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THE RELATIONSHIP BETWEEN NON-SURGICAL INVASIVE MEASURES AND THE DISCOVERY OF MULTIDRUG RESISTANT ORGANISM INFECTIONS IN HOSPITALIZED PATIENTS AT RSUD BANTEN

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ABSTRACT

Multidrug Resistant Organism (MDRO) infections have increased significantly worldwide, which can result in increased morbidity, mortality, and cause outbreaks that decrease hospital performance. Adhesion-colonization of MDROs can occur on non-surgical invasive equipment, which inpatients are usually given. The purpose of this study was to analyze the relationship between non-surgical invasive measures and the discovery of MDRO infections in inpatients at RSUD Banten. This study is an analytic observational study with a cross-sectional approach. The research data used were medical record data of inpatients who had microbiological culture examination results at the RSUD Banten's laboratory in the period January 2023-December 2023. The sampling technique used was simple random sampling with a sample size of 162 patients and used the chi square test in the form of univariate and bivariate analysis. There was a significant association (p=0.009) between non-surgical invasive measures and the discovery of MDRO infection in hospitalized patients at RSUD Banten (OR 2.580; 95% IC 1.246-5.341). Hospitalized patients who undergo non-surgical invasive measures have a higher risk of 2.580 times to be identified with MDRO infection, compared to hospitalized patients who do not undergo non-surgical invasive measures.

Keywords : *Non-surgical Invasive Measures, Infection, Multidrug Resistant Organism (MDRO), MDRO Infection*

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INTRODUCTION

In recent decades, the prevalence of Multidrug Resistant Organism (MDRO) has increased significantly worldwide. According to the Global Antimicrobial Resistance and Use Surveillance System (GLASS) data initiated by the *World Health Organization (*WHO) published in 2022, stated that in 2020 MDRO infections worldwide were dominated by MDRO originating from the bloodstream, which amounted to 17% of the total Bacteriologically Confirmed Infection (BCI) and urinary tract infections by 82% of the total BCI.[1] National scale survey data related to antimicrobial resistance from the Ministry of Health of the Republic of Indonesia in 2016 released the incidence of MDRO with indicators of *Escherichia coli* and *Klebsiella pneumoniae* producing *extended-spectrum beta-lactamase* (ESBL) ranging from 50-82%. The data shows the increasing prevalence of multi-drug resistant bacteria in Indonesia.[2]

Multidrug-resistant bacterial infections are a serious danger to patients as they can increase morbidity and mortality rates resulting in a poorer prognosis, and indirectly lead to increased healthcare costs.[3,4] Long-term problems arise if MDRO infections continue to increase in a hospital, causing outbreaks and degrading hospital performance.[3,4]

Previous research conducted by Subagyo, (2016) in Central Java and research conducted by Chen et al, (2019) in Taiwan showed inconsistent results.[5,6] Both studies analyzed the same factors, namely data on invasive actions received by patients with the discovery of MDRO infections. Research by Subagyo in 2016 showed that there was no relationship between the use of invasive equipment except the use of Nasogastric Tube (NGT) with MDRO infections, especially *Enterobacteriaceae*. Meanwhile, research conducted by Chen et al, (2019) stated that there was a significant relationship between the care received by patients in the ICU, in this case invasive measures with MDRO infections. [5,6]

Because this multi-drug resistant bacterial infection is a major problem and can cause an increase in morbidity and mortality to reduce hospital performance, as well as the discrepancies in the results of previous studies and the absence of such studies conducted in Banten Province, researchers are interested in conducting research on the relationship between non-surgical invasive actions received by hospitalized patients with the discovery of MDRO infections at Banten Hospital.

METHODS

The design of this study is an analytical observational with a cross-sectional approach that aims to determine the relationship between non-

surgical invasive actions and the discovery of Multidrug Resistant Organism (MDRO) infections in hospitalized patients at Banten Hospital. The target population of this study was all patients of Banten Hospital in the period January 2023-December 2023 with the affordable population being all patients of Banten Hospital who performed microbiological culture examination in the laboratory of Banten Hospital in the period January 2023-December 2023.

The sample data used in this study is secondary data in the form of medical records of inpatients who have conducted microbiological culture examinations at the Banten Hospital laboratory for the period January 2023-December 2023. The minimum sample size in this study was 162 with a sampling technique in the form of simple random sampling using a random table. Sampling was carried out in two rounds, namely the first round submitted 162 medical record numbers to the Banten Hospital medical records division, but there were 11 medical records that were excluded so that the second round of sampling was carried out to replace the previously excluded samples. The collected data were then subjected to chi-square test in the form of univariate analysis (analysis of patient age distribution, profile of infecting bacteria, proportion of antibiotic resistance, profile of resistance to antibiotic type, proportion of non-surgical invasive measures, profile of non-surgical invasive measures received by patients, prevalence of MDRO and infection profile based on MDRO bacteria in patients) and bivariate analysis (relationship between non-surgical invasive measures and the discovery of MDRO infection) using the Statistical Package For The Social Sciences (SPSS) version 27.0 program. The analyzed data were then presented using tables. This research has been approved by the Health Research Ethics Commission of the Faculty of Medicine and Health Sciences, Sultan Ageng Tirtayasa University with number: 28/UN43.20/KEPK/2024 and has received research permission from Banten Regional Hospital as a vehicle / research site with letter number B-000.9/057/KHERS/2024.

RESULTS

The results of univariate analysis are as follows, first, the age distribution of hospitalized patients is 26 (<1 - 59). Second, based on table 1, it is known that the most identified bacteria infecting hospitalized patients is *Staphylococcus hominis ssp hominis*, which is 24 patients (14.8%).

Table 1. Bacterial profile infecting hospitalized patients

Bacteria that infect	Frequency (n)	Percentage (%)
Achromobacter denitrificans	1	0,6
Acinetobacter baumannii	5	3,1
Aeromonas hydrophila/punctata(caviae)	1	0,6
Chryseobacterium gleum	1	0,6
Citrobacter freundii	1	0,6
Citrobacter koseri	1	0,6
Cronobacter sakazakii	1	0,6
Elizabethkingia meningoseptica	1	0,6
Enterobacter aerogenes	3	1,9

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Bacteria that infect	Frequency (n)	Percentage (%)
Enterobacter cloacae complex	3	1,9
Enterococcus faecalis	4	2,5
Enterococcus faecium	1	0,6
Escherichia coli	5	3,1
Escherichia coli ESBL	15	9,3
Klebsiella pneumoniae ssp pneumoniae	8	4,9
Klebsiella pneumoniae ssp pneumoniae ESBL	9	5,6
Proteus mirabilis	1	0,6
Pseudomonas aeruginosa	3	1,9
Pseudomonas fluorescens	1	0,6
Pseudomonas luteola	1	0,6
Pseudomonas stutzeri	2	1,2
Salmonella ser.Typhi	1	0,6
Salmonella spp	2	1,2
Sphingomonas paucimobilis	5	3,1
Staphylococcus aureus	14	8,6
Staphylococcus aureus MRSA	9	5,6
Staphylococcus capitis	2	1,2
Staphylococcus chromogenes	1	0,6
Staphylococcus cohnii ssp urealyticus	6	3,7
Staphylococcus epidermidis	12	7,4
Staphylococcus haemolyticus	14	8,6
Staphylococcus hominis ssp hominis	**24**	**14,8**
Staphylococcus saprophyticus	2	1,2
Stenotrophomonas maltophilia	1	0,6
Streptococcus agalactiae	1	0,6

Third, univariate analysis of the number of patients who experienced antibiotic resistance amounted to 94.4% as shown in table 2 below. Fourth, based on table 3, antibiotic resistance based on the largest group of antibiotics occurred in the beta lactam group (50.2%).

Table 2. Proportion of antibiotic resistance of hospitalized patients

Antibiotic resistance	Frequency (n)	Percentage (%)
Yes	**153**	**94,4**
No	9	5,6

Table 3. Proportion of antibiotic resistance of hospitalized patients

Antibiotic resistance	Frequency (n)	Percentage (%)
Beta lactam group	**456**	**50,2**
Penicillin		
Ampicillin	44	
Ampicillin/ Sulbactam	28	
Benzylpenicillin	81	
Oxacillin	65	
Piperacillin/ Tazobactam	19	
Cephalosporins		
Gen 1 (Cefazoline)	53	
Gen 3		
Ceftazidime	42	
Ceftriaxone	44	
Gen 4 (Cefepime)	23	
Carbapenem		
Meropenem	9	
Ertapenem	6	
Monobactam		
Aztreonam	42	
Glycopeptide group	**1**	**0,1**
Vancomycin	1	
Aminoglycoside group	**53**	**5,8**
Gentamicin	44	
Amikacin	9	
Tetracycline group	**39**	**4,3**
Tetracycline	30	
Tigecycline	9	
Macrolide group	**88**	**9,7**

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Antibiotic resistance	Frequency (n)	Percentage (%)
Erythromycin	51	
Rifampicin	37	
The lincosamide group	**49**	**5,4**
Clindamycin	49	
Cotrimoxazole (sulfamethoxazole + Trimethoprim)	**54**	**5,9**
Fluoroquinolone group	**151**	**16,6**
Ciprofloxacin	72	
Levofloxacin	44	
Moxifloxacin	35	
Other antibiotics	**18**	**2,0**
Linezolid	1	
Nitrofurantoin	12	
Quinupristin/Dalfopristin	5	
Total	909	100

The fifth univariate analysis is the proportion of non-surgical invasive measures in patients and the sixth univariate analysis is the proportion of non-surgical invasive measures in patients. Based on table 4, it can be seen that out of a total of 162 patients who became the study sample, most did not undergo non-surgical invasive measures, namely 65.4%. While the rest who underwent non-surgical invasive measures, it is known that the most accepted non-surgical invasive measures are mechanical ventilators, which amounted to 28% as can be seen in Table 5 below.

Table 4. Proportion of non-surgical invasive measures for hospitalized patients

Non-surgical invasive measures	Frequency (n)	Percentage (%)
Yes	56	34,6
No	**106**	**65,4**
Total	162	100

Table 5. Proportion of non-surgical invasive measures for hospitalized patients

Types of non-surgical invasive measures	Frequency (n)	Percentage (%)
Urinary catheter	53	27,6
Central venous catheter	2	1,0
Endotracheal Tube (ETT)	6	3,1
Nasogastric Tube (NGT)	48	25
Water seal drainage (WSD)	29	15,1
Mechanical ventilator	**54**	**28,1**
Total	192	100

Seventh, it was found that the prevalence of MDRO infection in hospitalized patients was only 25.3% and the remaining 74.7% of hospitalized patients had non-MDRO infections (table 6). Analysis

The last univariate is the infection profile based on MDRO bacteria in hospitalized patients, based on table 7, it is known that patients infected with MDRO are mostly caused by Escherichia coli producing Extended Spectrum Beta-Lactamase (ESBL), which is 36.6%. In MDRO infections by ESBL-producing *Escherichia coli*, beta lactam antibiotics are antibiotics with the largest percentage of resistance, namely 78.1%.

Prevalence of MDRO infection in hospitalized patients

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MDRO infection	Frequency (n)	Percentage (%)
Yes	**41**	**25,3**
No	121	74,7
Total	162	100,0

Table 7. Infection profile based on MDRO bacteria in hospitalized patients

MDRO Bacteria	n	%	Dominant antibiotic resistant (%)		
			Antibiotics	n	%
Escherichia coli ESBL	15	36,6	**Beta lactam group**		**78,1**
			Penicillin		
			Ampicillin	15	
			Ampicillin /Sulbactam	7	
			Piperacillin/Tazobactam	2	
			Cephalosporins		
			Gen 1 (Cefazoline)	14	
			Gen 3		
			Ceftazidime	10	
			Ceftriaxone	15	
			Gen 4 (Cefepime)	6	
			Monobactam		
			Aztreonam	13	
			Aminoglycoside Group		**4,8**
			Gentamicin	5	
			Fluoroquinolone		**11,4**
Klebsiella pneumoniae ssp pneumoniae ESBL	9	22,0	**Beta lactam group**		**70,6**
			Penicillin		
			Ampicillin	8	
			Ampicillin/Sulbactam	9	
			Piperacillin/Tazobactam	3	
			Cephalosporins		
			Gen 1 (Cefazoline)	9	
			Gen 3		
			Ceftazidime	9	
			Ceftriaxone	9	
			Gen 4 (Cefepime)	4	
			Monobactam		
			Aztreonam	9	
			Aminoglycoside Group		**4,7**
			Gentamicin	3	
			Amikacin	1	
			Tetracycline group		**2,4**
			Tigecycline	2	
			Fluoroquinolone		**9,4**
			Ciprofloxacin	12	
			Other antibiotics		**5,7**
			Nitrofurantoin	1	
			Quinupristin/Dalfopristin	5	

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MDRO Bacteria	n	%	Dominant antibiotic resistant (%)		
			Antibiotics	n	%
			Group		
			Ciprofloxacin	8	
			Other antibiotics		**12,9**
			Nitrofurantoin	5	
			Quinupristin/Dalfopristin	6	
Staphylococcus aureus MRSA	9	22,0	**Beta lactam group**		**47,37**
			Benzylpenicillin	9	
			Oxacillin	9	
			Fluoroquinolone group		**28,9**
			Ciprofloxacin	4	
			Levofloxacin	4	
			Moxifloxacin	3	
			The aminoglycaside group		**7,9**
			Gentamicin	3	
			The lincosamide group		**7,9**
			Clindamycin	3	
			Tetracycline group		**5,3**
			Tetracycline	2	
			Macrolide group		**2,63**
			Erythromycin	1	
Pseudomonas aeruginosa	3	7,3	**Beta lactam group**		**55,56**
			Penicillin		
			Benzylpenicillin	1	
			Oxacillin	1	
			Cephalosporins		
			Gen 1 (Cefazoline)	2	
			Gen 3 (Ceftazidime)	1	
			Tetracyline group		**22,22**
			Tigecycline	2	
			Macrolide group		**11,11**
			Erythromycin	1	
			The lincosamide group		**11,11**
			Clindamycin	1	
Acinetobacter baumannii	5	12,2	**Beta lactam group**		**68,96**
			Penicillin		
			Ampicillin/Sulbactam	2	
			Piperacillin/Tazobactam	2	
			Cephalosporins		
			Gen 1 (Cefazoline)	5	
			Gen 3		
			Ceftazidime	3	
			Ceftriaxone	3	
			Gen 4 (Cefepime)	3	
			Carbapenem		
			Meropenem	2	
			Aminoglycoside		**17,2**

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MDRO Bacteria	n	%	Dominant antibiotic resistant (%)		
			Antibiotics	n	%
			group		**4**
			Gentamicin	3	
			Amikacin	2	
			Tetracycline group		**3,45**
			Tigecycline	1	
			Fluoroquinolone group		**10,35**
			Ciprofloxacin	3	

Bivariate analysis to determine the relationship between non-surgical invasive measures and the discovery of Multidrug Resistant Organism Infection in hospitalized patients was performed using the chi-square test. Table 8 shows that there is a significant relationship between non-surgical invasive measures and the discovery of MDRO infection with a p value of 0.009 (p <0.05) and an Odds Ratio value of 2.580 (1.246-5.341).

Table 8. Relationship of non-surgical invasive measures with MDRO infection

Non-surgical invasive measures	MDRO infection				Total		P-value	OR (95% IK)
	Yes		No					
	n	%	n	%	n	%		
Yes	21	37,5	35	62,5	56	100	0,009*	2,580 (1,246-5,341)
No	20	18,9	86	81,1	106	100		
Total	41	25,3	121	74,7	162	100		

*Uji *Chi-Square*

DISCUSSION

Univariate analysis related to the age distribution of patients in this study had a median of 26 years with a minimum age of 28 days (<1 year) and a maximum age of 59 years. In this study, researchers set an age limit of a minimum age of 28 days and a maximum age of 60 years. This was done to exclude the confounding factor of secondary immunodeficiency occurring in patients with very young age (<28 days) and old age (>60 years).[7,8] This age distribution is not the same as the age distribution in a study conducted by Subagyo in 2016 which limited the age of patients to <60 years and ≥60 years.[5]

It is known that *Staphylococcus hominis ssp hominis is* a bacterium that infects the largest number of inpatients, namely 14.8%, this is not in line with previous research conducted at Dr. Moewardi Hospital, Surakarta City, Central Java in 2016 which found that antimicrobial multiresistant *Escherichia coli bacteria* are MDRO bacteria that infect the most patients, namely 42.9%.[5]

The proportion of antibiotic resistance in this study showed that patients who experienced resistance to antibiotics dominated, namely by 94.4% this is in line with research conducted by Subagyo in 2016 conducted in Surakarta City, Central Java, namely that patients infected with MDRO bacteria dominated, namely 67.7%. This implies that more than 50% of the population of each research site has experienced antibiotic resistance.

The type of antibiotics that experienced the most resistance regardless of MDRO or non-MDRO bacterial infections showed that penicillin type antibiotic resistance was the highest proportion of resistance in hospitalized patients at Banten Regional Hospital. This is different from the research conducted by Subagyo at Dr. Moewardi Hospital in 2016 which suggests that the highest proportion of anbiotic resistance is the cephalosporin group.[5] This can occur due to differences in the environment and the level of antibiotic use in one region with another.[9]

Non-surgical invasive actions in this study in order from most to least in the form of mechanical ventilators, urinary catheters, NGT, WSD, ETT and central venous catheters . These results are different from the results of research conducted by Subagyo at Dr. Moewardi Hospital in 2016 with the order of most to least actions, namely urinary catheters, NGT, mechanical ventilators, central venous catheters, ETT and WSD.[5] In this study, mechanical ventilators as the most non-surgical invasive device associated with MDRO infection, this can be due to the installation of mechanical ventilators can cause stagnation of secretions in the respiratory tract which is an ideal environment for MDRO bacteria to grow.[10] In addition, patients who use mechanical ventilation usually use this device for a long period of time, this can increase the risk of contamination by MDRO bacteria.[10] In this study, the use of central venous catheters led to lower MDRO infection. This may be due to the smaller size of the catheters/sleeves in central venous catheterization causing less damage/lesions to the blood vessel wall making it less likely for MDRO bacteria to grow.[10] The smaller diameter also allows for more frequent tube changes in catheterization, which reduces the opportunity for bacteria to multiply.[10] The small catheter size requires more careful insertion and management techniques, which indirectly reduces the chance of MDRO infection.[10]

MDRO bacterial infection in this study was dominated by infection *Escherichia coli* producing *extended-spectrum beta-lactamases* which amounted to 36.6% of the total patients identified with MDRO infection, this result is in line with Subagyo's research in Surakarta City in 2016, namely *Escherichia coli* infection producing extended-spectrum beta-lactamases infecting 42.9% of the total patients infected with MDRO.[5] Based on data from the World Health Organization (WHO) *Escherichia coli* producing *extended-spectrum beta-lactamases* has been resistant to antibiotics *carbapenem* and third generation cephalosporin .[1,11,12] Whereas in this study ESBL-producing *Escherichia coli was* resistant to third-generation *cephalosporins* only, as well as *Klebsiella pneumoniae ssp pneumoniae* ESBL and *Pseudomonas aeruginosa*. In this study, only *Acinetobacter baumannii is in* accordance with the theory of WHO, namely that this multi-drug resistant bacteria has resistance to *carbapenem* and third generation *cephalosporin*. *Staphylococcus aureus* MRSA based on the theory of resistance to beta lactamase antibiotics.[1,13] However, this study is not in perfect line with the theory, where the results showed that hospitalized patients at Banten

Hospital with *Staphylococcus aureus* MRSA infection were only resistant to oxacillin and benzylpenicillin antibiotics. This could be due to the fact that methicillin antibiotics are not actively used in health care so there is a possibility that methicillin was not checked in the process of antibiotic resistance testing. Regardless, the resistance of these bacteria to beta-lactams such as oxacillin is still referred to as "*methicillin-resistant*".[13]

Bivariate analysis related to the relationship of non-surgical invasive measures in the form of mechanical ventilators, urinary catheters, NGT, WSD, ETT, central venous catheters with the discovery of Multidrug Resistant Organism (MDRO) infections in hospitalized patients was statistically significant (p=0.009; OR=2.580; 95%IK=1.246-5.341).

The use of non-surgical invasive devices such as mechanical ventilators is one of the indirect contact transmissions that can cause Multidrug Resistant Organism infections. [14]Colonization of MDRO bacteria on mechanical ventilators installed in the airway can occur and cause Ventilator Associated Pneumonia (VAP), which is pneumonia that occurs due to ventilator use for at least 48 hours.[15] The results of this study are in line with research conducted by Prihandani OR, (2014) which states that the use of mechanical ventilators is a risk factor for MDR infections in high care units and pediatric intensive care *units* at Dr. Kariadi Hospital (p 0.01; OR 5.81; 95% IK 1.50 - 22.47) .[16]

Urinary catheters are non-surgical invasive devices that are closed systems that insert a catheter tube and retention balloon through the urethra into the *vesica urinaria* to drain urine into a drainage collection bag.[17] During the insertion process and when the catheter tube has been used, there is a risk of MDRO infection which occurs because the interior and/or exterior surfaces of the catheter can become a place for bacteria to attach and develop biofilms that can provide many advantages for MDRO bacteria to survive such as resistance to urine flow, resistance to phagocytosis and others.[17] Long-term use of urinary catheters can lead to Catheter Associated Urinary Tract Infection (CAUTI). CAUTI can occur due to MDRO or non-MDRO bacterial infections.[15] The results of this study are not only in line with research conducted by Subagyo (2016) but also in line with research conducted by Anggraini at Dr. Kariadi Hospital, which states that urinary catheters are considered an independent risk factor for the occurrence of CAUTI by MDRO (p=0.012; OR=2.415 (95%IK 1.212-4.811).[18]

Nasogastric Tube (NGT) is a non-surgical invasive device by inserting a tube from one of the patient's nostrils into the stomach.[19,20] The use of NGT can result in the formation of MDRO bacterial colonies on the tube so that infection can occur because the bacteria are aspirated into the respiratory tract.[5] The use of a nasogastric tube is at risk of causing pneumonia because this invasive device increases the chance of refluxing organisms from the stomach so that these organisms are inspired into the respiratory tract.[19,20] Another invasive device

that has the same infection concept as NGT is the endotracheal tube. However, there is a difference in the insertion location, where the ETT tube is inserted into the mouth towards the trachea and maintains an adequate airway. The results of this study are directly proportional to the theory above and previous research conducted by Subagyo (2016) which states that NGT has an influence on the incidence of *Enterobacteriaceae* MDRO infection (p 0.003; OR = 7.77; 95%IK = 2.00-30.15) and ETT has an influence on the incidence of *Enterobacteriaceae* MDRO infection (p 0.018; OR = 3.75; 95%IK = 1.23-11.46).[5]

Water Sealed Drainage (WSD) is a non-surgical invasive device in which a tube is inserted in the intercostae space on the side of the chest and penetrates the chest. Infection due to the use of this invasive device as a complication is quite rare, be it infection at the insertion site or superficial infection or infection of the internal organ space (empyema). [21,22]The results of this study showed a significant relationship between the use of non-surgical invasive devices WSD with the discovery of infection MDRO . Infectious complications as a risk from the use of WSD are rare because the installation of WSD itself is not commonly done, because WSD is only used in certain conditions such as hemothorax, pneumothorax, pleural effusion, and others. However, when patients use this non-surgical invasive device, usually the patient's vulnerability is already quite severe and the closed and moist WSD system is ideal for the growth of MDRO bacteria and from ineffective sterilization factors can cause MDRO infections to be more likely to occur in WSD installations even though the installation of this tool is only in certain conditions .[23,24]

Another non-surgical invasive device in this study that had a statistically significant association with MDRO infection was central venous catheters. Prolonged central catheterization is a major risk factor for Central Line-Associated Bloodstream Infection (CLABSI), which in this case is a primary bloodstream MDRO bacterial infection after insertion of a central venous catheter for 48 hours in the absence of infection in other locations that have not previously experienced primary bloodstream infection.[25] The results of this study are in line with research with multivariate analysis by Silma B, et al (2011) which states that CVC insertion is an independent risk factor for MDRO infection *(carbapenem-resistant Acinetobacter sp.*) with a p value of 0.023, OR = 13.333 and 95% IK = 1.434 - 123.989.[26]

CONCLUSIONS

There was a significant association between non-surgical invasive measures and the finding of Multidrug Resistant Organism infection (p 0.009). Patients who received non-surgical invasive procedures had a 2.580 times risk of being found infected with MDRO.

REFERENCES

1. World Health Organization (WHO). Global antimicrobial resistance and use surveillance system (GLASS) report 2022. 5th ed. New York World Health Organization (WHO);

2022.1-63
2. Regulation of the Minister of Health of the Republic of Indonesia Number 28 of 2021 (September 4, 2021)
3. Neubeiser A, Bonsignore M, Tafelski S, Alefelder C, Schwegmann K, Rüden H, et al. Mortality attributable to hospital acquired infections with multidrug-resistant bacteria in a large group of German hospitals. J Infect Public Health. 2020;13(2):204-10.
4. Tadese BK, DeSantis SM, Mgbere O, Fujimoto K, Darkoh C. Clinical Outcomes Associated with Co-infection of Carbapenem-Resistant Enterobacterales and Other Multidrug-Resistant Organisms. Infection Prevention in Practice [Internet]. 2022;4(4):100255. Available from: https://doi.org/10.1016/j.infpip.2022.100255
5. Subagyo DCD. Factors related to the incidence of Multidrug Resistant Organisms Enterobacteriaceae infection in intensive care unit patients of RSUD DR. Moewardi in 2015. Surakarta: Sebelas Maret University; 2016 [30 Jan; 25 Nov 2023]; Available from: https://digilib.uns.ac.id/dokumen/abstrak/67418/Faktor-Terkait-Kejadian-Infeksi-Multidrug-Resistant-Organisms-Enterobacteriaceae-Pasien-Intensive-Care-Unit-RSUD-Dr-Moewardi-Tahun-2015
6. Chen YP, Liang CC, Chang R, Kuo CM, Hung CH, Liao TN, et al. Detection and colonization of multidrug resistant organisms in a Regional Teaching Hospital of Taiwan. Int. J. Environ. Res. Public Health. 2019; 16(1104):1-10.
7. Regulation of the Minister of Health of the Republic of Indonesia Number 25 of 2016 concerning the national action plan for elderly health in 2016-2019.
8. Tuano KS, Seth N, Chinen J. Secondary immunodeficiencies: An overview. Annals of Allergy, Asthma and Immunology [Internet]. 2021;127(6):617-26.
9. Sanjaya DA, Juanita Rr A, Meriyani H, Siada NB, Lestasi KT. Trends in antibiotic use and resistance profiles in critical-priority bacteria groups in the ICU of Hospital "X" Bali Province (2017-2019). JPSCR. 2023; 8(3): 301-13p
10. Wang M, Xu X, Wu S, Sun H, Chang Y, Li M, Zhang X, Lv X, Yang Z, Ti X. Risk factors for ventilator-associated pneumonia due to multi-drug resistant organisms after cardiac surgery in adults. BMC Cardiovasc Disord. 2022;22(1):465. doi: 10.1186/s12872-022-02890-5
11. Lukito JI. Trends in antibiotic use. CDK. 2023. 2023;50(12):673-9p
12. ESBL-producing Enterobacterales [Internet]. Atlanta: Disease Control and Prevention (CDC); 2029 [Nov 22, 2019; May 5, 2023]; Available from: https://www.cdc.gov/hai/organisms/ESBL.html
13. Ali Alghamdi B, Al-Johani I, Al-Shamrani JM, Musamed Alshamrani H, Al-Otaibi BG, Almazmomi K, Yusnoraini Yusof N. Antimicrobial resistance in methicillin-resistant staphylococcus aureus. Saudi J Biol

Sci. 2023;30(4):103604. doi: 10.1016/j.sjbs.2023.103604.

14. Regulation of the Minister of Health of the Republic of Indonesia Number 27 of 2017 concerning guidelines for infection prevention and control in health care facilities (June 19, 2017).
15. Kurniawati AFS, Satyabakti P, Arbianti N. Differences in the risk of Multidrug Resistance Organisms (MDROS) according to risk factors and hand hygiene compliance. JBE.2015;3(3):277-89p
16. Prihandani OR. Risk factors for multidrug-resistant organism infection: a study in the PICU and HCU of Dr. Kariadi Hospital Semarang [Internet]. Semarang: Diponegoro University; 2014 [Aug 20, 2014; May 24, 2024]; Available from: http://eprints.undip.ac.id/48521/1/Halaman_Judul.pdf
17. Navarro S, Sherman E, Colmer-Hamood JA, Nelius T, Myntti M, Hamood AN. Urinary Catheters Coated with a Novel Biofilm Preventative Agent Inhibit Biofilm Development by Diverse Bacterial Uropathogens. Antibiotics (Basel). 2022.11(11):1514. doi: 10.3390/antibiotics11111514.
18. Anggarini FR. Risk factors for urinary tract infection by Multidrug Resistant Organisms in patients treated at Dr. Kariadi General Hospital [Internet]. Semarang: Diponegoro University; 2013 [Oct 8, 2014; May 5, 2023]; Available from: http://eprints.undip.ac.id/43884/
19. Sigmon DF, An J. Nasogastric Tube. [Updated 2022 Oct 31]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022. Available from: https://www.ncbi.nlm.nih.gov/books/NBK556063/
20. Shlamovitz GZ. Nasogastric intubation [Internet]. New York: Medscape; 2022 [May 13, 2022; May 5, 2023]. Available from: https://emedicine.medscape.com/article/80925-overview?form=fpf
21. 55.Rumanda W, Saputra TA, Pratomo IP [Internet]. Jakarta: University of Indonesia hospital; 2022 [Jan 6, 2022; May 5, 2023]. Available from: https://rs.ui.ac.id/umum/berita-artikel/artikel-populer/ketahuilah-tindakan-pemasangan-selang-dada-pada-penyakit-paru
22. 56.Ravi C, McKnight CL. Chest tube. [Updated 2022 Oct 3]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022. Available from: https://www.ncbi.nlm.nih.gov/books/NBK459199/
23. Lado MY. Modified water seal drainage [Internet]. Semarang: Sekolah tinggi ilmu kesehatan widya husada; 2018 [dec 2018; may 2024]; Available from: https://eprints.uwhs.ac.id/1716/1/MELDY%20YOSAFAT%20LADO.pdf
24. Anggaraditya PB, Chandra A. Culture results on chest tube thoracostomy water-sealed drainage inpatients with pneumothorax at Sanglah General Hospital, Bali-Indonesia.

DOAJ. 2019;10(1):188-191p

25. Alshahrani KM, Alhuwaishel AZ, Alangari NM, Asiri MA, Al-Shahrani NA, Alasmari AA, Alzahrani OJ, Ayedh AY, Qitmah MM. Clinical impacts and risk factors for central line-associated bloodstream infection: A systematic review. Cureus. 2023;15(6):e40954. doi: 10.7759/cureus.40954.
26. Risk factors and clinical effects of carbapenem-resistant Acinetobacter sp. infection at Dr. Kariadi Hospital Semarang [Internet]. Semarang: Diponegoro University; 2014 [Aug 20, 2014; May 24, 2024]; Available from: http://eprints.undip.ac.id/32878/1/Benita_Silma.pdf