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Ph Level Analysis Study on Patient Mortality in Hospitals

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Abstract

Chronic diseases are significant health issues classified by WHO into communicable and non-communicable types. Acid-base balance disorders are suspected to exacerbate disease severity, increase mortality risk, and potentially result in death. This research aimed to investigate the relationship between blood pH levels and mortality among hospitalized patients. A cross-sectional observational analysis was employed using medical record data from patients diagnosed with heart disease (CHF, IHD), diabetes mellitus (DM), stroke (ischemic and hemorrhagic), pulmonary disorders (pneumonia, tuberculosis), kidney function disorders (CKD), and sepsis (septic shock). Arterial blood gas analysis (ABG) data were collected from Jogja Hospital patients during 2022-2023. The research involved 194 subjects, categorized into two groups: deceased and surviving patients. Statistical analysis using a t-test compared the average pH levels between the groups. The findings revealed that the average pH level in the living group was 7.325, whereas the deceased group had a more acidic pH of 7.25, with a statistically significant difference ($p<0.05$). Severe acidosis, often caused by hyperlactatemia, was associated with organ dysfunction and increased mortality risk, particularly among sepsis patients. The research highlights that acidic blood pH, indicative of acidosis, is linked to various etiologies and a poor prognosis. These results underscore the importance of monitoring and managing acid-base balance disorders to improve patient outcomes and reduce mortality.

Keywords: Acidosis, Mortality, Chronic Disease, pH Value.

INTRODUCTION

Chronic diseases such as diabetes, heart disease, stroke, and cancer continue to dominate as the primary causes of morbidity and mortality on a global scale (Hacker, 2024). The World Health Organization (WHO) classifies chronic diseases into two categories: communicable diseases and non-communicable diseases (NCDs) (Kroll et al., 2015). In developing countries, communicable diseases such as tuberculosis remain significant health concerns, while non-communicable diseases—often linked to lifestyle factors—such as hypertension, stroke, heart failure, chronic kidney disease (CKD), and type 2 diabetes mellitus, are on the rise. These conditions not only increase morbidity rates but also lead to significant economic and social burdens worldwide. The rapid urbanization and globalization of unhealthy lifestyles, such as poor dietary habits, physical inactivity, and tobacco use, have further exacerbated the prevalence of NCDs (Hidayati & KM, 2024). Moreover, limited access to healthcare services in developing regions hampers early detection and effective management of these diseases. The interplay of genetic, environmental, and behavioral factors also complicates the prevention and control of chronic diseases, making them a formidable public health challenge (Renz et al., 2011).

Globally, non-communicable diseases are responsible for 63% of all deaths, equating to approximately 36 million fatalities annually. Alarmingly, 80% of these deaths occur in low- and middle-income countries, emphasizing the disproportionate impact of NCDs on vulnerable populations (Www.who.int, 2024). Among these, cardiovascular diseases, cancer, diabetes, and chronic obstructive pulmonary disease account for 61% of the total NCD-related deaths. For instance, in 2020, the Global Health Data Exchange (GHDx) reported 64.34 million cases of congestive heart failure worldwide, with 9.91 million resulting in fatalities. Additionally, the estimated global expenditure for managing heart failure reached an astonishing 346.17 billion US dollars, highlighting the immense economic strain associated with these conditions (Lippi & Sanchis-Gomar, 2020).

Heart disease, in particular, has consistently ranked as the leading cause of death worldwide over the past two decades (Ide, 2013). This persistent trend underscores the urgent need for targeted interventions and improved healthcare strategies to mitigate the impact of cardiovascular diseases. The aging global population has further intensified the prevalence of heart-related conditions, particularly in regions with limited healthcare resources (Osareme et al., 2024). Innovative approaches, such as telemedicine and artificial intelligence, are being explored to address gaps in early diagnosis and management. Additionally, public health campaigns focused on lifestyle modification have shown promise in reducing cardiovascular risk factors. However, disparities in access to healthcare services and preventive measures remain a significant barrier to achieving equitable health outcomes. Collaborative efforts involving governments, healthcare providers, and communities are crucial for effectively addressing the growing burden of heart disease.

Among the various factors influencing patient outcomes, acid-base balance disorders have emerged as critical determinants of disease severity and mortality. These disorders, which arise from disruptions in the body's acid-base homeostasis, can exacerbate underlying pathological processes, pose life-threatening risks, and, in severe cases, lead to death (Phetrittikun et al., 2023). Acid-base balance disorders are generally categorized into two groups based on their origin: respiratory disorders (respiratory acidosis and alkalosis) caused by volatile acids, and metabolic disorders (metabolic acidosis and alkalosis) caused by non-volatile acids. Clinical assessment of these disorders involves measuring specific parameters, including carbon dioxide levels (PaCO2) for respiratory disorders and bicarbonate concentration ([HCO3]), standardized base excess (SBE), and strong ion difference (SID) for metabolic disorders (Castro et al., 2024).

Several studies have explored the association between acid-base imbalances and clinical outcomes. For instance, research by (Thompson & Morgenstern, 2023) highlights that deviations in pH levels can serve as early indicators of disease progression and predict the likelihood of adverse outcomes in hospitalized patients. Similarly, (Phetrittikun et al., 2023) demonstrated that patients with severe acid-base disturbances are at a higher risk of mortality, particularly when these imbalances are left unaddressed. However, despite these findings, gaps remain in our understanding of the precise relationship between pH levels and patient mortality in hospital settings. Addressing these gaps is critical for improving prognostic accuracy and optimizing therapeutic interventions.

The urgency of this research is further underscored by the increasing prevalence of chronic diseases and the rising number of hospital admissions worldwide. As healthcare systems grapple with the dual challenges of managing chronic conditions and addressing acute complications, understanding the role of acid-base balance in patient outcomes becomes paramount. Moreover, the economic and social implications of prolonged hospital stays and high mortality rates necessitate a comprehensive approach to patient care that includes the assessment and management of acid-base disorders.

This research aims to investigate the relationship between pH levels and mortality among hospitalized patients. By focusing on this critical aspect of clinical care, the research seeks to address existing knowledge gaps and provide valuable insights into the prognostic significance of acid-base balance. The novelty of this research lies in its targeted exploration of pH levels as a potential biomarker for predicting patient outcomes, an area that remains underexplored despite its clinical relevance. The findings of this research are expected to have significant implications for both clinical practice and public health. From a clinical perspective, the results could inform the development of standardized protocols for monitoring and managing acid-base disorders, ultimately improving patient outcomes. On a broader scale, the research could contribute to healthcare policy by highlighting the importance of integrating acid-base balance assessments into routine patient care, particularly in resource-limited settings where the burden of chronic diseases is most pronounced.

RESEARCH METHOD

This type of research is a quantitative observational analysis with a cross-sectional research design on the medical record data of patients with a diagnosis of heart disease (CHF, IHD), diabetes mellitus (DM), stroke (ischemic and hemorrhagic), pulmonary disorders (pneumonia, tuberculosis), kidney function disorders (CKD), and sepsis (septic shock), which was examined for arterial blood gas analysis (AGD) at the Jogja Hospital in 2022-2023. This research has received an ethical permit with number 38/KEPK/RSUD/XII/2022. The research subjects were divided into 2 groups, namely the dead and living groups. The inclusion criteria applied to this research were that all inpatient subjects were dead or alive, diagnosed as above, and the pH value of arterial blood was examined. Subjects treated with unknown outcomes are ultimately excluded from the criteria. To find the difference in the average pH value of the two groups, a student T-test was carried out with a meaning of $p<0.05$.

RESULT AND DISCUSSION

This research obtained 194 subjects consisting of 117 males (60.3%) and 77 females (39.7%) and was grouped into 75 living subjects and 119 dead subjects, as seen in the subject characteristics table (Table 1).

Table 1. Subject Characteristics

Variables	Characteristics	n	%
Gender	Male	117	60,3
	Female	77	39,7

Variables	Characteristics	n	%
Condition	Live	75	38,66
	Dead	119	61,34

From the results of the calculation, the average pH value of the living subjects was 7.325, and the dead subjects were 7.252 ($p=0.002$). The student T-test in both groups showed that there was a significant difference in results as seen in table 2.

Table 2. Average pH Value with Subject Conditions

Subjects	Average pH value	n	SD	p
Live	7,325	75	0,142	0,002
Dead	7,252	119	0,18	

The results of this research showed that there was a difference between the pH values of living and dead subjects. The pH value was seen to be lower or acidic in the group of dead subjects than in the living subjects ($p<0.05$). Research conducted by Lee et al (2008) shows that patients with acidosis are more likely to die, especially in severe sepsis and septic shock due to chronic diseases (Lee et al., 2018).

The diagnosis and management of acid-base disorders is a standard aspect of care in critical patients. Metabolic acidosis is often found in hospitals in severe sepsis and septic shock, regardless of renal function and is often associated with a poor prognosis (Noritomi et al., 2019). In a previous research of 60 patients with severe sepsis or septic shock, it was concluded that patients who did not survive showed a complex response to metabolic acidosis while hospitalized. The severity of metabolic acidosis can be used as a predictor of mortality and the length of patient treatment in the hospital (Allyn et al., 2016).

Acidosis, especially metabolic acidosis, is often caused by hyperlactatemia in critical patients (Khosravani et al., 2019). Severe acidosis in sepsis causes hemodynamic instability due to reduced myocardial contractility, arterial vasodilation, and impaired catecholamine response. In severe acidosis (blood pH <7.1), this effect can result in organ dysfunction and lead to increased morbidity and mortality (Noritomi et al., 2019); (Samanta et al., 2018). Regardless of the etiology, metabolic acidosis is associated with increased mortality in patients with chronic disease (Gunnerson et al., 2016).

Early recognition and prompt correction of metabolic acidosis is essential for survival. Treatment of metabolic acidosis is multimodal, which involves the identification and treatment of the underlying cause with appropriate organ resuscitation and supportive measures simultaneously. Although RRT (Renal Replacement Therapy) appears to be exciting, particularly in patients with renal dysfunction, randomized controlled studies are needed to prove the benefits of this strategy in the management of lactic acidosis. Resolution of acidosis in surviving patients is due to a decrease in the gap between strong ions and lactates (Noritomi et al., 2019).

Human cell function will be carried out well in a normal pH environment (pH 7.35 - 7.45) or hydrogen ion (H) levels of about 40 nmol/L, a very small level. Therefore the body regulates it very tightly through a very complex process. To maintain pH (hydrogen ions), the body has three main systems that regulate acid-base balance, namely the buffer system, the lungs, and the kidneys (facilitated by the liver). If this mechanism of homeostasis does not work perfectly, there will be a disturbance of the acid-base balance (Hajjar & Zhou, 2023).

CONCLUSION

The conclusion in this research showed that there was a significant difference between the blood pH values of the deceased and living subject groups, with the average pH value being lower or more acidic in the deceased subject group. Acidotic conditions, especially metabolic acidosis, have been shown to be associated with poor prognosis and high mortality rates in patients with chronic diseases and critical conditions such as sepsis. These findings emphasize the importance of early identification and prompt treatment of acid-base balance disorders to improve patients' chances of survival.

This research contributes to providing a scientific basis for the use of blood pH value as a prognostic biomarker, which can assist medical personnel in clinical decision-making. For future research, studies with larger populations and prospective approaches are recommended to explore biological mechanisms as well as effective interventions in managing acidosis. In addition, technological innovations such as artificial intelligence can be developed to predict acid-base balance disorders as an indicator of mortality risk.

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