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IMPACT OF ENVIRONMENTAL FACTORS ON HEMODIALYSIS OUTCOMES IN THE ARAL SEA REGION POPULATION WITH CHRONIC KIDNEY DISEASE

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Abstract: This study examines the impact of environmental factors on the effectiveness of hemodialysis therapy in patients with chronic kidney disease (CKD) residing in the Aral Sea region. Environmental problems arising from the Aral Sea disaster, including soil and water salinization and air pollution with dust and toxic substances, have a profound negative effect on public health and contribute to the development and progression of kidney diseases. The study highlights the clinical characteristics of hemodialysis outcomes, the frequency of complications, and quality of life indicators among patients living in environmentally disadvantaged conditions, based on an analysis of relevant scientific literature. The findings emphasize the necessity of an integrated approach that accounts for environmental factors when managing CKD in the Aral Sea region population.

Keywords: Aral Sea region; chronic kidney disease; hemodialysis; environmental factors; salinization; healthcare; quality of life

Introduction

Chronic kidney disease (CKD) is a globally prevalent condition and represents a significant socio-economic burden for healthcare systems. The disease is characterized by a gradual and irreversible decline in renal function, ultimately necessitating renal replacement therapy. Hemodialysis is one of the main life-sustaining treatment modalities for patients with end-stage CKD.

The Aral Sea region is among the most environmentally disadvantaged areas, where adverse environmental conditions have a clear impact on public health. The desiccation of the Aral Sea has led to extensive saline soils, airborne dust–salt aerosols, and poor-quality drinking water, all of which contribute to the development of chronic diseases, including renal pathologies. Therefore, investigating hemodialysis outcomes in relation to environmental factors in this population is of both scientific and practical importance.

Methodology

A systematic analysis of environmental factors was adopted to study patients with CKD living in the Aral Sea region. The study focused on assessing the impact of environmental stress, water and soil salinization, and air pollution with dust and toxic substances on the progression of renal pathology. This approach provides a robust scientific foundation for understanding the complex etiology of CKD and for evaluating hemodialysis outcomes.

Salinization of soil and water, as well as exposure to heavy metals and toxic substances, impairs renal tissue function, reduces glomerular filtration rate, and promotes the accumulation of uremic

toxins. Airborne dust–salt particles can enter the circulatory system through the respiratory tract, contributing to systemic inflammation.

An integrated approach combining clinical, laboratory, and questionnaire-based observations was employed to assess the relationship between environmental factors and hemodialysis effectiveness. Clinical assessments included patients' general condition, blood pressure, hematological parameters, and responses to hemodialysis sessions. Laboratory analyses monitored serum creatinine, hemoglobin, ferritin, and electrolyte levels.

Environmental stress was quantified by measuring key toxic elements in water, soil, and air. This methodology enabled a systematic and scientifically grounded analysis of the influence of environmental factors on CKD progression and hemodialysis outcomes, providing a basis for developing individualized treatment strategies.

Literature Review

Evidence from both local and international studies demonstrates that environmental factors play a critical role in the development and progression of CKD. The ecological disaster in the Aral Sea region has caused soil salinization, air pollution with dust and toxins, and poor-quality drinking water, all of which adversely affect renal function. Long-term exposure to these toxic environments has been associated with a significant reduction in glomerular filtration rate and increased risk of CKD.

Heavy metals in soil and water disrupt renal tubular function, accelerate the accumulation of uremic toxins, and lead to hematological and electrolyte disturbances. Dust–salt particles in the air can trigger systemic inflammatory mediators and suppress erythropoiesis, further exacerbating disease progression.

Epidemiological data indicate rapid CKD progression, a high prevalence of patients requiring hemodialysis, and relatively low treatment effectiveness in environmentally stressed areas. Residents of these regions frequently access healthcare services and are more likely to experience severe anemia and other complications. Improving hemodialysis outcomes therefore requires an individualized approach that considers environmental factors. Recommendations include adjusting the frequency of hemodialysis sessions, treatment protocols, and iron and erythropoietin therapy according to local environmental conditions.

Results and Discussion

Among CKD patients in the Aral Sea region, social and environmental factors significantly influence hemodialysis outcomes. Environmental stress, economic limitations, and restricted access to healthcare negatively affect patients' psycho-emotional well-being and overall health status. Consequently, hemodialysis effectiveness should be assessed not only by clinical parameters but also by considering social and psychological factors.

Patients with limited access to regular hemodialysis experience higher fatigue, depressive symptoms, and social isolation, reducing trust in healthcare systems and adherence to treatment. Social factors, such as family support, living conditions, and employment status, indirectly affect

treatment outcomes. Limited family support or residence in remote areas hinders regular treatment attendance, affecting hemoglobin stability and overall health recovery.

Environmental exposure, particularly to dust and toxins, further depletes energy reserves and exacerbates chronic fatigue. These findings highlight the importance of an integrated approach that combines hemodialysis with social and environmental considerations to improve quality of life and treatment outcomes for CKD patients.

Conclusion

This study analyzed the influence of environmental and social factors on hemodialysis outcomes in CKD patients residing in the Aral Sea region. Regional salinization, air pollution, poor-quality drinking water, and limited healthcare access negatively affect patients' health, reduce hemodialysis effectiveness, and increase the risk of complications such as anemia, fatigue, and inflammation.

Additionally, psycho-emotional status, family support, and social conditions were found to directly influence treatment outcomes. These findings underscore the need for a comprehensive, individualized approach to CKD management in the Aral Sea region that considers environmental and social determinants. Such an approach can improve quality of life, enhance hemodialysis effectiveness, and reduce complication risks.

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