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ORIGINAL RESEARCH

Microbiological and urinalysis assessment of UTIs in COVID-19 patients at Dr. Zainoel Abidin Hospital, Banda Aceh

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Abstract. One of the secondary infections observed among COVID-19 patients is a Urinary Tract Infection (UTI). The presence of bacteria and fungi causes UTI, which can certainly occur after a urine culture. Urinalysis is one of the critical examinations to diagnose UTIs and assess functional disorders in the urinary tract. This study examines the characteristics of microbes isolated from urine specimens and urinalysis results in COVID-19 patients at Dr. Zainoel Abidin Hospital, Banda Aceh . This observational analytic study used secondary data from urine culture and urinalysis results of COVID-19 patients by implementing the total sampling technique. This study involved 110 urine culture data from confirmed COVID-19 patients. Comparative analysis of parameters between positive and negative urine culture groups with urinalysis results using categorical variables through the Chi-square test and Fisher's Exact test. The findings suggest that *Escherichia coli*, *Enterococcus spp.,* and *Candida spp.* are the predominant uropathogens in COVID-19 patients, with urinalysis frequently indicating leukocytosis as a marker of urinary tract involvement. Urine culture is the gold standard for quantitatively diagnosing UTIs by determining bacterial density and identifying specific pathogens. Urinalysis, which checks for leukocytes in the urine, can support these results.

Keywords: COVID-19, urinalysis, urinary tract infection, urine culture.

INTRODUCTION

An unidentified pneumonia outbreak was documented in Wuhan, Hubei Province, China, in December 2019. Epidemiological evidence connected the Huanan Seafood Wholesale Market to pneumonia cases. A novel respiratory virus was isolated from respiratory samples. This virus was named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) after genome analysis revealed a novel SARS-CoV-related coronavirus. The betacoronavirus SARS-CoV-2 is a member of the sarbecovirus subgenus [1]. The World Health Organization declared a pandemic due to the global spread of SARS-CoV-2 on March 12, 2020. The thousands of deaths brought on by coronavirus disease (COVID-19) [2].

The pandemic has been extremely aggressive around the world, resulting in 20% of infected individuals needing hospitalization and 5% of their conditions progressing to critical, involving more complex systemic involvement in addition to respiratory issues. [3]. Indonesia's national COVID-19 fatality rate has fluctuated over time but is typically estimated to be 2.7%. It was found in a study that examined data from March 2020 to February 2022, with 148,034 deaths out of 5,539,333 confirmed cases [4]. The most accurate estimate of Aceh's overall COVID-19 fatality rate is 3.5% [5]. According to a study conducted at Dr. Zainoel Abidin Hospital in Aceh, the hospital mortality rate for COVID-19 patients treated there in 2021 was approximately 30.34% [6].

Immunocompromised COVID-19 patients are particularly vulnerable to secondary infections [7]. A European Society of Clinical Microbiology and Infectious Diseases (ESCMID) meta-analysis study found that 6.9% of COVID-19 patients had bacterial infections, and up to 14.3% experienced secondary infections [8]. Urinary Tract Infection (8%) is one of the secondary infections that accompany COVID-19 patients, caused by Gram-positive bacteria (55%), Gram-negative bacteria (30%), and fungi (15%) [9]. Severely ill COVID-19 patients often stay in the ICU, where they need urinary catheters, which can introduce bacteria and cause infections [10]. This is supported by findings that catheter-associated urinary tract infections (CA-UTIs) occur in about 28% of ICU COVID-19 patients [10]. Many COVID-19 patients receive long courses of antibiotics, which can disrupt healthy bacteria, promote multidrug-resistant organisms, and increase the risk of complicated UTIs [11].

COVID-19 patients have a higher prevalence of lower urinary tract symptoms (LUTS) such as urinary frequency, nocturia, and urgency, which may overlap or be exacerbated by UTIs [12]. COVID-19 infection may worsen pre-existing urinary tract conditions or increase the risk of new infections, possibly because SARS-CoV-2 binds to ACE2 receptors found in the urinary tract [13]. Furthermore, COVID-19 patients may experience acute renal injury and impaired immune function, which can predispose them to secondary infections such as UTIs [14]. According to studies, a large proportion of COVID-19 patients develop UTI symptoms after recovery, with some requiring antibiotic treatment for confirmed infections. Furthermore, catheter-related UTIs are common in critically ill COVID-19 patients, complicating outcomes [10].

Urine culture is widely considered the gold standard for diagnosing UTIs. However, this method is limited by its turnaround time, which typically takes 24 to 72 hours to yield results [15]. This delay can impact clinical decisions. Conversely, urinalysis is a quick and comprehensive screening test examining urine's physical, chemical, and microscopic properties. It can provide immediate results and is available in almost every clinical laboratory, making it suitable for quick screening and initial assessment [16]. The objective of this study was to determine the diagnostic value and to investigate the correlation between urine analysis findings and positive urine culture results.

METHODOLOGY

Study participants

The study's populations were all COVID-19 patients who underwent urine culture and urinalysis procedures at the provincial referral, Dr. Zainoel Abidin Hospital, Banda Aceh. This study employed the total sampling technique. Secondary data from the Clinical Microbiology and Clinical Pathology Laboratory Records, July 2020 to June 2021, were used in this study. Inclusion criteria for research samples included COVID-19 patients whose urine culture results met the UTI criteria for the number of colonies. The results of a complete urinalysis examination were also used to perform urine culture tests on COVID-19 patients. Unidentified urine culture results from COVID-19 patients were among the exclusion criteria for research samples. The statistical tests for each parameter are the Chi-square and Fisher's Exact tests.

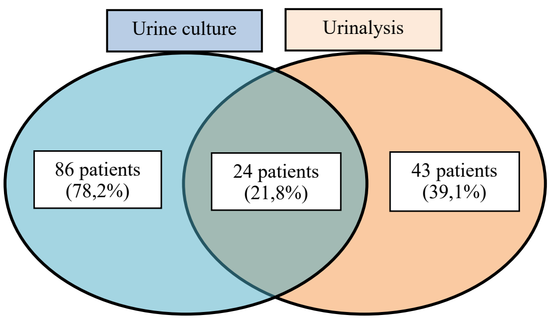

Figure 1. The number of patients with urine culture and urinalysis results

Laboratory testing and data analysis

Microbial identification was performed using a VITEK® 2 Compact semi-automatic system (Biomerieux, Lyon, France). Urinalysis was performed using UriSed 3 PRO and LabUMat urine analysis devices (77 Elektronika, Budapest, Hungary). The examination was performed according to standard laboratory operating procedures. The Health Research Ethics Committee of the Faculty of Medicine at Syiah Kuala University - Dr. Zainoel Abidin Hospital has approved this study for expedited ethical approval (registration number 326/EA/FK-RSUDZA/2021).

RESULTS AND DISCUSSION

Distribution of urine culture and urinalysis

This study consisted of 110 urine culture tests. Complete urinalysis results were obtained for 67 patients. Patients who had results from both urine culture and urinalysis examinations were 24 (21.8%); those who had urine culture examination results alone were 86 (78.2%); and those who had urinalysis examination results alone were 43 (39.1%) (Figure 1).

In this study, urine culture tests were used more frequently than urinalysis in UTI patients. Urine culture is more prioritized because it is the definitive test for diagnosing UTI, crucial for antibiotic selection, and essential in managing complicated cases [17, 18]. But the results are rarely available within 24 hours [19]. Urinalysis is useful as a rapid and inexpensive screening test to rule in or rule out UTI initially, guiding clinical decision-making [20]. Urinalysis helps screen patients for empirical antibiotic therapy, but culture and antibiograms guide definitive therapy [21]. Urine culture is the gold standard for diagnosing UTIs because it identifies the specific bacteria causing the infection and quantifies bacterial growth [22], which helps confirm the diagnosis and differentiate actual infection from contamination [23].

Characteristics of patients

The majority of patients in this study were adults (25 - ≤59 years), namely 78 people (70.9%), followed by elderly patients with 31 people (28.2%). The youngest age category of patients in this study was teenagers (15 - ≤24 years), one patient (0.9%) (Table 1).

This is consistent with the findings of Davies et al. (2020), who found that patients aged 20 to 59 years (73%) were more likely to be exposed to the COVID-19 virus than those under 21 and over 60 years (27%) [24]. The productive age group is 25 to 59 years old, and they participate in more activities outside the home than

Table 1. Age classification characteristics of patients

Age groups	Positive urine culture		Negative urine culture		Total	
	n	**%**	**n**	**%**	**n**	**%**
Children (0 - ≤14 years old)	0	0	0	0	0	0
Teenager (15 - ≤24 years old)	1	0.9	0	0	1	0.9
Adult (25 - ≤59 years old)	26	23.6	52	47.3	78	70.9
Elderly (≥60 years old)	9	8.2	22	20.0	31	28.2
Total	36	32.7	74	67.3	110	100

Table 2. Gender characteristics of patients

Gender	Positive urine culture		Negative urine culture		Total	
	n	**%**	**n**	**%**	**n**	**%**
Male	18	16.4	46	41.8	64	58.2
Female	18	16.4	28	25.5	46	41.8
Total	36	32.7	74	67.3	110	100

Table 3. Characteristics of patients' hospitalization wards

Wards	Positive urine culture		Negative urine culture		Total	
	n	**%**	**n**	**%**	**n**	**%**
Emergency	2	1.8	3	2.7	5	4.5
RICU	18	16.4	52	47.3	70	63.7
PINERE	15	13.6	19	17.3	34	30.9
Pulmonology inpatient ward	1	0.9	0	0	1	0.9
Total	36	32.7	74	67.3	110	100

children, teenagers, and older people. This makes COVID-19 easier to transmit and spread [25].

The elderly are more vulnerable to COVID-19, as their immune system does not function as well as when they were younger. The body experiences a variety of declines as it ages, including reduced hormone production, bone density, and other bodily functions. Furthermore, the elderly frequently have comorbidities and other chronic conditions that can increase the risk of COVID-19 infection [25]. Teenagers and children are the age groups least exposed to COVID-19. School closures are one of the contributing factors to this low rate. This has reduced teenagers' and children's exposure to COVID-19 [26].

The genders of the patients in this study were found to be male (64 patients, 58.2%) and female (46 patients, 41.8%). This indicates that male patients undergo more urine culture tests. Men account for the vast majority of COVID-19 cases (Table 2). Of the 64 male patients, 18 had positive urine cultures and 46 had negative ones.

The study included 64 male patients, 18 with positive and 46 with negative urine cultures. This suggests that male respondents were more likely to have urine culture tests. These findings are consistent with those of Bienvenu et al. (2020), who found that the majority of COVID-19 patients were male (54.3%) rather than female (45.7%) [27]. Men account for a large percentage of COVID-19 cases. This is due to varying lifestyles and biological conditions. Men's lifestyles, which include frequent trips outside the home for work, are among the factors that make them susceptible to coronavirus infection [28]. Furthermore, men have higher levels of ACE 2 enzymes than women, which may serve as an entry point for the coronavirus. Men are more susceptible to COVID-19 complications since men have fewer CD4+, CD8+, and type 1 T helper cells [29]. Secondary UTIs are more common in male COVID-19 ICU patients due to anatomical and clinical factors such as catheter use, according to data from studies on COVID-19 ICU patients [30].

The majority of patients in this study came from the Respiratory Intensive Care Unit (RICU), namely 70 patients, 18 patients with positive urine culture, and 52 patients with negative urine culture. Followed by the isolation room for emerging and reemerging infectious diseases (PINERE), as many as 34 patients, namely 15 patients with positive urine culture, and 19 patients with negative urine culture (Table 3).

The RICU ward provided the majority of the patients for this study, with 70 in total, 18 with positive and 52 with negative urine cultures. The PINERE ward had 34 patients, including 15 respondents and 19 patients. These findings are consistent with the findings of Grasselli et al. (2020), who reported 1,591 COVID-19 patients admitted to Intensive Care Units (ICUs) over 26 days from February 20 to March 18, 2020 [31]. Another study by Bardi et al. (2020) found that COVID-19 patients in

Table 4. Frequency distribution of microbial isolates in urine specimens

Microbial isolates	Frequency	
Bacterial	**(n)**	**(%)**
Gram-positive bacteria (n=7)		
Enterococcus faecalis	4	11.1
Enterococcus faecium	1	2.8
Staphylococcus aureus	1	2.8
Streptococcus agalactiae	1	2.8
Gram-negative bacteria (n=23)		
Escherichia coli	11	30.6
Klebsiella pneumoniae	3	8.3
Pseudomonas putida	3	8.3
Acinetobacter lwoffii	1	2.8
Enterobacter cloacae	1	2.8
Proteus rettgeri	1	2.8
Pseudomonas aeruginosa	1	2.8
Pseudomonas cepacia	1	2.8
Stenotrophomonas maltophilia	1	2.8
Fungal (n=6)		
Candida tropicalis	2	5.6
Candida albicans	1	2.8
Candida famata	1	2.8
Candida lusitaniae	1	2.8
Trichosporon asahii	1	2.8
Total	**36**	**100**

the ICU had a higher risk of secondary infection (40.7%) than those in other units [9].

Prolonged ICU stay and intubation duration increase the risk of secondary infections, including UTIs, partly due to immune suppression, disruption of normal flora, and exposure to multidrug-resistant organisms [32]. COVID-19 patients in the ICU are more likely to contract bacterial infections because using medical devices and invasive monitoring promotes bacterial colonization and invasion. Antibiotic use is very high up to 86% in COVID-19 ICU patients, which contributes to the development of multidrug resistance among bacterial pathogens, causing secondary UTIs [33]. Combination antibiotics are one option for empirical therapy of infections in ICU patients. Long-term use of multiple antibiotics frequently results in high rates of antibiotic resistance in the ICU [34]. Secondary infections, including UTIs, increase patient morbidity and mortality in critically ill COVID-19 patients, aggravating outcomes already compromised by the viral disease and other complications [10].

Microbial isolates distribution

The results of urine culture examination in this study showed microbial growth according to UTI criteria in 36 patients (32.7%) out of 110 patients. The results of the culture examination of the patients' urine samples showed that Gram-negative bacterial infections, with as many as 23 isolates (63.8%), were the highest cause compared to Gram-positive bacteria, seven isolates (19.5%), followed by fungal group microbes, six isolates (16.7%) (Table 4).

Gram-negative bacteria cause more UTIs than Gram-positive bacteria and fungi. *Escherichia coli* is the most common Gram-negative bacterium responsible for infections, followed by *Klebsiella pneumoniae* and *Pseudomonas putida*. A comprehensive study of UTI cases before and during the COVID-19 pandemic discovered that Gram-negative bacteria accounted for 86.35% of all UTI-causing strains, while Gram-positive bacteria accounted for only 13.64%. The most common Gram-negative bacteria were *Escherichia coli* (60.95%), followed by *Klebsiella spp*. (17.25%). The study also noted the presence of significant Gram-negative pathogens, *Pseudomonas spp*. [35]. *Candida spp*. are the primary cause of yeast urinary infections. Other yeasts, such as *Trichosporon asahii*, are documented complications in COVID-19 patients, particularly those critically ill or immunocompromised [36, 37, 38].

Urinalysis Findings

A total of 67 of the 110 patients had their urine tested. Some abnormal urinalysis results included elevated white blood cells (WBCs), red blood cells (RBCs), and protein in urine. The comparison of the frequency distribution of urinalysis results between the positive and negative urine culture groups can be seen in Table 5.

Out of the 67 patients who underwent both urinalysis and urine culture testing, a comparative analysis was conducted to determine whether specific urinalysis parameters were significantly associated with positive urine culture findings. We compared urinalysis parameters between two groups (positive vs negative urine culture) using categorical variables (normal/abnormal). Statistical testing revealed that only the presence of WBCs (leukocytes) in urinalysis among

Table 5. Urinalysis result frequency distribution based on urine culture results

Urinalysis parameters	Positive urine culture (n=24)				Negative urine culture (n=43)				*p-value*
	Normal		Abnormal		Normal		Abnormal		
	n	(%)	n	(%)	n	(%)	n	(%)	
Appearance (clarity)	24	100	0	0	43	100	0	0	1.000
Color	23	95.8	1	4.2	41	95.3	2	4.7	1.000
Specific Gravity	23	95.8	1	4.2	42	97.6	1	2.4	1.000
pH	24	100	0	0	43	100	0	0	-
Red Blood Cells (RBCs)	6	25	18	75	15	34.8	28	65.2	0.5744
White Blood Cells (WBCs)	7	29.2	17	70.8	27	62.8	16	37.2	0.0171
Protein	13	54.2	11	45.8	23	53.5	20	46.5	1.000
Glucose	18	75	6	25	29	67.4	14	32.6	0.7115
Nitrite	20	83.3	4	16.6	40	93	3	7	0.239
Ketones	15	62.5	9	37.5	26	60.5	17	39.5	1.000
Bilirubin	23	95.8	1	4.2	42	97.6	1	2.4	1.000
Urobilinogen	21	87.5	3	12.5	33	76.7	10	23.3	0.350

the evaluated parameters was significantly associated with positive urine culture results ($p = 0.0171$). Patients with positive cultures showed more abnormal leukocyte findings (70.8%) than those with negative cultures (37.2%).

Other parameters, including nitrite, blood, protein, glucose, ketones, bilirubin, urobilinogen, specific gravity, color, and appearance, did not show statistically significant differences between the two groups ($p > 0.05$ for all). Parameters such as urine appearance and pH were uniformly standard across all samples and were therefore not eligible for statistical comparison. Most patients had abnormal erythrocytes in both the positive (75%) and negative (65.2%) urine cultures, although the presence of blood was not significantly associated with UTI. Hematuria in COVID-19 patients can arise through multiple mechanisms involving both direct viral effects and systemic complications, regardless of secondary UTIs. Hematuria in COVID-19 patients is caused by viral damage to ACE2-rich urinary tissues, immune-mediated injury, hypercoagulability, and secondary infections. These mechanisms frequently overlap, complicating clinical management and negatively impacting outcomes [39, 40, 41].

This study was performed in a single location during the COVID-19 pandemic and may not reflect broader epidemiological patterns in different settings or time periods. The absence of antimicrobial susceptibility testing data limited the analysis, preventing the evaluation of resistance patterns among the isolated pathogens. This limitation restricts the ability to determine the clinical relevance of the identified organisms, along with the potential implications for empirical antibiotic selection and stewardship. Furthermore, the study was conducted retrospectively using existing laboratory records, which could have resulted in incomplete data and possible selection bias, especially since only a subset of patients had both urine culture and urinalysis results.

CONCLUSION

This study found that the adult age group is the largest among COVID-19 patients with secondary UTI. Males make up the vast majority. Urine culture testing and urinalysis are most commonly performed in the intensive care unit. By integrating urine culture and urinalysis, clinicians can achieve a more accurate diagnosis. Urinalysis guides initial decisions, and urine culture provides confirmation and targeted therapy guidance. This combined approach minimizes the risk of misdiagnosis, reduces unnecessary antibiotic use, and helps prevent the development of antimicrobial resistance, which is especially critical in COVID-19 patients who are often immunocompromised and exposed to multiple antibiotics during hospitalization. Specifically, this study contributes to the understanding of the microbial spectrum of secondary urinary infections in COVID-19 patients, showing that Gram-negative bacteria, especially *Escherichia coli*, remain the predominant pathogens even in this special population. Urinalysis showed that leukocyturia strongly indicates a urinary tract infection in COVID-19 patients. Clinical laboratory utilization highlights that urine culture was prioritized over urinalysis in hospitalized COVID-19 patients, likely due to the need for accurate microbiological confirmation and targeted antimicrobial therapy.

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