 1.7  | 127    | 37.5 | 119    | 35   | 20     | 5.8  | 65     | 19.2 | 3     | 0.8   | 340   | 100   |
| Tracheal aspirate    | 5      | 1.9  | 99     | 38.1 | 64     | 24.6 | 40     | 15.3 | 52     | 20.1 | -     | -     | 260   | 100   |
| Catheter             | -      | -    | 3      | 18.2 | 3      | 27.3 | 6      | 45.5 | 1      | 9.1  | -     | -     | 12    | 100   |
| Pleural fluid        | -      | -    | 10     | 100  | -      | -    | -      | -    | -      | -    | -     | -     | 10    | 100   |
| Surgical field       | -      | -    | -      | -    | 25     | 66.7 | 10     | 25   | 3      | 8.3  | -     | -     | 38    | 100   |
| CSF                  | 7      | 66.7 | -      | -    | -      | -    | -      | -    | 3      | 33.3 | -     | -     | 10    | 100   |

Table 1: The distribution of the samples obtained from reanimation unit according to patient groups

The isolated microorganisms were mostly from wound samples (54%). No microorganism grew on CSF samples. The most frequently isolated microorganisms according to clinical samples were as follows: Escherichia coli (E. coli) (60.86%) from urine samples, Staphylococcus aureus (S. aureus) (53.84%) from the blood stream, Pseudomonas aeruginosa (P. aeruginosa) (26.22%) from tracheal aspirate samples, and Acinetobacter spp. (50.00%) from surgical wound samples.

Among all the samples, the most frequently isolated microorganism was methicillin-resistant Staphylococcus aureus (MRSA) (24.00%) followed by P. aeruginosa (17.0%) and Acinetobacter spp. (17%). The distribution of the growing microorganisms according to the samples showed significant difference (p=0.0001). The encountered isolates are listed in Table 2.
The antibiotic sensitivities of predominant bacteria are shown in Table 3. Among the 200 patients included in the study, (30 bacteremia, 24 pneumonia, 12 urinary tract infections, and 2 surgical field infections). The infection rate in the ICU was 34%.

Table 2: The distribution of growing microorganisms in the samples

| Microorganism          | Urine | Blood | Tracheal aspirate | Catheter | Pleural fluid | Surgical field | Total |
|------------------------|-------|-------|-------------------|----------|---------------|----------------|-------|
|                        | No    | %     | No    | %     | No    | %     | No    | %     |
| Candida spp.           | 1     | 0.5   |       |       |       |       |       |       |
| P. aeruginosa          | 3     | 13    | 16    | 1     | 1    | 34    | 17.0  |
| E. coli                | 14    | 2     | 8     |       |      |       | 25    | 12.0  |
| Acinetobacter spp.     | 2     | 23    | 5     | 1     | 3    | 34    | 17.0  |
| Group-D streptococci   | 1     |       |       |       | 1    | 0.5   |       |       |
| Proteus spp.           | 1     |       |       |       |      |       | 1     | 0.5   |
| S.epidermidis          | 1     | 2     | 5     |       | 1    | 9     | 4.5   |
| MRSA                   | 42    | 4     | 1     | 1     | 48   | 24.0  |
| MSSA                   | 14    | 8     |       | 1     | 23   | 11.5  |
| Enterobacter spp.      | 3     | 4     | 1     |       | 8    | 4.0   |
| S. typhi               | 1     |       |       |       | 1    | 0.5   |
| Budding yeast cells    | 1     | 2     |       |       | 3    | 1.5   |
| K. pneumonia           | 1     | 2     |       |       | 3    | 1.5   |
| Streptococcus spp.     | 1     | 3     |       |       | 4    | 2.0   |
| Citrobacter            | 1     |       |       |       | 1    | 0.5   |
| Streptococci Gr A-2    |       |       |       |       | 3    | 1.5   |
| Streptococci Gr F-1    |       |       |       |       | 1    | 0.5   |
| S.pneumoniae           |       |       |       |       | 1    | 0.5   |
| **Total (%)**          | 23(11.5) | 104(52) | 61(30.5) | 5(2.5) | 1(0.5) | 6(3) | 200(100) | 100  |

Table 3: Susceptibilities of the predominant pathogens

| Antibiotics | P. aeruginosa (Tn: 34) | Acinetobacter (Tn: 34) | E. coli (Tn: 24) | S. aureus (Tn: 71) |
|-------------|------------------------|------------------------|------------------|---------------------|
|             | Rn /%                  | Rn /%                  | Rn /%            | Rn /%              |
| Amox/Clav   | 32/94.7                | 11/48.1                | 48/67.5          |
| Pip/Tazo    | 1/ 2.94                | 0/0                    | -/-              |
| Ceftazidime | 20/57.9                | 28/84.2                | 4/18.5           |
| Cefepime    | 14/42.1                | 27/81.6                | 5/22.2           |
| Ciprofloxacin| 8/23.7                | 21/63.2                | 6/25.9           |
| Amikacin    | 15/44.7                | 13/39.5                | 2/7.4            |
| Netilmicin  | 20/60.5                | 21/63.2                | 3/11.1           |
| Imipenem    | 16/47.4                | 11/34.2                | 0/0              |
| Vancomycin  | -/-                    | -/-                    | -/-              |

Tn – total number; Rn – resistant number.
DISCUSSION: Microbiological surveillance in the ICU facilitates the monitoring of changes of dominant microorganisms and antibiotic susceptibilities in the unit, detecting epidemics, deciding empirical treatment regimes and, as a result, selecting the right antibiotics.⁷

Starting empirical treatment without microbiological investigations and surveillance studies is recognized as a mistake. In our Lord Buddha Koshi Medical College, & Associated Hospital, Saharsa, the Anesthesiology & Surgery unit Medical Officer works in cooperation with the infection control committee in performing the necessary microbiological investigations. A total of 1000 bacteriologic samples from the patients included in our study were sent to our Clinical Microbiology laboratory.

The most of the samples were sent from the respiratory insufficiency and trauma patients (Table 1). A long hospitalization time in the ICU is found to be the most important risk factor for the development of ICU infections.⁸ In our study, trauma cases were hospitalized in the ICU for longer periods (mean: 19.2±17.8 days). The increased number of bacteriological culture samples is related to the longer ICU stay period of patients with trauma and respiratory problems.

Staphylococci are the most frequently isolated bacteria in hospital infections. Intensive care units are suitable places for methicillin-resistant bacteria. Hospitalization in an ICU is an important risk factor for MRSA colonization and infection.⁹ Some studies showed that MRSA is most commonly isolated from surgical fields.¹⁰ In our study; MRSA was most frequently isolated from the bloodstream, as reported by Berghmans T et al.¹¹

In our study the most commonly isolated bacteria in ICU patients was MRSA (24.00%). According to the results of the same study, Pseudomonas and Acinetobacter species are commonly isolated from the lower respiratory tract, and S. aureus was the leading cause of bacteremia as in our study. Usually in the non-fermenter group, P. aeruginosa is the most common hospital infection agent.

The second most frequently isolated non-fermenter bacteria are Acinetobacter spp. Both bacteria are related with a high mortality rate.¹² In our study; both bacteria are the second most frequently isolated bacteria if all samples are taken into account. P. aeruginosa is the most frequently isolated bacterium from tracheal aspirate cultures. Acinetobacter spp. is the most commonly isolated bacteria from wound cultures.

Resistance rates were high in the frequently isolated Gram-negative bacilli such as P. aeruginosa and Acinetobacter strains, and in S. aureus, a Gram-positive microorganism. The increase in resistance was related with the severity of underlying disease, long duration of hospitalization, and prior inappropriate antibiotic use in patients hospitalized in the ICU.

These microorganisms pose difficulties not only in the treatment of ICU infections, but also other hospital- or community-acquired infections because of their antibiotic resistance. Piperacillin-tazobactam was reported to be the most effective agent against P. aeruginosa and Enterobacteriaceae by Dzierzanowska-Fangrat K et al.¹³

We also found piperacillin-tazobactam to be the most active agent against P. aeruginosa and E. coli, inhibiting 97% and 100% of isolates, respectively. As with other opportunistic Gram-negative organisms (e.g. P. aeruginosa), increasing antibiotic resistance has hindered therapeutic management in Acinetobacter. Acinetobacter infections have been treated with ampicillin, second-generation cephalosporins, carbenicillin, and gentamicin in recent years.

Combined measures with a reasonable antibiotic policy and observation of the principles of hygiene and monitoring for possible infections may help to prevent the spread of multiple-resistant strains in hospital environment.
Intensive care units are also appropriate environments for the colonization of resistant microorganisms. The microbiologic results must be interpreted by differentiating infection from colonization. Colonization is the presence and reproduction of microorganisms without any immune response and clinical findings in the host. Among the samples taken, surgical field infections are the least commonly detected although growth occurs most commonly in wound samples.

CONCLUSION: As a result, there are major differences in patient characteristics between other hospital departments and the ICU. The growing knowledge and technology in intensive care services and the development of invasive procedures bring complicated problems. Effective infection-control programs need to be considered for the prevention of infection with resistant bacteria in the ICU. Surveillance results and antibiotic resistance tests should be routinely evaluated.

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