Prevalence of *A. baumannii* as a nosocomial pathogen in the ICU patients of Surat City

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Abstract : Immuno-compromised or hospitalized for longer duration increase the rate of infection of A. baumannii, a nosocomial pathogen. There are various routes and site of infection for this microorganism. It was seen that patients with pneumonitis, urinary tract infections, blood infection, post surgical patients are more prone to get infected with A. baumannii. Studies have that certain A. baumannii strains are multidrug resistance (MDR) which make it difficult to treat. If one can know the chances of infection with A. baumannii in particular types of disease than it will be helpful in determination of precautionary measures. Here a study is carried out to determine the prevalence of A. baumannii in the ICU patients of Surat city with objective of identify most susceptible condition for infection. For this study, samples from 198 patients in form of respiratory fluid, blood, urine and pus were collected Microbes were isolated on blood agar, MacConkey's agar and Nutrient agar. Selected strains were further processed and identified by Vitek GN2 ID card. Microorganisms identified as A. baumannii was consider for determination of prevalence in various conditions including age, gender, type of samples and duration of hospitalization. Results of the study have shown that patient with endotracheal tube and catheter are more prone to get infected as compare to other mode of infection.

Keywords: *A. baumannii*, **ICU patients, Prevalence, site of infection, age,**

I. INTRODUCTION

Acinetobacter baumannii is considered as a prime opportunistic pathogen among hospitalized patients. It mainly infects patients with immuno-suppressed patients and intensive care unit patients. (Carruthers, Nicholson, Tracy, & Munson, 2013; Fodor et al., 2020; Kyriakidis, Vasileiou, Pana, & Tragiannidis, 2021; Sarshar, Behzadi, Scribano, Palamara, & Ambrosi, 2021) It is observed that the chances of infection of *A. baumannii* is very high in the patients who are suffering from blood stream and urinary tract infections, meningitis, wound and many others. (Gellings, Wilkins, & Morici, 2020; Kousovista et al., 2021; Loh et al., 2020; Vazquez-Lopez et al., 2020) According to World Health Organization (WHO) multidrug resistance (MDR) properties of *A. baumannii* makes the organisms as top most pathogen for which a better treatment option is sought. The main reason for multidrug resistance a property is frequent and long term use of antibiotic for treatment of various diseases. (Harris et al., 2019; Kakoullis, Papachristodoulou, Chra, & Panos, 2021) Initially, it can suppress the growth of *A. baumannii* but after long term exposure microorganisms adapted gradually to survive in presence of these antibiotics. It was seen that three main types of mechanisms namely include inactivation of certain enzymes, restricted entry of bacterial targets and mutations in gene play vital role in resistance against various antibiotics. (El-Kazzaz et al., 2020; Fodor et al., 2020; Hu et al., 2020; Hujer et al., 2017) Previous studies have shown that several species of *A. baumannii* are highly adapted and able to survive against 3rd or 4th generation of drug. (Jia, Sun, Ruan, & Xie, 2019; Kirtikliene, Mierauskaite, Razmiene, & Kuisiene, 2021; Lasarte-Monterrubio et al., 2021) Studies have shown that prevalence of *A. baumannii* varies from one site to another site in the body. Prevalence study in a specific region will provide information about the chances of infection with *A. baumannii* in the hospitalized patients. This information will help in early diagnosis, prevention and better treatment planning against *A. baumannii* infections. (Monnheimer et al., 2021; Rafa, Walaszek, Walaszek, Domanski, & Rozanska, 2021; Raorane, Lee, & Lee, 2020) Here a similar study is carried out to determine the prevalence of *A. baumannii* in various patients in the Surat city to determine site and rate of infection in the city. Result of the study will be helpful in interpretation of possible chances of *A. baumannii* infection for early precaution. In this study 198 patients suffering from nosocomial infections were tested for *A. baumannii* infections. In 50 cases, we have found infection of *A. baumannii* in various sites. Results of the study have proved that respiratory fluid has highest prevalence of *A. baumannii* followed by urinary tract infection. Least prevalence was found in the patients having blood infection.

II. MATERIALS AND METHODS

2.1 Collection of Samples

For isolation of *A. baumannii* various biological samples like respiratory fluid, blood, urine, pus samples of 198 patients of ICU of a hospital of Surat were selected. Brief histories of patients were taken including their gender, age and type of infection. For collection of respiratory fluid was collected from tracheal tube using sterile syringe. Blood was collected by venipucture in sterile BHI media containing vial. Urine samples were collected from catheters in sterile containers and pus samples were collected by swab stick method. All the collected samples were immediately processed for isolation of microorganisms. (Martinez et al., 2019; Sarshar et al., 2021; Singh et al., 2020)

2.2 Isolation of *A. baumannii*

Isolation of microorganisms form the collected samples were carried out on Blood agar, MacConkey's Agar and Nutrient agar. Spread plate method was performed for each sample after serial dilution, if required. 100 µl of sample were speared on each plate and plates were incubated at 37 °C until the visible colonies are observed in the plates. (Ejaz et al., 2021; Tiwari, Vashistt, Kapil, & Moganty, 2012)

2.3 Primary screening of *A. baumannii*

For primary screening, colonies of all the plates were studies for colony characteristics and colonies having different morphology were collected and purified on nutrient agar. Each colony was subjected to gram staining to discriminate between gram positive and gram negative microorganisms. Among them, colonies having gram negative character and round/coccobacillus shape were further considered for further study. (Alamri, Alsultan, Ansari, & Alnimr, 2020)

2.4 Identification of *A. baumannii*

All the isolated strains were identified using Vitek2 system using Vitek2 GN ID card (bioMerieux Vitek, USA). All the obtained isolated *A. baumannii* further analyzed for various parameters. (El-Kazzaz et al., 2020; Tyumentseva et al., 2021)

2.5 Prevalence study

To determine the prevalence of *A. baumannii* in patients all the samples identified as positive were correlated with age, gender and type of samples.

III. Results and Discussion

From 110 males and 88 females, 32 males and 18 females were found positive for *A. baumannii*. When these patients were categories according to age groups than it is found that maximum patients were belong to the age group of 31 years to 60 years followed by 15 years to 30 years (Table1). Above the age of 60 years very less rate of infection is found this is only because of less number of patients admitted. In overall observation it was found that male are more prone to infection than the females. (Alamri et al., 2020; Gu et al., 2021; Kentache, Abdelkrim, Jouenne, De, & Hardouin, 2017) However, this can only be assured by considering the larger group for the study. Less rate of infection in the age group of 15 years to 30 years is may be because of good health and better immunity. (Nocera, Attili, & De Martino, 2021; Yang et al., 2019)

Table 1. Prevalence of *A. baumannii* in the patients as per age group

Age Group (in years)	Gender		Culture Positivity	
	MALE	FEMALE	MALE	FEMALE
15-30	31	27	4	7
31-60	62	55	24	10
> 60	17	6	4	1
TOTAL	110	88	32	18

When results were compared with type of specimen, it was found that among all the type of respiratory fluids contains more number of *A. baumannii* followed by urine samples. (Table 2) (Carruthers et al., 2013; Gu et al., 2021; Sacco, Visca, Runci, Antonelli, & Raponi, 2021; Vrancianu, Gheorghe, Czobor, & Chifiriuc, 2020) Pneumonitis is one the most common disease where infection of *A. baumannii* has more prevalence. It general makes colonies in the endotracheal tube or similar structures and remains for longer period of time. (Lavrinenko, Sheck, Kolesnichenko, Azizov, & Turmukhambetova, 2021; Vazquez-Lopez et al., 2020) Use of catheter for certain surgeries and during hospitalization also increases the chances of *A. baumannii* infection in the urinary tract. (Rafa et al., 2021; Tyumentseva et al., 2021) (Baginska, Cieslik, Gorski, & Jonczyk-Matysiak, 2021) Patients with after surgery may prone to infection in blood but compare to respiratory fluid and urine, it is less common. (Ismail, Samir, Saber, Ahmed, & Farag, 2020; LaVergne et al., 2018)

Table 2. Prevalence of *A. baumannii* in the patients as per specimen type

Specimen Type	No. of Total Samples	No. of Males	No. of Females	No. of Positive Male	No. of Positive Female	Total Positive
Blood	25	13	12	03	00	3
Urine	45	23	22	08	04	12
Respiratory fluid	98	58	40	19	09	28
Pus	30	16	14	02	05	7
Total	198	110	88	32	18	50

When the prevalence was determined based on the days since hospitalization, it was seen that most of the patients get infection in the second week of hospitalization. (Table 3) In the first week of hospitalization, patient may have better immunity which protects them against *A. baumannii* infection. As time passes, immunity becomes week and this opportunistic pathogen try to infect at various locations. (Harris et al., 2019; Sarshar et al., 2021) Patients whose immunity lowers in the week of hospitalization may prone to infection. Once such infections are observed patients are treated with suitable antibiotics and patients are generally cured by 3rd or 4th week. Hence the rate at this duration goes down. If proper treatment is not given to patient than it will lead to many other sever complications. (Harris et al., 2019; Hujer et al., 2017; Kakoullis et al., 2021; Katip, Uitrakul, & Oberdorfer, 2021; Kousovista et al., 2021; Sarshar et al., 2021)

Table 3. Prevalence of *A. baumannii* since day of hospitalization in the patients

No. of days	Total	Positive	Type of Sample			
			Resp. Flu.	Urine	Blood	Pus
1-7 DAYS	58	10	4	6	0	0
8-14 DAYS	91	28	24	4	0	0
15-21 DAYS	42	6	0	1	0	5
22-31 DAYS	4	4	0	0	2	2
> 31 DAYS	3	2	0	1	1	0

IV CONCLUSION

Based on the entire study it was concluded that person with high immunity has less chances of infection with *A. baumannii*. But in hospitalized patients where immunity is low, patients having endotracheal insertion of catheters are more prone of nosocomial infections with A. baumannii.

REFERENCES

[1] Alamri, A. M., Alsultan, A. A., Ansari, M. A., & Alnimr, A. M. (2020). Biofilm-Formation in Clonally Unrelated Multidrug-Resistant Acinetobacter baumannii Isolates. *Pathogens, 9*(8). doi: 10.3390/pathogens9080630

[2] Baginska, N., Cieslik, M., Gorski, A., & Jonczyk-Matysiak, E. (2021). The Role of Antibiotic Resistant A. baumannii in the Pathogenesis of Urinary Tract Infection and the Potential of Its Treatment with the Use of Bacteriophage Therapy. *Antibiotics (Basel), 10*(3). doi: 10.3390/antibiotics10030281

[3] Carruthers, M. D., Nicholson, P. A., Tracy, E. N., & Munson, R. S., Jr. (2013). Acinetobacter baumannii utilizes a type VI secretion system for bacterial competition. *PLoS One, 8*(3), e59388. doi: 10.1371/journal.pone.0059388

[4] Ejaz, Hasan, Younas, Sonia, Qamar, Muhammad Usman, Junaid, Kashaf, Abdalla, Abualgasim Elgaili, Abosalif, Khalid Omer Abdalla, . . . Bukhari, Syed Nasir Abbas. (2021). Molecular Epidemiology of Extensively Drug-Resistant mcr Encoded Colistin-Resistant Bacterial Strains Co-Expressing Multifarious β-Lactamases. *Antibiotics, 10*(4), 467. doi: 10.3390/antibiotics10040467

[5] El-Kazzaz, W., Metwally, L., Yahia, R., Al-Harbi, N., El-Taher, A., & Hetta, H. F. (2020). Antibiogram, Prevalence of OXA Carbapenemase Encoding Genes, and RAPD-Genotyping of Multidrug-Resistant Acinetobacter baumannii Incriminated in Hidden Community-Acquired Infections. *Antibiotics (Basel), 9*(9). doi: 10.3390/antibiotics9090603

[6] Fodor, A., Abate, B. A., Deak, P., Fodor, L., Gyenge, E., Klein, M. G., . . . Makrai, L. (2020). Multidrug Resistance (MDR) and Collateral Sensitivity in Bacteria, with Special Attention to Genetic and Evolutionary Aspects and to the Perspectives of Antimicrobial Peptides-A Review. *Pathogens, 9*(7). doi: 10.3390/pathogens9070522

[7] Gellings, P. S., Wilkins, A. A., & Morici, L. A. (2020). Recent Advances in the Pursuit of an Effective Acinetobacter baumannii Vaccine. *Pathogens, 9*(12). doi: 10.3390/pathogens9121066

[8] Gu, Y., Jiang, Y., Zhang, W., Yu, Y., He, X., Tao, J., . . . Xu, J. (2021). Risk factors and outcomes of bloodstream infections caused by Acinetobacter baumannii: a case-control study. *Diagnostic Microbiology and Infectious Disease, 99*(2), 115229. doi: 10.1016/j.diagmicrobio.2020.115229

[9]   Harris, A. D., Johnson, J. K., Pineles, L., O'Hara, L. M., Bonomo, R. A., & Thom, K. A. (2019). Patient-to-Patient Transmission of Acinetobacter baumannii Gastrointestinal Colonization in the Intensive Care Unit. *Antimicrob Agents Chemother, 63*(8). doi: 10.1128/aac.00392-19

[10]   Hu, L., Shi, Y., Xu, Q., Zhang, L., He, J., Jiang, Y., . . . Zhou, Z. (2020). Capsule Thickness, Not Biofilm Formation, Gives Rise to Mucoid Acinetobacter baumannii Phenotypes That are More Prevalent in Long-Term Infections: A Study of Clinical Isolates from a Hospital in China. *Infect Drug Resist, 13*, 99-109. doi: 10.2147/idr.s230178

[11]   Hujer, A. M., Higgins, P. G., Rudin, S. D., Buser, G. L., Marshall, S. H., Xanthopoulou, K., . . . Bonomo, R. A. (2017). Nosocomial Outbreak of Extensively Drug-Resistant Acinetobacter baumannii Isolates Containing bla(OXA-237) Carried on a Plasmid. *Antimicrob Agents Chemother, 61*(11). doi: 10.1128/aac.00797-17

[12]   Ismail, M. M., Samir, R., Saber, F. R., Ahmed, S. R., & Farag, M. A. (2020). Pimenta Oil as A Potential Treatment for Acinetobacter Baumannii Wound Infection: In Vitro and In Vivo Bioassays in Relation to Its Chemical Composition. *Antibiotics (Basel), 9*(10). doi: 10.3390/antibiotics9100679

[13]   Jia, H., Sun, Q., Ruan, Z., & Xie, X. (2019). Characterization of a small plasmid carrying the carbapenem resistance gene bla (OXA-72) from community-acquired Acinetobacter baumannii sequence type 880 in China. *Infect Drug Resist, 12*, 1545-1553. doi: 10.2147/idr.s202803

[14]   Kakoullis, Loukas, Papachristodoulou, Eleni, Chra, Paraskevi, & Panos, George. (2021). Mechanisms of Antibiotic Resistance in Important Gram-Positive and Gram-Negative Pathogens and Novel Antibiotic Solutions. *Antibiotics, 10*(4), 415. doi: 10.3390/antibiotics10040415

[15]   Katip, Wasan, Uitrakul, Suriyon, & Oberdorfer, Peninnah. (2021). Short-Course Versus Long-Course Colistin for Treatment of Carbapenem-Resistant A.baumannii in Cancer Patient. *Antibiotics, 10*(5), 484. doi: 10.3390/antibiotics10050484

[16]   Kentache, Takfarinas, Abdelkrim, Ahmed Ben, Jouenne, Thierry, De, Emmanuelle, & Hardouin, Julie. (2017). Global Dynamic Proteome Study of a Pellicle-forming Acinetobacter baumannii Strain. *Molecular & Cellular Proteomics, 16*(1), 100-112. doi: 10.1074/

[17]   Kirtikliene, T., Mierauskaite, A., Razmiene, I., & Kuisiene, N. (2021). Multidrug-Resistant Acinetobacter baumannii Genetic Characterization and Spread in Lithuania in 2014, 2016, and 2018. *Life (Basel), 11*(2). doi: 10.3390/life11020151

[18]   Kousovista, Rania, Athanasiou, Christos, Liaskonis, Konstantinos, Ivopoulou, Olga, Ismailos, George, & Karalis, Vangelis. (2021). Correlation between Acinetobacter baumannii Resistance and Hospital Use of Meropenem, Cefepime, and Ciprofloxacin: Time Series Analysis and Dynamic Regression Models. *Pathogens, 10*(4), 480. doi: 10.3390/pathogens10040480

[19]   Kyriakidis, I., Vasileiou, E., Pana, Z. D., & Tragiannidis, A. (2021). Acinetobacter baumannii Antibiotic Resistance Mechanisms. *Pathogens, 10*(3). doi: 10.3390/pathogens10030373

[20]   Lasarte-Monterrubio, C., Vazquez-Ucha, J. C., Maneiro, M., Arca-Suarez, J., Alonso, I., Guijarro-Sanchez, P., . . . Beceiro, A. (2021). Activity of Imipenem, Meropenem, Cefepime, and Sulbactam in Combination with the beta-Lactamase Inhibitor LN-1-255 against Acinetobacter spp. *Antibiotics (Basel), 10*(2). doi: 10.3390/antibiotics10020210

[21]   LaVergne, S., Hamilton, T., Biswas, B., Kumaraswamy, M., Schooley, R. T., & Wooten, D. (2018). Phage Therapy for a Multidrug-Resistant Acinetobacter baumannii Craniectomy Site Infection. *Open Forum Infect Dis, 5*(4), ofy064. doi: 10.1093/ofid/ofy064

[22]   Lavrinenko, Alyona, Sheck, Eugene, Kolesnichenko, Svetlana, Azizov, Ilya, & Turmukhambetova, and Anar. (2021). Antibiotic Resistance and Genotypes of Nosocomial Strains of Acinetobacter baumannii in Kazakhstan. *Antibiotics, 10*, 382-391.

[23]   Loh, B., Chen, J., Manohar, P., Yu, Y., Hua, X., & Leptihn, S. (2020). A Biological Inventory of Prophages in A. baumannii Genomes Reveal Distinct Distributions in Classes, Length, and Genomic Positions. *Front Microbiol, 11*, 579802. doi: 10.3389/fmicb.2020.579802

[24]   Martinez, J., Fernandez, J. S., Liu, C., Hoard, A., Mendoza, A., Nakanouchi, J., . . . Ramirez, M. S. (2019). Human pleural fluid triggers global changes in the transcriptional landscape of Acinetobacter baumannii as an adaptive response to stress. *Sci Rep, 9*(1), 17251. doi: 10.1038/s41598-019-53847-2

[25]   Monnheimer, M., Cooper, P., Amegbletor, H. K., Pellio, T., Gross, U., Pfeifer, Y., & Schulze, M. H. (2021). High Prevalence of Carbapenemase-Producing Acinetobacter baumannii in Wound Infections, Ghana, 2017/2018. *Microorganisms, 9*(3). doi: 10.3390/microorganisms9030537

[26]   Nocera, F. P., Attili, A. R., & De Martino, L. (2021). Acinetobacter baumannii: Its Clinical Significance in Human and Veterinary Medicine. *Pathogens, 10*(2). doi: 10.3390/pathogens10020127

[27]   Rafa, E., Walaszek, M. Z., Walaszek, M. J., Domanski, A., & Rozanska, A. (2021). The Incidence of Healthcare-Associated Infections, Their Clinical Forms, and Microbiological Agents in Intensive Care Units in Southern Poland in a Multicentre Study from 2016 to 2019. *Int J Environ Res Public Health, 18*(5). doi: 10.3390/ijerph18052238

[28]   Raorane, C. J., Lee, J. H., & Lee, J. (2020). Rapid Killing and Biofilm Inhibition of Multidrug-Resistant Acinetobacter baumannii Strains and Other Microbes by Iodoindoles. *Biomolecules, 10*(8). doi: 10.3390/biom10081186

[29]   Sacco, F., Visca, P., Runci, F., Antonelli, G., & Raponi, G. (2021). Susceptibility Testing of Colistin for Acinetobacter baumannii: How Far Are We from the Truth? *Antibiotics (Basel), 10*(1). doi: 10.3390/antibiotics10010048

[30]   Sarshar, M., Behzadi, P., Scribano, D., Palamara, A. T., & Ambrosi, C. (2021). Acinetobacter baumannii: An Ancient Commensal with Weapons of a Pathogen. *Pathogens, 10*(4). doi: 10.3390/pathogens10040387

[31]   Singh, M., De Silva, P. M., Al-Saadi, Y., Switala, J., Loewen, P. C., Hausner, G., Kumar, A. (2020). Characterization of Extremely Drug-Resistant and Hypervirulent Acinetobacter baumannii AB030. *Antibiotics (Basel), 9*(6). doi: 10.3390/antibiotics9060328

[32] Tiwari, V., Vashistt, J., Kapil, A., & Moganty, R. R. (2012). Comparative proteomics of inner membrane fraction from carbapenem-resistant Acinetobacter baumannii with a reference strain. *PLoS One, 7*(6), e39451. doi: 10.1371/journal.pone.0039451

[33] Tyumentseva, M., Mikhaylova, Y., Prelovskaya, A., Tyumentsev, A., Petrova, L., Fomina, V., . . . Akimkin, V. (2021). Genomic and Phenotypic Analysis of Multidrug-Resistant Acinetobacter baumannii Clinical Isolates Carrying Different Types of CRISPR/Cas Systems. *Pathogens, 10*(2). doi: 10.3390/pathogens10020205

[34] Vazquez-Lopez, R., Solano-Galvez, S. G., Juarez Vignon-Whaley, J. J., Abello Vaamonde, J. A., Padro Alonzo, L. A., Rivera Resendiz, A., . . . Barrientos Fortes, T. (2020). Acinetobacter baumannii Resistance: A Real Challenge for Clinicians. *Antibiotics (Basel), 9*(4). doi: 10.3390/antibiotics9040205

[35] Vrancianu, C. O., Gheorghe, I., Czobor, I. B., & Chifiriuc, M. C. (2020). Antibiotic Resistance Profiles, Molecular Mechanisms and Innovative Treatment Strategies of Acinetobacter baumannii. *Microorganisms, 8*(6). doi: 10.3390/microorganisms8060935

[36] Yang, Z., Yin, S., Li, G., Wang, J., Huang, G., Jiang, B., . . . Zhao, X. (2019). Global Transcriptomic Analysis of the Interactions between Phage φAbp1 and Extensively Drug-Resistant Acinetobacter baumannii. *mSystems, 4*(2). doi: 10.1128/mSystems.00068-19