Rapid Diagnostic with Measurements of Power of Hidrogen (pH), Protein, Leukocytes Esterase and Nitrites Using Dipstic Methods to Diagnose Chronic Rhinosinusitis

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Abstract. Hemodialysis, which involves regular visits to the hospital, increases the risk of social disability, where lack of social support contributes to mental and emotional problems experienced by patients undergoing hemodialysis. This study aims to determine the effect of social support and family functionality on the quality of life of chronic kidney disease patients undergoing hemodialysis. This study involved 42 patients with chronic kidney disease undergoing hemodialysis at the Hemodialysis Unit of Royal Prima Medan Hospital, selected by incidental technique. Primary data in this study were collected using the Kidney Disease Quality of Life Questionnaire, Multidimensional Scale of Perceived Social Support, and Family APGAR, while secondary data were sourced from patients' medical records. Data were analyzed using binomial logistic regression. This study found that 78.5% of respondents had hypertension, 40.5% had diabetes mellitus, and 31% had both. In addition, most respondents had low levels of social support (38.1%) but had highly functional families (47.6%). Logistic regression analysis found that social support was the only factor affecting the quality of life of chronic kidney disease patients undergoing hemodialysis ($p < 0.001$; OR: 13.355). It can be concluded that adequate social support benefits the quality of life of chronic kidney disease patients undergoing routine hemodialysis, so promoting a positive social environment that supports hemodialysis patients is necessary.

Keywords: Chronic rhinosinusitis, Dipstic test, Leucocytes esterase

1 Introduction

Sinusitis is one of the most common diseases affecting a large portion of the population. According to data from the National Ambulatory Medical Care Survey, sinusitis ranks as the fifth most common condition for which antibiotics are prescribed [1]. The bacterial flora in the paranasal sinuses of patients with cystic fibrosis can develop into chronic rhinosinusitis [2].

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The diagnosis of chronic rhinosinusitis can be established through physical examination (frontal rhinoscopy, endoscopy), radiography, or CT scans [2]. CT scans are considered the gold standard for identifying inflammation in the sinuses and have become routine radiological procedures for diagnosing sinusitis [3].

CT scans have high sensitivity and specificity for diagnosing sinusitis. In a study conducted by Vahid (2012), CT scans demonstrated a sensitivity of 92%, specificity of 94%, positive predictive value of 90%, and negative predictive value of 95% in diagnosing sinusitis [3]. Conventional X-rays, such as Waters' View, are often used as the first-line examination for sinusitis. In the study, the weighted average sensitivity for detecting maxillary sinus anomalies was 67.7%, specificity 87.6%, accuracy 78.6%, positive predictive value 82.5%, and negative predictive value 76.9% [4].

The high incidence of chronic rhinosinusitis necessitates an accurate, rapid, and efficient method for confirming the diagnosis. Clinical information, physical examinations, as well as radiological and nasoendoscopic follow-up examinations, remain reliable in supporting diagnostics, assessing abnormalities, and identifying possible causes of chronic rhinosinusitis. While a variety of radiological examinations are available, they remain expensive and are an option for identifying sinus infections [5]. Cheaper, easier, and more efficient examination alternatives are still being explored. Currently, no diagnostic tests for sinusitis are available that do not involve positive bacterial culture or corresponding tissue changes in the sinus cavity [6].

It has been shown that nasal secretion dipstick tests are strongly correlated with sinus radiology and can be used for diagnosis. Other studies have also shown that these tests can be correlated with the findings from culture and polymerase chain reaction (PCR) [7]. The parameters evaluated from nasal secretion in this study include pH, protein, leukocyte esterase, and nitrite [8].

Although paranasal sinus CT is the gold standard in diagnosing chronic rhinosinusitis, the cost, availability of tools, quality of instruments, and resources to perform it remain uneven, especially in primary health care. Therefore, the researchers were interested in investigating rapid diagnostic methods for sensitivity, specificity, positive predictive value, negative predictive value, and dipstick accuracy tests by measuring the degree of acidity, protein, leukocyte esterase, and nitrites in the diagnosis of chronic rhinosinusitis.

2 Literature Review

Chronic rhinosinusitis is initiated by inflammation of the mucosal lining of the sinuses, which can be predisposed by several factors such as upper respiratory infections, allergies, or environmental factors. Inflammation is followed by mucosal edema, obstruction of the ostium, and alterations in the conditions of the sinus environment, leading to thickening and accumulation of secretions in the paranasal sinuses, which results in a decrease in pH and partial pressure of oxygen (PO2). These environmental changes allow for the growth of bacteria, which in turn causes infection.

Nitric Oxide (NO) has a dual function in the context of social interactions and relationships. The oxidation of nitrogen oxides, specifically the examination of NO oxidation, leads to the stabilization of nitrite and nitrate. The formation of nitric oxide nitrite occurs in the sinonasal epithelium from nitric oxide synthase located in the cilia and microvilli of the epithelium. NO plays a role in damaging bacterial proteins and inhibiting virus replication.

This metabolite functions in the immune system by acting as a substrate for various proteins and enzymes involved in antimicrobial activities in nasal secretions. Chronic rhinosinusitis is characterized by the presence of nitric oxide in the nasal cavity and sinuses, leading to an increase in nitric oxide levels in chronic sinusitis, with a return to normal levels during recovery.

Strips of leukocyte esterase reagents work by detecting esterases, which are enzymes found in the azurophilic granules produced by granulocytes (neutrophils, eosinophils, and basophils). These tests can detect leukocyte esterase, although microscopic examinations often fail to identify leukocytes [9]. Proteins released during inflammation stimulate respiratory mucus secretion, increase vascular permeability, and further cause increased plasma transudation [10]. In patients with chronic rhinosinusitis, nitric oxide in the nose and sinus undergoes oxidation, resulting in increased levels of nitrate metabolites in chronic sinusitis [11].

The indicators used to detect the presence of secretions in the nasal cavity include pH, protein, leukocyte esterase, and nitrates. This is evaluated using a dipstick test conducted on nasal secretions taken from the medial meatus, employing endoscopic techniques and direct application, along with an absorption system using sterile materials. The results of this evaluation are compared with several qualitative aspects regarding control and management from the factory. The study by [7] discusses the relationship between nasal secretions and sinusitis, providing insights into the potential causes of sinus infections.

The diagnosis of chronic rhinosinusitis can be established through physical examination (anterior rhinoscopy, endoscopy) or through radiography and CT scans [2]. CT scans are the gold standard for depicting inflammation in the sinuses and have become a routine radiological examination in the diagnosis of sinusitis [3].

There is an innovative approach for diagnosing both acute and chronic rhinosinusitis using a dipstick [6]. It has been reported that nasal secretion dipstick tests are highly correlated with sinus radiology and can be used for diagnosis. Even from other studies, it can be correlated with the findings of culture and polymerase chain reaction. (PCR) [6]. The parameters assessed from nasal secretions in this study include pH, protein, leukocyte esterase, and nitrite [7]. In patients with chronic rhinosinusitis compared to healthy subjects, a more alkaline nasal pH was found [8].

3 Method

This research is done in an analytical form with a widescreen approach (cross sectional study). Research sites to take samples of research were conducted at RSUD Drs. H. Amri Tambunan, Deli Serdang and RSU Mitra Medika Tanjung Mulia. The target population in this study is the entire patient with chronic rhinosinusitis. The suspicious rinosinusitis who came to RSUD Drs. H. Amri Tambunan, Deli Serdang and RSU Mitra Medika. The sample of this study is a population segment of rhinosinusitis diagnosed from anamnesies, physical examination of anterior and posterior rhinoscopy and Paranasal Sinus CT Scan that meets the inclusion and exclusion criteria with a sample number of at least 25 subjects.

Before starting this research, ethical approval must be obtained. This research has passed the ethical review based on Ethical Approval No.967 KEPK/FKUMSU/2022 from the Health Research Ethics Committee, Faculty of Medicine, Muhammadiyah University of North Sumatera to inform that this research complies with national and international guidelines for human research. The inclusion and exclusion criteria are as follows:

Inclusion Criteria

1. New patient diagnosed with chronic rhinosinusitis, both male and female, in certain age groups
2. Willing to participate in the research

Exclusion criteria

1. Has never received antibiotic treatment
2. Within a week, they were free from both oral and topical corticosteroid and antihistamine

Sampling is done using non-probability consecutive sampling. Where the sample taken is the entire subject observed and meets the inclusion criteria until the size of the required sample is met. The free variables in this study are the results of nasal secretion removal of acidity (pH), leukocyte esterase, nitrates and proteins measured by dipstic methods, while the variables are tied to sensitivity, specificity, positive predictive value, negative predictive value and accuracy. The data collected is primary data obtained from direct measurements of secretion examination in patients using dipstic methods. Secondary data includes age and gender.

The material used in this study is Nasal Secretions Swab. The measurement of protein, pH, leukocyte esterase, and nitrate was conducted using dipstick tests commonly used in various fields. The dipstick used for this research is the Combur test UX dipstick obtained from Roche Corp with an expiration date of November 2024. The specimens used in this study are nasal secretions obtained from the middle meatus. The research samples were obtained from the nasal cavity with the hope that the secretion results would better reflect the condition of the sinuses.

The dipstick can be directly applied to the area of the middle meatus. Another alternative for collecting secretions is to take the secretion directly using a cotton swab laterally, directing it towards the middle meatus, and then evenly spreading it across the entire strip. All tests are read at 1 minute after sample application, except for leukocyte esterase, which is read at 2 minutes.

The data will be presented in the form of a table of frequency distribution and percentage of each variable studied. Data analysis will be done with the help of SPSS (Statistical Product and Service Solution) version 20 for windows. The data will be analyzed statistically to find out how rapid diagnosis is made by measuring the degree of acidity, protein, leukocyte esterase and nitrite using dipstic methods to establish chronic rhinosinusitis. The statistical assessment continued with the calculation of sensitivity, specificity, positive predictive value, negative predictive value and accuracy values.

4 Results

Table 1. Frequency Distribution of The Subjects

Variable	Frequency (f)	Percentage (%)
Age		
17-25 years	8	32.0
26-35 years	5	20.0
36-45 years	5	20.0
46-55 years	6	24.0
> 55 years	1	4.0
Gender		
Male	4	16.0
Female	21	84.0
pH		
6	10	40.0
7	7	28.0
8	6	24.0
9	2	8.0
Protein		
Negative	11	44.0
Positive 1	3	12.0
Positive 2	9	36.0
Positive 3	2	8.0
Leukocytes Esterase		
Negative	7	28.0
Positive 1	4	16.0
Positive 2	12	48.0
Positive 3	2	8.0

Table 2. Frequency Distribution of The Subjects (Continue)

Variable	Frequency (f)	Percentage (%)
Nitrites		
Negative	11	44.0
Positive	14	56.0
Total	25	100.0

Abbreviation: pH = Power of Hidrogen

Table 3. Distribution of Research Subjects on CT Scan PNS Compared to Dipstic Test

	CT Scan PNS	
	Positive	**Negative**
pH		
Positive (Acid)	15(a)	4(b)
Negative (Not acidic)	2(c)	4(d)
Protein		
Positive ($\geq +2$)	13(a)	5(b)
Negative ($<+2$)	4(c)	3(d)
‘ Leukocytes Esterase		
Positive ($\geq +2$)	14(a)	5(b)
Negative ($<+2$)	2(c)	4(d)
Nitrites		
Positive (Pink)	14(a)	8(b)
Negative (Uncolored)	2(c)	1(d)

Abbreviation: PPV = Positive Predictive Value; NPV = Negative Predictive Value

Table 4. Distribution of Research Subjects on CT Scan PNS Compared to Dipstic Test

	Dipstic Test			
	pH	**Proteins**	**Leukocytes Esterase**	**Nitrites**
Sensitivity	88.2%	66.67%	87.5%	87.5%
Specificity	50%	37.5%	44.4%	11.1%
Positive Predictive Value	78.9%	72.2%	73.68%	63.6%
Negative Predictive Value	66.67%	64%	66.67%	33.3%
Accuracy	76%	64%	72%	60%

5 Discussion

Based on the results of studies conducted using the dipstick method to diagnose chronic rhinosinusitis, data were obtained from 25 patients who participated in the study. The results show that the majority of the subjects, 32%, were in the age range of 17-25 years. Additionally, the vast majority were women, comprising 84% of the sample. Based on these results, it can be concluded that most patients suffering from chronic rhinosinusitis are women between the ages of 17-25.

Several factors may contribute to the differing prevalence of chronic rhinosinusitis between women and men, as well as across different age groups. These include hormonal differences and variations in patterns of allergen and irritant exposure in different age and gender groups [12]. This is consistent with a study conducted by Rahayu and Koesnoe (2016), which indicated that chronic rhinosinusitis is more common in women and in individuals of productive age. According to the American Academy of Otolaryngology-Head and Neck Surgery Foundation, chronic rhinosinusitis occurs more frequently in women than in men, with a ratio of about 2:1. However, this study involved a relatively small sample (25 patients) and was carried out in a specific population, so its findings may not be generalized to the broader population. Therefore, further research with a larger and more representative sample is needed to understand the prevalence of chronic rhinosinusitis in different age groups [13].

A healthy nasal tract and sinuses typically maintain a balanced pH, while unhealthy conditions can alter this balance and lead to various health problems. In rhinosinusitis, a decrease in pH disrupts the microbial environment in the nasal tract and sinuses [14].

The majority of patients in this study tested negative for proteins. This suggests that the nasal and sinus secretions from these patients contained little or no protein. Factors such as age, gender, and the type of rhinosinusitis the patient experiences can affect the protein content in nasal and sinus secretions.

According to a study conducted by Kim et al. (2016), the protein content in nasal and sinus secretions can vary depending on the type of rhinosinusitis. In acute rhinosinusitis, the protein content in nasal secretions and sinuses tends to be higher than in chronic rhinosinusitis [15].

In this study, the majority of patients tested positive for leukocyte esterase, with most results falling into category (2). This indicates that the level of leukocyte esterase in the patient's secretions is moderate, suggesting the possibility of a bacterial infection in the nasal tract and sinuses [9].

Additionally, the majority of patients tested positive for nitrites. This suggests that the nasal and sinus secretions contain nitrites, which may indicate a bacterial infection in the nasal tract and sinuses. However, the presence of nitrites can also be influenced by other factors, such as diet and the use of certain medications. According to a study by Wachs et al. (2016), nitrites can be detected in the nasal secretions and sinuses of patients with both acute and chronic rhinosinusitis [16].

6 Conclusion

Based on the conclusions of this study, it can be stated that the sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of the dipstick test are still low when compared to CT scans, which are the gold standard for diagnosing chronic rhinosinusitis.

Further research is expected to use a larger sample size so that the data obtained are more variable. Additionally, future studies should be conducted more extensively and in greater depth to assess the use of the dipstick method in diagnosing chronic rhinosinusitis, including evaluating its validity and accuracy in distinguishing different types of infections in the nasal and sinus tracts.

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