Original Articles

Analysis of blood/tracheal culture results to assess common pathogens and pattern of antibiotic resistance at medical intensive care unit, Lady Ridgeway Hospital for Children

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Abstract

Background: Intensive care units (ICUs) are burdened with a high frequency of nosocomial infections often caused by multi resistant nosocomial pathogens.

Objectives: To determine the common pathogens in medical intensive care unit of Lady Ridgeway Hospital for Children (MICU-LRH) and to look for the pattern of antibiotic resistance of these pathogens.

Design & Setting: This retrospective study was performed by tracing all the culture reports of MICU-LRH done at microbiology laboratory of LRH in the year 2006.

Results: Total number of blood cultures done in 2006 was 659. Of them 123(18.7%) became positive. Out of positive blood cultures 38.2% were for spores and 24% for coliforms. Staphylococcus aureus (10.6%), streptococcus spp. (4.1%), pseudomonas spp. (4.1%) and candida spp. (4.9%) were the other pathogens in blood cultures.

Out of 457 tracheal cultures done in 2006, 251(56%) were positive. Contamination with spores was 3.1%. Majority (43%) of tracheal cultures were positive for coliforms. Other common pathogens were pseudomonas spp. (19.5%) and candida spp. (9.8%)

Resistance pattern of coliforms varied in blood cultures and tracheal cultures. There was significant resistance to aminoglycosides. Imipenem & meropenem resistant isolates were not found in blood cultures but in tracheal cultures 44% of isolates were resistant to imipenem & 42% were resistant to meropenem.

Resistance pattern of pseudomonas to amikacin was around 34% in both blood & tracheal cultures. 25% of isolates in blood cultures and 50% of isolates in tracheal cultures were resistant to ceftazidime. Although, there was no resistance to ticarcillin in blood cultures, 51% pseudomonas isolated in tracheal cultures showed resistance. Resistance rate to ciprofloxacin was 50% in blood cultures and 34% in tracheal cultures.

Eighty three percent of staphylococcus spp. in both blood & tracheal cultures were resistant to cloxacillin. More than 70% were resistant to gentamicin. Around 33% isolates in blood cultures & 22% in tracheal cultures were resistant to fusidic acid. However, all staphylococcus spp. were sensitive to Vancomycin.

Conclusions: There were more positive tracheal cultures than blood cultures. Majority of septicaemia were due to coliforms. Coliforms and pseudomonas were major pathogens in tracheal cultures. There was significant colonization of candida spp. in respiratory tract of patients at MICU-LRH in contrast to candida septicaemia. Emergence of antibiotic resistance to broad spectrum antibiotics is a significant problem.

(Key words: Blood culture; tracheal culture; medical intensive care unit; pathogens; antibiotic resistance)

Introduction

Sepsis is a major problem in intensive care units (ICUs) and antibiotics are one of the most common therapies administered in the ICU setting. However, in addition to treating infections, extensive antibiotics usage may also contribute to the emergence of resistance among pathogenic microorganisms.

Antimicrobial resistance among ICU pathogens is generally increasing but many different patterns and variations do exist in different countries, probably due to different antimicrobial usage patterns. When new medical practices and alternative antimicrobials are introduced, changes in the dominant microbial aetiologies may emerge

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which would include novel resistant organisms. Appropriate therapy of ICU infections directed by local resistance data can have significant consequences for both patient and the healthcare system[1,2].

The emergence of antimicrobial-resistant pathogens in ICUs has made treating these infections very difficult and, in some rare cases, almost impossible. ICU patients are particularly susceptible to nosocomial infections due to underlying illnesses, suppressed immune systems and frequent use of invasive devices[3].

There is no data available up to the present time on the common pathogens of blood cultures or tracheal aspirates together with an assessment of the antibiotic resistance pattern in the medical intensive care unit at Lady Ridgeway Hospital (MICU – LRH). This is the largest children's hospital in Sri Lanka and this MICU has 10 beds with 10 ventilators and accepts transfers from the entire island. Both paediatric patients and neonates are being treated here. Therefore, an assessment of common pathogens and patterns of antibiotic resistance at MICU is very important to start empirical treatment for patients who are critically ill. The study presented in this manuscript was undertaken to mitigate this deficiency.

Objectives

- To determine the proportions of positive blood and tracheal cultures at the MICU-LRH in the year 2006.
- To describe types of organisms in positive cultures & categorize them into pathogens and probable contaminants.
- To determine the pattern of antibiotic resistance in common pathogens isolated in the MICU - LRH.

Design, setting & method

This retrospective study was performed by tracing all blood & tracheal culture reports of patients admitted to the MICU - LRH during the year 2006. Using the admission book to the MICU – LRH, Bed Head Ticket (BHT) numbers of all the admissions in 2006 were taken and categorized into monthly aggregates. The culture reports entry books at MICU and Microbiology department were used to collect data. BHTs were traced in some positive culture reports whenever we could not find a proper report.

Number of blood cultures & tracheal cultures done in each month, number of positive & negative cultures, organisms in positive cultures and sensitivity for antibiotics in the common pathogens (coliforms, staphylococcus aureus, pseudomonas sp.) were documented. Results were analyzed on monthly aggregates, separately on blood cultures and tracheal cultures after entering data into Microsoft Excel sheets. The patterns of antibiotic resistance of common pathogens were assessed separately in blood and tracheal cultures. Consultant Microbiologist's opinion was taken to categorize true pathogens & probable contaminants.

Results

Total number of blood cultures done in 2006 was 659. Out of these cultures 123 (18.7%) became positive. Total number of tracheal cultures done in 2006 was 457 and out of these 256 (56%) were positive. Figures 1 & 2 show these results in monthly aggregates:

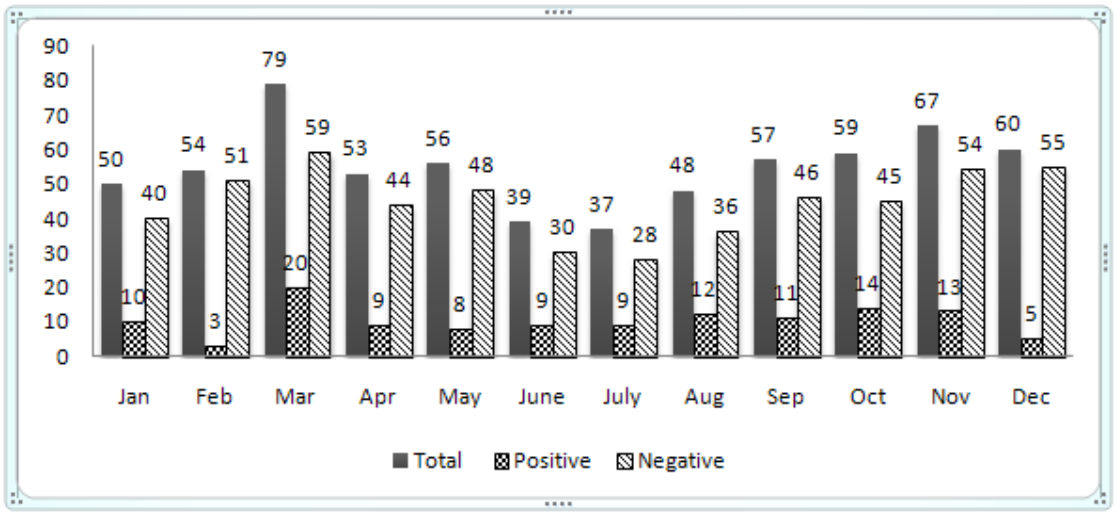

Figure 1: ***Blood culture results- 2006***

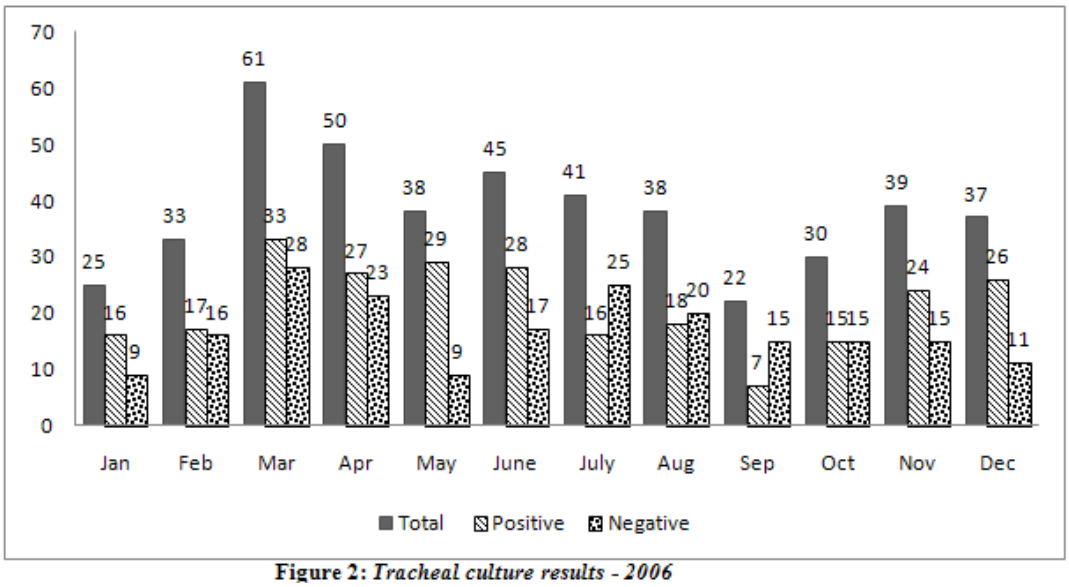

Figure 2: ***Tracheal culture results - 2006***

Organisms found in positive blood & tracheal cultures were as follows:

True Pathogens
Coliforms: E. coli, klebsiella or proteus
Staphylococcus aureus: Methicillin resistant (MRSA) or methicillin sensitive
Streptococcus: groups A, B or D
Pseudomonas species

Probable Contaminants
From environment: Spores
From skin: Diphtheroids, CONS or mixed growth
Hospital associated: Acenetobacter, candida species

Species identification was not done in our laboratory

Percentages of true pathogens and probable contaminants in blood culture are shown in Figure 3.

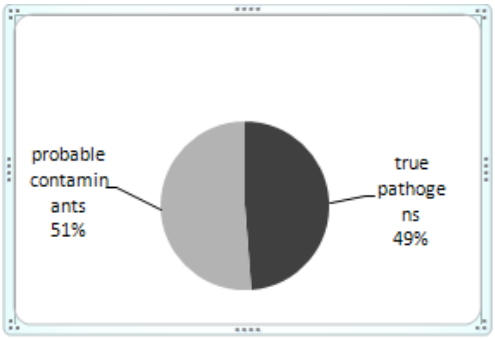

Figure 3: ***Percentage of true pathogens & probable contaminants in blood culture***

The percentages of true pathogens and probable contaminants in tracheal culture are shown in Figure 4.

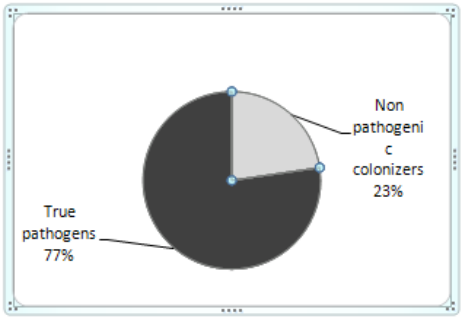

Figure 4: *Percentage of true pathogens & contaminants in tracheal culture*

Organisms identified in blood cultures are shown in Figure 5. Coliforms were the most common pathogens identified in blood cultures. Out of the contaminants the majority were spores.

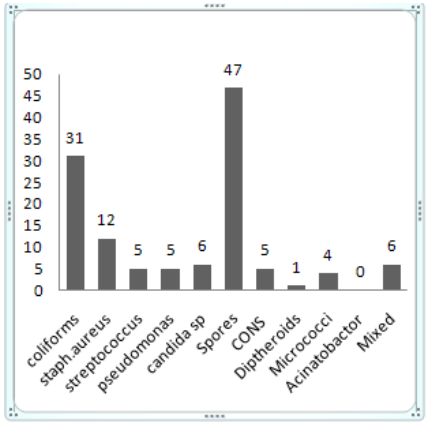

Figure 5: *Organisms in positive blood cultures*

Organisms identified in tracheal cultures are shown in Figure 6. Coliforms were the commonest pathogens in tracheal cultures. Spores and acenetobacter were the common contaminants.

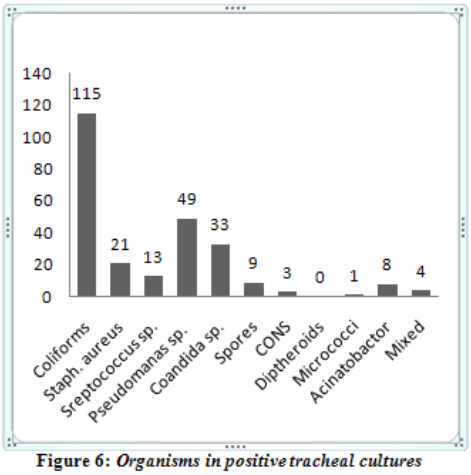

Figure 6: *Organisms in positive tracheal cultures*

Tables 1-3 show the resistance patterns to some common pathogens.

Table 1: ***Resistance pattern for coliforms***

Antibiotics	Resistance in blood cultures	Resistance in tracheal cultures
Gentamicin	90.3%	82.9%
Netilmicin	75%	58.2%
Amikacin	32.1%	40.5%
Ampicillin	94.1%	97.6%
Co-Amoxiclav	96.3%	95.9%
Ticarcillin	72.4%	70%
Cefuroxime	93%	97.9%
Cefotaxime	89.3%	92.1%
Ceftazidime	69.6%	74.5%
Ceftriaxone	100%	100%
Ciprofloxacin	15.4%	35.5%
Imipenem	0%	44.1%
Meropenem	0%	42.3%

Table 2: ***Resistance pattern for pseudomonas***

Antibiotics	Resistance in blood cultures	Resistance in tracheal cultures
Gentamicin	100%	52.6%
Netilmicin	100%	42.4%
Amikacin	33.3%	35.7%
Ceftazidime	25%	50%
Ciprofloxacin	50%	34.3%
Aztreonam	100%	48.6%
Meropenem	66.6%	50%
Ticarcillin	0%	51.20%

Table 3: ***Resistance pattern for staphylococcus***

Antibiotics	Resistance in blood cultures	Resistance in tracheal cultures
Gentamicin	70%	77.8%
Netilmicin	25%	42.9%
Erythromycin	100%	66.7%
Cloxacillin	83.3%	83.3%
Vancomycin	0%	0%
Fusidic acid	33.3%	22.2%

Discussion

Majority of septicaemia in 2006 at MICU – LRH was due to coliforms. As species identification was not done at our laboratory we could not assess the common coliform species. There were more positive tracheal cultures compared to blood cultures. As we did not correlate culture reports with clinical findings of patients, it is difficult to say whether all positive cultures indicate ventilator associated pneumonias. Coliforms and pseudomonas were the major pathogens in tracheal cultures. They are the common pathogens found in ventilator associated pneumonias in other studies[1,2].

One particular concern is the nosocomial infection caused by enterobacteria producing extended-spectrum beta lactamases (ESBLs). Organisms that possess these enzymes are usually resistant to multiple antimicrobials and hydrolyze third-

generation cephalosporins and aztreonam, rendering these potent antibacterial agents useless[4]. In our study we found ESBL producing coliforms in one blood culture and four tracheal cultures. All ESBL producing coliforms at MICU – LRH were resistant to ceftriaxone and some were resistant to meropenem also.

Examination of Gram-positive microorganisms, such as *S. aureus* and coagulase-negative staphylococci shows that rates of methicillin-resistant isolates in ICU have increased steadily over the past decade[5-7]. In our study methicillin-resistant staphylococcus were found in 10 blood cultures & 12 tracheal cultures but all were sensitive to vancomycin. It was reassuring as we did not find staphylococcus resistant to vancomycin. In various studies, it was reported that increased resistance rates have been detected against carbapenems, quinolones and third-generation cephalosporins for pseudomonas aeruginosa worldwide[2,8].

Data from a multicentre Intensive Care Unit Surveillance Study (ISS) in the United States demonstrated that resistance to anti pseudomonal agents among ICU isolates of *P. aeruginosa*, especially fluoroquinolones (ciprofloxacin) was increasing[9]. Our study also shows that 50% of pseudomonas in blood cultures and 34% of pseudomonas in tracheal cultures were resistant to ciprofloxacin. 51% of pseudomonas in tracheal aspirates were resistant to anti pseudomonal penicillin (ticarcillin) and majority of pseudomonas (>50%) isolated from both blood cultures and tracheal aspirates were also resistant to meropenem.

Many studies have demonstrated that the development of antimicrobial resistance at the hospital level is strongly correlated with the use of the relevant antimicrobial[10]. Data from project ICARE showed that their usage was significantly higher among ICU patients than non-ICU patients for third-generation cephalosporins, vancomycin, anti-pseudomonal penicillin, intravenous fluoroquinolones and imipenem[11]. Our study also shows that there are significant percentagesof common pathogens resistant to above mentioned antibiotics.

Limitations

As this is a retrospective study, it has several limitations including the fact that we cannot say that all positive culture reports represented active infection. In addition, as we did not have admission data for each patient/clinical specimen, we were not able to provide a more accurate description of community versus nosocomial onset. Ventilator associated pneumonia cannot be accurately identified in this study

Recommendation

A prospective study should be carried out to get more information. Then, each year we can audit to see emergence of new antibiotic resistance to prepare a protocol for empirical antibiotic therapy at MICU LRH.

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References

1. Anonymous. Intensive Care Antimicrobial Resistance Epidemiology (ICARE) surveillance report data summary from January 1996 through December 1997: a report from the National Nosocomial Infections Surveillance (NNIS) system. *Am J Infect Control* 1999; **27**: 279–84. http://dx.doi.org/10.1053/ic.1999.v27.a98878

2. Streit JM, Jones RN, Sader HS, Fritsche TR. Assessment of pathogen occurrences and resistance profiles among infected patients in the intensive care unit: report from the SENTRY Antimicrobial Surveillance Program (North America, 2001). *Int J Antimicrob Agents* 2004; **24**:111-8. http://dx.doi.org/10.1016/j.ijantimicag.2003.12.019

3. AysenBayram, IclalBalci: Patterns of antimicrobial resistance in a surgical intensive care unit of a university hospital in Turkey *BMC Infectious Diseases* 2006; **6**: 155. http://dx.doi.org/10.1186/1471-2334-6-155

4. Rice LB, Eckstein EC, DeVente J, et al: Ceftazidine resistant *Klebsiella pneumoniae* isolates recovered at the Cleveland Department of Veterans Affairs Medical Center. *Clin Infect Dis* 1996; **23**:118–24. http://dx.doi.org/10.1093/clinids/23.1.118

5. Diekema DJ, Pfaller MA, Jones RN, Doern GV, Kugler K, Beach ML, Sader HS. Trends in antimicrobial susceptibility of bacterial pathogens isolated from patients with bloodstream infection in the USA, Canada and Latin America. SENTRY Participants Group. *Int J Antimicrob Agents.*2000; **13**: 257–71. http://dx.doi.org/10.1016/S0924-8579(99)00131-4

6. Fridkin SK, Gaynes RP. Antimicrobial resistance in intensive care units. *Clinics in Chest Medicine* 1999; **20**: 303–16. http://dx.doi.org/10.1016/S0272-5231(05)70143-X

7. Aubry-Damon H, Courvalin P. Bacterial Resistance to Antimicrobial Agents: Selected Problems in France, 1996 to 1998. *Emerg Infect Dis*. 1999; **5**:315–20. http://dx.doi.org/10.3201/eid0503.990301

8. Hancock REW. Resistance mechanism in Pseudomonas aeruginosa and other non fermentative gram-negative bacteria. *Clin Infect Dis* 1998; **27**: 289-99.

9. Friedland I, Gallagher G, King T, Woods GL. Antimicrobial susceptibility patterns in Pseudomonas aeruginosa: data from a multicenter Intensive Care Unit Surveillance Study (ISS) in the United States. *J Chemother* 2004; **16**:437–41.

10. Shlaes DM, Gerding DN, John JF Jr, et al: Society for Healthcare Epidemiology of America and Infectious Diseases Society of America Joint Committee on the Prevention of Antimicrobial Resistance: guidelines for the prevention of antimicrobial resistance in hospitals. *Infect ControlHospEpidemiol*1997; **18**: 275-91. http://dx.doi.org/10.1086/647610

11. Fridkin SK, Steward CD, et al: Surveillance of antimicrobial use and antimicrobial resistance in US hospital: project ICARE Phase 2. Project Intensive Care Antimicrobial Resistance Epidemiology (ICARE) hospitals. *Clin Infect Dis* 1999; **29**: 245-52. http://dx.doi.org/10.1086/520193

12. Ibrahim EH, Sherman G, Ward S, Fraser VJ, Kollef MH. The influence of inadequate antimicrobial treatment of bloodstream infections on patient outcome in the ICU setting. *Chest* 2007; **118**:146-55.