Acinetobacter baumannii: Identification, Antibiotic Sensitivity and Biofilm Formation in Different Clinical Samples

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Abstract

Background: Acinetobacter baumannii is responsible for nosocomial infections which are related to biofilm formation of this pathogen. Biofilm formation helps the bacteria in surviving stressed environmental conditions and bacteria growing in biofilms are resistant to most of the commonly used antibiotics.

Objectives: The objective of this study was to detect A. baumannii, to see antibiotic sensitivity and biofilm formation in different clinical samples.

Methods: Total 108 Acinetobacter spp. were collected from different clinical samples which were identified by conventional microbiological procedures. Out of 108 Acinetobacter spp, 85 were identified as A. baumannii by polymerase chain reaction by detecting blaOXA-51 gene which is intrinsic to A. baumannii. Antibiotic sensitivity was detected by modified disc diffusion method and biofilm formation was detected by Tissue culture plate method.

Results: Among 85 isolates, 45.9% A. baumannii were obtained from tracheal aspirate followed by blood (21.2%), wound swab (15.3%), urine (10.6%), pus (5.9%) and pleural fluid (1.1%). More than 80% of A. baumannii was resistant to cephalosporin, aminoglycosides, quinolone, carbapenem. By Tissue culture plate method, 78.8% of isolates showed biofilm formation. Biofilm formation in tracheal aspirate was 82.1%, in blood 72%, in wound swab 92%, in urine 44.4%, in pus 100% and in pleural fluid 100%.

Conclusion: Detection rate of A. baumannii was more in tracheal aspirates. Biofilm producing A. Baumannii was resistant to most of the antibiotics.

Key words: Biofilm, Tissue culture plate method, Polymerase chain reaction

Introduction

Thirty-three genomic species (gen. sp.) of the Acinetobacter genus have so far been identified of which Acinetobacter baumannii is an important nosocomial pathogen that is responsible for a wide range of human infections such as pneumonia, septicemia, wound sepsis, urinary tract infections, endocarditis and meningitis.1,2 A. baumannii, genomic species 3 and 13TU, three of the most clinically relevant species, are genetically and phenotypically very similar to an environmental species, Acinetobacter calcoaceticus, and are therefore grouped together into the so-called A. calcoaceticus–Acinetobacter baumannii complex.1 Because antibiotic susceptibility and clinical relevance are significantly different between different genomic species, exact identification of Acinetobacter species are required.2 Identification within the genus is difficult and requires molecular methods.3 Several genotypic methods have been developed for genomic species identification, which include amplified 16S rRNA gene restriction analysis, high-resolution fingerprint analysis by amplified fragment length polymorphism, sequence analysis of the 16S–23S rRNA gene spacer region, rpoB sequencing and gyrB multiplex PCR.4 The recA gene5 and blaOXA-51-like gene6,7 were also used for A. baumannii genotypic identification. The genes blaOXA-51-like is intrinsically present in A. baumannii.7

Recently, the rapid development of multiple antibiotic resistance of A. baumannii has caused a serious problem for public health. The ability of biofilm formation contributes to Acinetobacter easily survive and transfer in the hospital environment, such as attached to various biotic and abiotic surfaces, e.g., vascular catheters, cerebrospinal fluid shunts or Foley’s catheter.8 In the clinical samples, the most commonly
**Materials and Methods**
This cross sectional study was conducted at the Department of Microbiology & Immunology, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh from September 2017 - August 2018.

**Bacterial Isolates and Laboratory Identification of Acinetobacter spp.**
Total 108 Acinetobacter spp. were collected from different clinical samples (tracheal aspirate, wound swab, pus, blood, urine, pleural fluid). The clinical samples were sent from different ward of Bangabandhu Sheikh Mujib Medical University Hospital in Department of Microbiology & Immunology (BSMMU) for culture and antimicrobial sensitivity test. Acinetobacter spp. were identified by culture, Gram stain and biochemical tests (catalase test, oxidase test, urease test, motility test, citrate utilization test and Oxidation-Fermentation test).

**Identification of A. baumannii by PCR**
From 108 Acinetobacter spp. 85 were confirmed as A. baumannii by identification of the blaOXA-51-like gene. The PCR was performed in culture isolates using specific primers for detection of blaOXA-51-like gene (Applied biosystems, Thermofisher scientific, USA). DNA was extracted from bacterial colonies by boiling method. Two colonies of overnight growth of A. baumannii were taken in a 2 ml micro centrifuge tube (Extra-Gene, Taiwan). One ml of distilled water was added and boiled in a heat block (Incublock, Denville scientific inc. USA) for 10 minutes at 100°C. The tubes were then centrifuged for 5 minutes at 168 g (Herml Z.233 M-2, Labnet international inc. USA). Supernatant was taken for PCR analysis. The specific primer for blaOXA-51-like gene was (Forward - 5’TAA TGC TTT GAT CGG CCT TG; Reverse - 5’TGG ATT GCA CTT CAT CTT GG; Amplicon size 351 bp). The PCR assay was performed in a reaction mixture with total volume of 25 µl containing 15 µl of master mix (TBG biotechnology Corp. USA), 0.15 µl Taq polymerase (Solis BioDyne Germany), 1 µl of forward and reverse primer each (10 pmol/µl), 3 µl of distilled water and 5 µl of undiluted extracted DNA. The amplification condition was: initial denaturation at 95°C for 5 minutes, 30 cycles containing of denaturation at 95°C for 25 seconds, annealing at 60°C for 40 seconds, extension at 72°C for 50 seconds and final extension at 72°C for 6 minutes. The amplified products were subjected to electrophoresis in 1.5% agarose gel. (Photograph-I)

**Antimicrobial Susceptibility Testing**
A. baumannii were tested for antimicrobial susceptibility to ceftriaxone (30 µg), cefotaxime (30 µg), cefazidime (30 µg), cefepime (30 µg), ciprofloxacin (5 µg), cotrimoxazole (1.25/23.75 µg), imipenem (10 µg), meropenem (10 µg), gentamicin (10 µg), amikacin (10 µg), netilmicin (30 µg), piperacillin-tazobactum (100/10 µg), ticarcillin-clavulanic acid (100/10 µg), colistin (10 µg), polymixin (300 units) (Oxoid, UK). The susceptibility was performed on Mueller Hinton Agar media (Merck, Germany) by modified disc diffusion method. Zone of inhibition were interpreted per recommendation of the Clinical Laboratory Standard Institute (CLSI) guidelines. In case of netilmicin zone of inhibition was used per BSAC standardized disc susceptibility testing method, for colistin and polymixin B zone of inhibitions were used per Gales et al (2001). E. coli (ATCC 25922) strains was used as the quality control reference strains according to CLSI.

**Study of Biofilm Formation**
Biofilm production of A. baumannii was done by tissue culture plate method (TCP) according to Toledo-Aranza et al (2001). A. baumannii were grown overnight in Brain heart infusion broth (BHI) (Becton Dickinson and company, USA) with 0.25% glucose at 37°C. The broth culture was diluted at a ratio of 1:40. 200µl of this diluted culture suspension was inoculated in a sterile 96 well flat bottom polystyrene microtiter plate (Greiner Bio-One International, Kremsmünster, Austria). The positive control (Klebsiella pneumoniae ATCC 700603) and negative control (sterile BHI-0.25% glucose) were also added.
to microtiter plate in the same way. After overnight incubation at 37°C, the wells were gently washed three times with 200 µl of phosphate buffer saline (PBS). The plate was air dried, fixed with 200 µl/well of 2% formalin at 4°C for 1 hour. After that, the wells were stained with 1% crystal violet for 15 min. Afterward, the wells were rinsed under running tap water to remove the excess stain. Then 200 µl ethanol-acetone (80:20, v/v) was added in each well to solubilize crystal violet. Each assay was performed in triplicate and repeated three times. The optical density (OD) at 630 nm was measured using ELISA plate reader (Plate reader, model–A4, serial no.-1910, Das, Italy).

The cut-off value (ODc) was calculated for each microtiter plate. ODc was of three standard deviations (SD) above the mean OD of the negative control: ODc = average OD of negative control + (3xSD of negative control).

Final OD value of a tested strain was expressed as average OD value of the strain reduced by ODc value (OD = average OD of a strain - ODc). If a negative value is obtained, it should be presented as zero, while any positive value indicates biofilm production. Different steps of TCP method were depicted in photograph-II.

Data Analysis
The data were analyzed using SPSS software Version-23 (SPSS Inc., Chicago, IL, USA).

Results
Isolates and Identification
Total 108 Acinetobacter spp. were collected from which, 85 were identified as A. baumannii. Among 85 isolates, 39 (45.9%) A. baumannii were obtained from tracheal aspirate, 13 (15.3%) from wound swab, 5 (5.9%) from pus, 18 (21.2%) from blood, 9 (10.6%) from urine, 1 (1.1%) from pleural fluid. Majority of A. baumannii were isolated from tracheal aspirate (Table I).

Table-I: Distribution of A. baumannii Isolated from Different Type of Samples (n=85)

| Type of samples   | Number of A. baumannii isolates | Percentage |
|-------------------|---------------------------------|------------|
| Tracheal aspirate | 39                              | 45.9       |
| Wound swab       | 13                              | 15.3       |
| Pus               | 05                              | 5.9        |
| Blood             | 18                              | 21.2       |
| Urine             | 09                              | 10.6       |
| Pleural fluid     | 01                              | 1.2        |
| Total             | 85                              | 100        |

Antimicrobial Susceptibility of A. baumannii
Figure I showed antimicrobial resistance pattern of A. baumannii. A. baumannii showed 94.1%, 97.6%, 82.4%, 87.1%, 63.5%, 82.4%, 83.5%, 88.2%, 89.4%, 75.3%, 85.9%, 80%, 82.4%, 88.2% resistance to ceftriaxone, cefotaxime, ceftazidime, cefepime, ciprofloxacin, gentamicin, amikacin, netilmicin, imipenem, meropenem, piperacillin-tazobactam, ticarcillin-clavulanic acid, colistin, polymixin B respectively.

Figure-I: Antimicrobial Resistance Pattern of A. baumannii (n=85)
Table II showed antimicrobial resistance pattern of A. baumannii in different type of samples. In tracheal aspirate, cefotaxime and ceftazidime were 100% resistant followed by ceftriaxone (97.4%), cefepime (97.4%), imipenem (97.4%), meropenem (97.4%), piperacillin-tazobactam (97.4%), ticarcillin-clavulanic acid (97.4%), amikacin (97.4%), ciprofloxacin (97.4%), gentamicin (94.7%), netilmicin (82.1%) whereas colistin and polymixin B showed only 2.6% resistance. In wound swab cefotaxime was 100% resistant followed by ceftazidime (92.3%), ceftriaxone (92.3%), cefepime (92.3%), amikacin

CTR: Ceftriaxone, CTX: Cefotaxime, CAZ: Ceftazidime, CFM: Cefepime, COT: Cotrimoxazole, CIP: Ciprofloxacin, GEN: Gentamicine, AK: Amikacin, NET: Netilmicin, IMP: Imipenem, MEM: Meropenem, TZP: Piperacillin-tazobactam, TIC: Ticarcillin-clavulanic acid, COL: Colistin, PB: Polymixin B.
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Table III showed Biofilm producer isolates of A. baumannii in different type of samples. A. baumannii showed 82.1%, 92.3%, 72.2%, 44.4% of biofilm formation in tracheal aspirate, wound swab, blood and urine respectively whereas showed 100% biofilm formation in Pus and pleural fluid.

**Table-III: Biofilm producer isolates of A. baumannii in different type of samples**

| Type of samples | Biofilm producer isolates (67) | Non biofilm producer isolates (18) |
|-----------------|-------------------------------|-----------------------------------|
| Tracheal aspirate (39) | 32 (82.1) | 7 (17.9) |
| Wound swab (13) | 12 (92.3) | 1 (7.7) |
| Pus (8) | 5 (100) | 0 (0) |
| Blood (18) | 13 (72.2) | 5 (27.8) |
| Urine (99) | 04 (44.4) | 05 (55.6) |
| Pleural fluid (01) | 01 (100) | 0 (0) |
| Total (85) | 67 (78.8%) | 18 (21.2%) |

**Discussion**

Most of the A. baumannii, 45.9% of isolates were obtained from tracheal aspirates in this study. About 40.9% of A. baumannii in tracheal aspirates was reported by Barai et al (2010)\textsuperscript{19} in Ibrahim Medical College, Dhaka. Angoti et al (2016)\textsuperscript{20} reported 49.3% in Iran and Prabhu et al (2017)\textsuperscript{21} found 20.4% A. baumannii in tracheal aspirate in Nepal. In this study 15.3% of A. baumannii was isolated from wound swab whereas Angoti et al (2016)\textsuperscript{20}, Babapour et al (2016)\textsuperscript{22} isolated 11.6% and 10% of A. baumannii respectively. About 5.9% A. baumannii was isolated from pus in this study whereas 9.1% was isolated by Prabhu et al (2017)\textsuperscript{21} in blood. 21.2% of A. baumannii was isolated in this study and Angoti et al (2016)\textsuperscript{20} isolated 16.7% of A. baumannii. About 10.6% of A. baumannii was isolated from urine in this study whereas 6.5% and 17% was isolated by Angoti et al (2016)\textsuperscript{20} and Babapour et al (2016)\textsuperscript{22} respectively. In pleural fluid 1.1% of A. baumannii was isolated in this study and Babapour et al (2016)\textsuperscript{22} isolated 5% of A. baumannii in pleural fluid.

In this study, the resistance of A. baumannii isolates was found as follows: ceftaxime (94.1%), cefotaxime (97.6%), ceftazidine (82.4%), cefepime (87.1%), ceftriaxone (83.3%), gentamicin (77.8%), amikacin (77.8%), netilmicin (72.2%). Pus, pleural fluid showed 100% resistance to all antimicrobial agent except colistin, polymixin B.

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rate of colistin and polymixin B was 5.9%. According to Prabh et al (2017)A. baumannii was found resistance against ceftriaxone (93.2%), cefotaxime (97.7%), ceftazidime (95.4%), cefepime (88.6%), ciprofloxacin (97.7%), cotrimoxazole (93.2%), gentamicin (52.3%), amikacin (43.2%), and piperacillin/tazobactam (97.7%). Angoti et al (2016) found A. baumannii was resistance against ceftriaxon (99%), ceftazidime (98%), cefepime (99%), ciprofloxacin (99%), cotrimoxazole (84%), gentamicin (77%), amikacin (48%), imipenem (99%), meropenem (99%), colistin (11%). According to Babapour et al (2016) 94.87% of the A. baumannii were resistant to Ceftriaxon, 94.23% to cefepime, 89.10% to cotrimoxazole, 83.33% to gentamicin, 91.03% to imipenem, 95.51% to Piperacillin-tazobactam, 93.59% to ticarcillin-clavulanic acid. There was a high degree of susceptibility to PB (300).

In this study, 67 (78.8%) of A. baumannii produce biofilm which was consistent with the results of Nahar et al (2013) in Bangladesh, Gurung et al (2013) in India, Thummepak et al (2016) in Thailand. Nahar et al (2013) and Thummepak et al (2016) found 75% biofilm producing A. baumannii; Gurung et al (2013) found 73% biofilm producing A. baumannii.

In this study, 82.1% of A. baumannii produce biofilm in tracheal aspirate whereas Gurung et al (2013) and Rodríguez-Baño et al (2008) reported 51.2% and 32% of biofilm formation in respiratory samples where they include tracheal aspirate and sputum. In this study biofilm formation was detected only in tracheal aspirate. This may be the cause of highest rate of biofilm formation in tracheal aspirate in this study. In blood, 72% biofilm producing A. baumannii was detected and 100% was detected by Rodríguez-Baño et al (2008). About 44.4% of biofilm producing A. baumannii was detected in urine in this study whereas Gurung et al (2013) and Rodríguez-Baño et al (2008) reported 25% and 69% of biofilm producing A. baumannii in urine. 100% of biofilm producing A. baumannii was detected in pleural fluid in this study. Gurung et al (2013) reported 100% biofilm producing A. Baumannii In sterile fluids (Pleural fluid and Peritoneal fluid).

Conclusion
This study demonstrated the ability of the clinical isolates of A. Baumannii to produce biofilm. Resistant to commonly used antibiotics such as cephalosporin, aminoglycosides, quinolone, carbapenem was also observed. Polymyxins were the only effective therapeutic agent in the study. This trend of multidrug resistance among A. Baumannii is a matter of concern.

Ethical Approval
Ethical clearance was taken from Institutional Review Board (IRB) of Bangabandhu Sheikh Mujib Medical University, Shahbag, Dhaka (No.BSMMU/2018/4348).

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Disclosure
The author reports no conflicts of interest in this work.

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