Correlation between Diabetes Mellitus and Pseudomonas aeruginosa infection in Dr. Soetomo General Hospital

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Abstract

Background: Diabetes mellitus may be a risk factor to Pseudomonas aeruginosa infection. Diabetes mellitus is a metabolic syndrome which causes a dysfunction of the host's immune system. Pseudomonas aeruginosa is an opportunistic pathogen.

Objective: To determine the correlation between diabetes mellitus and Pseudomonas aeruginosa infection

Methods: The study is conducted in the internal medicine ward of RSUD Dr. Soetomo, a tertiary hospital in Indonesia in 2021. The population of this study is all patients aged 18 or above with positive blood, sputum, urine, and pus cultures.This study uses systematic random sampling for non-Pseudomonas aeruginosa infection patients and total sampling for Pseudomonas aeruginosa infection patients. Data was obtained through logbooks of the microbiology department and the patient's medical records. Only the first culture of each type per patient was considered. Analysis was done using the relative risk (RR) formula.

Result: The relative risk of diabetes mellitus in Pseudomonas aeruginosa infections is 1.75 for bloodstream infection, 0.88 for pneumonia, 1.68 for urinary tract infection, and 0.87 for pyogenic infection.

Conclusion: When compared to non-Pseudomonas aeruginosa infections, diabetes mellitus is a risk factor for bloodstream and urinary tract infections and a protective factor for pneumonia and pyogenic infections.

Keywords: Pseudomonas aeruginosa; diabetes mellitus; prevalence; risk factor; bacteremia; pneumonia; urinary tract infection; pyogenic infection

1. Introduction

Diabetes mellitus is a metabolic syndrome which causes a dysfunction of the host's immune system (Casiquero et al., 2012). Pseudomonas aeruginosa is a multi drug resistant pathogen which is known to infect patients in the hospital (Jameson et al., 2018). This dysfunction of the immune system may be correlated with Pseudomonas aeruginosa infection which causes diabetes mellitus to be a risk factor.

Indonesia's health ministry's data regarding diabetes mellitus prevalence showed an increase of 1.6% in 5 years (KEMENKES, 2018). Pseudomonas aeruginosa is the cause of between 11-13.8% of all hospital associated infections, with a higher prevalence in intensive care. Pseudomonas aeruginosa is also an important pathogen in the infection of patients with immune dysfunction (Driscoll, Brody, and Kollef, 2007).

Diabetes mellitus causes humoral and cellular immune dysfunction which facillitates microorganism adherence to the mucosa and inhibits its eradication (Geerlings and Hoepelman, 1999). Pseudomonas aeruginosa is an opportunistic pathogen (Alhazmi, 2015). Therefore the immune system dysfunction caused by diabetes mellitus may be a risk factor to Pseudomonas aeruginosa infection.

The correlation between diabetes mellitus and Pseudomonas aeruginosa infection will be analyzed by the odds ratio between diabetes mellitus with Pseudomonas aeruginosa infection and non-Pseudomonas aeruginosa infection. Diabetes mellitus can be considered a risk factor if its odds ratio is >1.

2. Methods

2.1 Study design and site

This study is an observational analytic study with a cross-sectional approach. The study was approved by Clinical Research Ethics Committee of Dr. Soetomo General Hospital (reference no. 1177/LOE/301.4.2/XII/2022). The need for written informed consent was waived due to the study being observational.

2.2 Sampling and study subject

This study uses systematic random sampling by using even registry numbers for non-Pseudomonas aeruginosa infection patients (n = 541) and total sampling for Pseudomonas aeruginosa infection patients (n = 82).

2.3 Data collection and analysis

The data in this study was obtained through logbooks of the microbiology department and the patient's medical records. Retrospective analysis of all patients aged ≥18 years old with positive blood, sputum, urine, and pus cultures in the internal medicine ward of Dr. Soetomo General Hospital from January 2021 to December 2021 was conducted. Only the first culture of each type per patient was considered. Data collected includes initials, age, sex, microbiology test results, comorbidities, and clinical outcome. Data was analyzed in Microsoft Excel 2019 with the relative risk formula. The final result is then presented in tables and graphs.

3. Result

3.1 Pseudomonas aeruginosa prevalence

Based on **Table 1** the prevalence of Pseudomonas aeruginosa in this study is 2.6% in blood cultures, 13.2% in sputum cultures, 5.5% in urine cultures, and 9.3% in pus cultures.

Table 1. Pseudomonas aeruginosa prevalence

Specimen	Pseudomonas aeruginosa	Non-Pseudomonas aeruginosa	Prevalence
Blood	8	299	2.6%
Sputum	39	256	13.2%
Urine	24	412	5.5%
Pus	12	117	9.3%

3.2 Subject characteristic

Based on **Table 2**, the majority of patients are women, both in Pseudomonas aeruginosa and non-Pseudomonas aeruginosa groups. In both groups, the most common age group is pre-elderly (45-59 years old). The most prevalent comorbidities are the same between both groups which are diabetes mellitus, hypertension, malignancy, chronic kidney disease, and HIV/AIDS. Mortality rate is slightly higher in Pseudomonas aeruginosa group (38.2% vs 35.6%). Univariate analysis show 2 significantly correlated variables which are chronic kidney disease and HIV/AIDS.
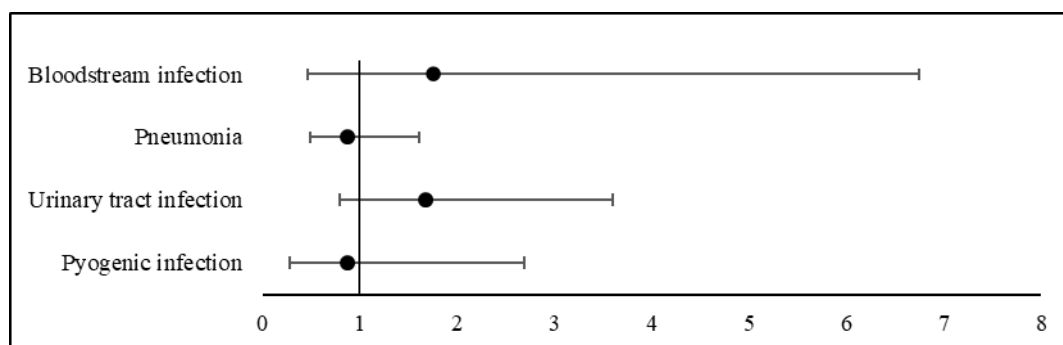
Table 2. Subject characteristics

Variable	No. of patients (%)		P value
	Pseudomonas aeruginosa n = 82	Non-Pseudomonas n = 483	
Demography			
Male sex	36 (43.9)	221 (45.8)	0.7553
Age			
Adult (18-44)	30 (36.6)	154 (31.9)	0.4009
Pre-elderly (45-59)	31 (37.8)	186 (38.5)	0.9035
Elderly (≥60)	21 (25.6)	143 (29.6)	0.4610
Comorbidity			
Diabetes mellitus	33 (40.2)	188 (38.9)	0.8208
Hypertension	19 (23.2)	152 (31.5)	0.1304
Malignancy	17 (20.7)	102 (21.1)	0.9368
Chronic kidney disease	17 (20.7)	44 (9.1)	**0.0017**
HIV/AIDS	11 (13.4)	33 (6.8)	**0.0397**
Mortality	29 (38.2)	172 (35.6)	0.9658

3.3 Correlation between diabetes mellitus and Pseudomonas aeruginosa infection

The correlation diabetes mellitus and Pseudomonas aeruginosa infection is analyzed using its relative risk to non-Pseudomonas aeruginosa infection. The relative risk is 1.75 for bloodstream infection, 0.88 for pneumonia, 1.68 for urinary tract infection, and 0.87 for pyogenic infection.

Graph 1. Relative risk of Pseudomonas aeruginosa infection

4. Discussion

We found the prevalence of Pseudomonas aeruginosa in bloodstream (Toyyibah, Rusli, and Juniastuti, 2022; Bandy and Almaeen, 2020; Schöneweck et al., 2021; Diekema et al., 2019), pneumonia (Widyasar, Aman, and Tholib, 2022; Hyun et al., 2022; Arancibia et al., 2002; Chen, Huang, and Chen, 2021), and urinary tract infections (Huang et al., 2022; Li et al., 2023; Islam et al., 2022) are consistent with other simillar studies both done in Indonesia and other countries. However we also found that the prevalence of Pseudomonas aeruginosa pyogenic infections are lower when compared to other studies (Nurmala, Virgiandhy, and Liana, 2015; Chakraborty et al., 2021; Ergin and Mutlu, 1999; Alharbi 2022). This may be caused by the difference in population studied wherein other studies uses the entire hospital which includes surgery and dermatology department where pyogenic infections are more commonly found.

We compared the characteristics of each sample group and found that the sex distribution in this study contradicts other studies done before which consistently show males being more susceptible to Pseudomonas aeruginosa infections (Akhabue et al., 2011; Cui et al., 2022; Frem et al., 2023; Kula, Hudson, and Sligl, 2020; Lautenbach et al., 2010; Pottier et al., 2023). This may be due to urinary tract infections being the most common infection found in this study, which is known to have a high female to male ratio (Huang et al., 2022). The average age is also found to be lower compared to other studies (Cao et al., 2004; Cui et al., 2022; Frem et al., 2023; Kula, Hudson, and Sligl, 2020; Paramythiotou et al., 2004). The cause of this discrepancy could be the difference in sample as other studies include the entire hospital as the population. Hill et al found that the average age of patients in the ICU is higher than patients found in other wards. In the case of comorbidities, the prevalence of diabetes mellitus is much higher when compared to other studies (Akhabue et al., 2011; Frem et al., 2023; Kula, Hudson, and Sligl, 2020; Zavascki et al., 2006). This may be caused due to Indonesia being the country with the fifth highest diabetes mellitus prevalence with a high underdiagnosis rate (International Diabetes Federation, 2021). In the case of hypertension, we found no other studies which discuss it as a risk factor to Pseudomonas aeruginosa infection. The prevalence of malignancy and chronic kidney disease is in line with the other referenced studies (Ahkabue et al., 2010; Cao et al., 2004; Frem et al., 2023; Kula, Hudson, and Sligl, 2020; Lautenbach et al., 2010). HIV/AIDS prevalence is found to be much higher than the other studies (Akhabue et al., 2010; Zavascki et al., 2006). Mortality rate is also found to be higher than other studies referenced (Akhabue et al., 2010; Cui et al., 2022; Frem et al., 2023; Kula, Hudson, and Sligl, 2020) but is in line with one other study by Zavascki et al in 2006.

In this study, when compared to non-Pseudomonas aeruginosa infections, diabetes mellitus is observed as a risk factor in bloodstream and urinary tract infections due to its relative risk being above 1. It is also observed as a protective factor in pneumonia and pyogenic infections due to its relative risk being below 1. Comparing the results of this study to other studies proves to be difficult since we didn't find any other study that uses non-Pseudomonas aeruginosa infections as a control group.

5. Conclusion

When compared to non-Pseudomonas aeruginosa infections, diabetes mellitus is a risk factor for bloodstream and urinary tract infections and a protective factor for pneumonia and pyogenic infections.

Acknowledgements

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