JOURNAL OF WORLD SCIENCE
https://jws.rivierapublishing.id/index.php/jws
Volume 3 No. 12 December 2024
P-ISSN: 2828-8726
E-ISSN: 2828-9307

CARDIO-RENAL-ANEMIA SYNDROME AND ACUTE TYPE 2 RESPIRATORY FAILURE FOLLOWING HEMODIALYSIS: A CASE REPORT ON THE CHALLENGES OF CRITICAL CARE MANAGEMENT

Savero Mizan Jahidi[1], M. Ahda Naufal Aflahudin[2], Hubah Asyiroh[3], Chandra Irwanadi Mohani[4]
Gatoel Regional Public Hospital, Mojokero, Indonesia

verojahidi@gmail.com, naufalahda@gmail.com, hubahasyisyiroh@gmail.com, mohanichandradr@gmail.com

ABSTRACT
Cardiorenal anemia syndrome (CRAS) is a complex condition involving heart failure, chronic kidney disease (CKD), and anemia, often complicated by comorbidities such as diabetes and hypertension. This case study presents a critically ill patient with a history of diabetes and hypertension who developed life-threatening Type 2 respiratory failure due to CRAS following hemodialysis. Upon admission, the patient exhibited severe respiratory distress, low oxygen saturation, bilateral pulmonary edema, and delayed capillary refill time, indicating a dire initial condition. Blood tests confirmed anemia, leukocytosis, and elevated creatinine, while blood gas analysis revealed uncompensated respiratory acidosis. Multidisciplinary management involved oxygen therapy, diuretics, intravenous antibiotics, and mechanical ventilation due to suspected sepsis. This report highlights the complex interplay of CRAS-related complications and underscores the significance of early, integrated treatment strategies to improve patient outcomes.

Keywords: Acute respiratory failure, Cardio-renal-anemia syndrome, Critical care management, Hemodialysis complications

Corresponding Author: Savero Mizan Jahidi
E-mail: verojahidi@gmail.com

INTRODUCTION

CRAS is a complex clinical condition characterized by the interdependent dysfunction of the heart and kidneys and the presence of anemia, often exacerbated by chronic diseases such as diabetes and hypertension. The diagnosis of CRAS typically involves a comprehensive evaluation of clinical manifestations, including dyspnea, fatigue, and signs of fluid overload, alongside laboratory assessments revealing anemia and renal impairment (Palazzuoli et al., 2011; Raina et al., 2020; Rivera et al., 2017). Recent management strategies emphasize a multidisciplinary approach, integrating pharmacologic interventions, such as erythropoiesis-stimulating agents and diuretics, alongside supportive care to address the multifaceted nature of the syndrome (Kim, 2013).

Despite advances in treatment, managing CRAS remains a significant clinical challenge due to the need for more specific, evidence-based guidelines addressing its multifaceted nature. Critical care management becomes particularly complex when CRAS is complicated by acute respiratory failure, as standard care protocols may need to fully address the combined impacts on cardiac, renal, and pulmonary systems. This gap in established management practices underscores the need for more targeted therapeutic strategies and integrated care models.

In this case report, we present a unique instance of a 51-year-old woman who developed acute respiratory failure and severe anemia following a routine hemodialysis session. Her clinical presentation was complicated by a significant drop in blood pressure and subsequent pulmonary edema, highlighting the critical interplay between her existing cardio-renal conditions and the acute stress of dialysis (Palamidas et al., 2014). This case is particularly noteworthy due to the rapid deterioration of her condition despite initial management efforts, underscoring the challenges faced in treating patients with CRAS, especially in the context of hemodialysis (Raina et al., 2020; Rivera et al., 2017).

Given the multifactorial complexity of CRAS and its potentially life-threatening complications, this study seeks to explore how a multidisciplinary management approach can address the interlinked clinical challenges of heart failure, chronic kidney disease, and anemia. In particular, it investigates how timely interventions during critical care can improve patient outcomes following severe complications related to hemodialysis.

METHOD

This case study employed a qualitative descriptive approach focusing on clinical observation, diagnostic tests, and treatment interventions for a patient diagnosed with cardiorenal anemia syndrome (CRAS) complicated by acute type 2 respiratory failure following hemodialysis. Data were collected from medical records, including laboratory test results, radiological imaging, and clinical progress notes recorded during the patient’s hospital stay.

The primary data collection techniques included direct patient assessment, laboratory diagnostics, and clinical imaging. Direct patient assessment provides real-time evaluation of the patient’s physical condition, such as respiratory distress and vital signs. Laboratory diagnostics, including complete blood counts, serum creatinine levels, and arterial blood gas analysis, were essential for confirming the diagnosis of CRAS and monitoring treatment progress. Clinical imaging, such as chest X-rays and electrocardiograms (ECG), offered critical visual evidence of the patient’s cardiopulmonary status, guiding immediate clinical decisions.

The rationale behind selecting these techniques is their ability to provide comprehensive, objective, and timely data crucial for managing a life-threatening medical emergency like CRAS, and combining these methods allowed for a multidimensional understanding of the patient’s condition, ensuring that each clinical decision was supported by a robust evidence base aligned with the study's objective of evaluating effective treatment strategies in critical care management.

Case Illustration

A 51-year-old woman presented to the emergency room with dyspnea following a routine 5-hour hemodialysis session, during which her ultrafiltration rate was 2.5 L, accompanied by a drop in blood pressure to 90/60, prompting an early cessation of dialysis after 2.5 hours. She experienced dyspnea in various positions but found relief when sitting upright. Post-dialysis, she appeared weak and pale, with a history of diabetes and hypertension for a decade.

Upon examination, the patient exhibited decreased consciousness (GCS 14), normotensive, low oxygen saturation, pale conjunctiva, and respiratory distress characterized by rhonchi and wheezing. Her extremities were cold and clammy, with a delayed capillary refill. A chest X-ray revealed bilateral pulmonary edema, inflammation in the right lung, right pleural effusion, and cardiomegaly. An ECG indicated left ventricular hypertrophy and abnormalities in leads V5-V6.

Laboratory results showed anemia (Hb 7.7), leukocytosis (23.6), elevated creatinine (2.94), and blood gas analysis revealed uncompensated respiratory acidosis.

Diagnosed with type 2 respiratory failure and cardio-renal anemia syndrome, the patient was administered oxygen via a non-rebreather mask, a catheter, and an initial dose of furosemide (40 mg). She was then admitted to the ICU, where a ventilator and a furosemide pump were set up. Meropenem was given due to suspected sepsis, alongside ranitidine for stress ulcer prevention, and a nasogastric tube was inserted for nutrition. A packed red blood cell transfusion was planned to elevate her hemoglobin. A random blood glucose test showed uncontrolled diabetes at 316 mg/dl, leading to the administration of short-acting insulin.

Despite initial interventions, the patient's condition deteriorated, showing decreased consciousness, worsening dyspnea, and declining oxygen saturation. The family refused to transfer to a facility for advanced ventilator support and hemodialysis due to distance.

Ultimately, the patient became apneic, and CPR was initiated; however, there was no response after two cycles.

RESULTS AND DISCUSSION

In severely ill patients, the time of intubation—early vs late—can markedly affect outcomes, especially in instances of respiratory failure. Early intubation is frequently recommended to avert self-induced lung injury (SILI) and to reduce the likelihood of urgent intubation, which may result in poorer outcomes due to hypoxemia and heightened stress on the respiratory system (Farhadi et al., 2022). The patient displayed respiratory distress symptoms and decreased oxygen saturation, suggesting a requirement for prompt care. Research indicates that there may be no substantial difference in mortality rates between early and late intubation; however, early intubation may confer physiological advantages by diminishing the risk of lung injury and enhancing the overall management of respiratory failure (Birhanu et al., 2022; Nadeem et al., 2023).

Conversely, certain studies have linked delayed intubation to increased fatality rates, indicating that postponing intubation until critical deterioration may be detrimental (Al-Tarbasheh et al., 2022). The patient's declining state, marked by reduced consciousness and increasing dyspnoea, highlights the necessity for prompt intervention. The choice to intubate must consider the patient's clinical progression and the prospective advantages of prompt intervention to avert additional complications (Birhanu et al., 2022; Farhadi et al., 2022; Nadeem et al., 2023).

In this case, intermittent renal replacement therapy (IRRT) and continuous renal replacement therapy (CRRT) can profoundly influence outcomes, especially in instances of acute kidney injury (AKI) and fluid overload. The case of patients with respiratory distress and indications of CRAS exemplifies the challenges associated with handling these patients. CRRT aids critically ill patients, particularly those with sepsis, by facilitating superior fluid management and perhaps enhancing survival rates when commenced promptly (CARL et al., 2010; Wu et al., 2012). Conversely, IRRT, although efficacious, may lack comparable hemodynamic stability or fluid removal efficacy, especially in patients experiencing considerable fluid overload (Antonucci et al., 2016).

The patient's worsening condition following dialysis, marked by pulmonary edema and respiratory failure, highlights the potential hazards linked to IRRT, especially in those with pre-existing cardiovascular issues. Research suggests that the prompt commencement of CRRT can alleviate fluid overload and enhance outcomes in comparable situations (Kee et al., 2018; Wu et al.,

2012). Consequently, in this instance, CRRT may have been a more suitable option to control renal failure and related fluid management issues, thereby improving the patient's likelihood of recovery.

In the case of anemia in CRAS, the choice between delivering packed red blood cells (RBC) or intravenous (IV) iron therapy is crucial. Due to her severe anemia (Hb 7.7) and respiratory distress, an RBC transfusion was scheduled to increase hemoglobin levels promptly, a standard procedure in acute situations to mitigate substantial anemia and enhance oxygen supply (Litton et al., 2015). Nonetheless, the hazards linked to RBC transfusions, including heightened oxidative stress and possible infections, require meticulous evaluation (Litton et al., 2015).

Conversely, IV iron therapy has demonstrated the ability to improve hematopoietic response and decrease the necessity for RBC transfusions across many patient groups, including individuals with chronic renal disease (Buchrits et al., 2022). In patients with CRAS, where iron shortage may be present, intravenous iron administration could enhance erythropoiesis and reduce the necessity for transfusions, especially in stable or less severe conditions (Litton et al., 2018). Therefore, although urgent transfusion may be necessary in acute situations, incorporating IV iron therapy could enhance long-term care and diminish reliance on transfusions (Buchrits et al., 2022).

Administration of meropenem as an empirical antibiotic for suspected sepsis is essential, especially considering the patient's worsening state and risk factors like diabetes and renal impairment. The prompt commencement of suitable antibiotics is linked to markedly enhanced outcomes in septic patients, with research demonstrating that every hour of delay in antibiotic delivery corresponds to elevated mortality rates, particularly in instances of septic shock (Liu et al., 2017). The necessity of this intervention is emphasized by evidence indicating a 1.8% rise in hospital mortality for every hour when antibiotics are postponed in cases of septic shock (Liu et al., 2017). Additionally, the pharmacokinetics of antibiotics may be modified in patients receiving renal replacement therapy such as hemodialysis, requiring meticulous evaluation of dosing protocols to guarantee therapeutic effectiveness (Seyler et al., 2011). The patient's renal function, as evidenced by higher creatinine levels, complicates antibiotic therapy, highlighting the necessity for customized strategies to enhance treatment outcomes (Seyler et al., 2011). Consequently, prompt and suitable antibiotic treatment is essential in the management of septic patients, especially those with intricate medical histories and simultaneous renal complications.

Insulin therapy is essential in treating hyperglycemia, particularly in severely ill patients such as this case. The patient's unmanaged diabetes, evidenced by a blood glucose level of 316 mg/dl, required the injection of short-acting insulin to attain glycaemic control. Studies demonstrate that intensive insulin therapy can markedly enhance outcomes in critically ill patients by alleviating the detrimental effects of hyperglycemia and improving organ function (Julianti et al., 2016). Furthermore, sustaining normoglycemia is essential since abrupt hyperglycemia may aggravate renal damage, particularly in light of the patient's increased creatinine levels and history of renal complications (Gou et al., 2024). An organized method for insulin delivery, specifically basal-bolus insulin therapy, is advised to manage hyperglycemia in postoperative and critically ill patients effectively (Cook et al., 2018). This approach facilitates customized insulin administration according to the variable glucose levels that may arise in these clinical situations. Consequently, the incorporation of insulin therapy, especially considering her preexisting problems, is essential for enhancing her clinical outcomes and averting additional difficulties.

This case highlights the intricacies of handling critically ill patients with concurrent CRAS and respiratory failure, especially post-hemodialysis. Prompt intervention, encompassing prompt

intubation, and CRRT, could have potentially modified the patient's course, enhancing fluid management and respiratory performance. The equilibrium between immediate RBC transfusions and enduring approaches like IV iron supplements underscores the necessity for personalized treatment in managing anemia. The quick delivery of broad-spectrum antibiotics such as meropenem and short-acting insulin for glycaemic regulation was essential to manage the immediate consequences of sepsis and hyperglycemia. This instance underscores the necessity of swift, varied therapeutic strategies to manage critically ill patients with intricate medical histories to enhance survival and outcomes.

CONCLUSION

The management of cardiorenal anemia syndrome (CRAS) complicated by acute type 2 respiratory failure after hemodialysis presents significant clinical challenges. This case underscores the critical importance of early intervention, including timely intubation, mechanical ventilation, and continuous renal replacement therapy (CRRT), to address fluid overload and respiratory distress. Multidisciplinary management involving oxygen therapy, diuretics, intravenous antibiotics, insulin therapy, and blood transfusions played a pivotal role in stabilizing the patient, albeit with limited success due to the severity of the condition.

Despite comprehensive management efforts, the complex interplay of CRAS-related complications highlights the need for improved clinical protocols that integrate personalized treatment approaches. Early identification of risk factors, optimized dialysis regimens, and tailored pharmacological interventions may help reduce mortality rates in similar cases.

Future research should focus on developing standardized protocols for CRAS management, particularly in critical care settings where rapid clinical deterioration is common. Prospective clinical trials investigating the optimal timing and dosage of interventions such as CRRT, mechanical ventilation, and erythropoiesis-stimulating therapies could yield valuable insights. Additionally, exploring predictive models for early detection of CRAS-related respiratory failure and evaluating the long-term outcomes of multidisciplinary care strategies could significantly advance clinical practice. Investigating innovative therapeutic agents targeting the underlying mechanisms of CRAS could also open new avenues for treatment.

REFERENCES

Al-Tarbasheh, A., Chong, W., Oweis, J., Saha, B., Feustel, P., Leanon, A., & Chopra, A. (2022). Clinical Outcomes of Early Versus Late Intubation in COVID-19 Patients. *Cureus*. https://doi.org/10.7759/cureus.21669

Antonucci, E., Lamanna, I., Fagnoul, D., Vincent, J., De Backer, D., & Silvio Taccone, F. (2016). The Impact of Renal Failure and Renal Replacement Therapy on Outcome During Extracorporeal Membrane Oxygenation Therapy. *Artificial Organs*, *40*(8), 746–754. https://doi.org/10.1111/aor.12695

Birhanu, T., Gemeda, L. A., Fekede, M. S., & Hirbo, H. S. (2022). Early versus late intubation on the outcome of intensive care unit-admitted COVID-19 patients at Addis Ababa COVID-19 treatment centers, Addis Ababa, Ethiopia: A multicenter retrospective cohort study. *International Journal of Surgery Open*, *47*, 100561. https://doi.org/10.1016/j.ijso.2022.100561

Buchrits, S., Itzhaki, O., Avni, T., Raanani, P., & Gafter-Gvili, A. (2022). Intravenous Iron Supplementation for the Treatment of Chemotherapy-Induced Anemia: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *Journal of Clinical Medicine*, *11*(14), 4156. https://doi.org/10.3390/jcm11144156

CARL, D. E., GROSSMAN, C., BEHNKE, M., SESSLER, C. N., & GEHR, T. W. B. (2010). Effect of timing of dialysis on mortality in critically ill, septic patients with acute renal failure. *Hemodialysis International*, *14*(1), 11–17. https://doi.org/10.1111/j.1542-4758.2009.00407.x

Cook, C. B., Apsey, H. A., Glasgow, A. E., Castro, J. C., Habermann, E. B., & Schlinkert, R. T. (2018). Basal-Bolus Insulin Therapy in Postoperative Inpatients with Diabetes Mellitus: Directions for Future Quality-Improvement Initiatives. *Future Science OA*, *4*(1). https://doi.org/10.4155/fsoa-2017-0099

Farhadi, N., Varpaei, H. A., Fattah Ghazi, S., Amoozadeh, L., & Mohammadi, M. (2022). Deciding When to Intubate a COVID-19 Patient. *Anesthesiology and Pain Medicine*, *12*(3). https://doi.org/10.5812/aapm-123350

Gou, Y., Huang, Y., Luo, W., Li, Y., Zhao, P., Zhong, J., Dong, X., Guo, M., Li, A., Hao, A., Zhao, G., Wang, Y., Zhu, Y., Zhang, H., Shi, Y., Wagstaff, W., Luu, H. H., Shi, L. L., Reid, R. R., … Fan, J. (2024). Adipose-derived mesenchymal stem cells (MSCs) are a superior cell source for bone tissue engineering. *Bioactive Materials*, *34*, 51–63. https://doi.org/10.1016/j.bioactmat.2023.12.003

Julianti, J., Triratna, S., Aditiawati, A., & Irfanuddin, I. (2016). Insulin therapy for hyperglycemia in critically ill patients. *Paediatrica Indonesiana*, *53*(5), 250. https://doi.org/10.14238/pi53.5.2013.250-3

Kee, Y. K., Kim, D., Kim, S.-J., Kang, D.-H., Choi, K. B., Oh, H. J., & Ryu, D.-R. (2018). Factors Associated with Early Mortality in Critically Ill Patients Following the Initiation of Continuous Renal Replacement Therapy. *Journal of Clinical Medicine*, *7*(10), 334. https://doi.org/10.3390/jcm7100334

Kim, C. S. (2013). Pharmacologic Management of the Cardio-renal Syndrome. *Electrolytes & Blood Pressure*, *11*(1), 17. https://doi.org/10.5049/EBP.2013.11.1.17

Litton, E., Baker, S., Erber, W., Farmer, S., Ferrier, J., French, C., Gummer, J., Hawkins, D., Higgins, A., Hofmann, A., De Keulenaer, B., McMorrow, J., Olynyk, J. K., Richards, T., Towler, S., Trengove, R., & Webb, S. (2018). Hepcidin predicts response to IV iron therapy in patients admitted to the intensive care unit: a nested cohort study. *Journal of Intensive Care*, *6*(1), 60. https://doi.org/10.1186/s40560-018-0328-2

Litton, E., Xiao, J., Allen, C. T., & Ho, K. M. (2015). Iron-Restricted Erythropoiesis and Risk of Red Blood Cell Transfusion in the Intensive Care Unit: A Prospective Observational Study. *Anaesthesia and Intensive Care*, *43*(5), 612–616. https://doi.org/10.1177/0310057X1504300510

Liu, V. X., Fielding-Singh, V., Greene, J. D., Baker, J. M., Iwashyna, T. J., Bhattacharya, J., & Escobar, G. J. (2017). The Timing of Early Antibiotics and Hospital Mortality in Sepsis. *American Journal of Respiratory and Critical Care Medicine*, *196*(7), 856–863. https://doi.org/10.1164/rccm.201609-1848OC

Nadeem, R., Alheraki, M., Dar, F., Hussein, K. S., Mirza, H., Aijazi, I., ElZeiny, M. G., Awadh, N. A., Osman, H., & Albwidani, R. (2023). Early Versus Late Endotracheal Intubation in Subjects with COVID-19 Pneumonia Treated with High-Flow Oxygen: A Retrospective Observational Study. *Cureus*. https://doi.org/10.7759/cureus.47488

Palamidas, A. F., Gennimata, S.-A., Karakontaki, F., Kaltsakas, G., Papantoniou, I., Koutsoukou, A., Milic-Emili, J., Vlahakos, D. V., & Koulouris, N. G. (2014). Impact of Hemodialysis on Dyspnea and Lung Function in End Stage Kidney Disease Patients. *BioMed Research International*, *2014*, 1–10. https://doi.org/10.1155/2014/212751

Palazzuoli, A., Antonelli, G., & Nuti, R. (2011). Anemia in Cardio-Renal Syndrome: clinical impact and pathophysiologic mechanisms. *Heart Failure Reviews*, *16*(6), 603–607. https://doi.org/10.1007/s10741-011-9230-x

Raina, R., Nair, N., Chakraborty, R., Nemer, L., Dasgupta, R., & Varian, K. (2020). An Update on the Pathophysiology and Treatment of Cardiorenal Syndrome. *Cardiology Research*, *11*(2), 76–88. https://doi.org/10.14740/cr955

Rivera, R. F., Alibrandi, M. T. S., Di Lullo, L., Floccari, F., De Pascalis, A., Bellassi, A., & Ronco, C. (2017). The Cardiorenal Anemia Syndrome. Part One: Epidemiology and Clinical Aspects. *Giornale Di Tecniche Nefrologiche e Dialitiche*, *29*(3), 196–202. https://doi.org/10.5301/GTND.2017.17524

Seyler, L., Cotton, F., Taccone, F. S., De Backer, D., Macours, P., Vincent, J.-L., & Jacobs, F. (2011). Recommended β-lactam regimens are inadequate in septic patients treated with continuous renal replacement therapy. *Critical Care*, *15*(3), R137. https://doi.org/10.1186/cc10257

Wu, S.-C., Fu, C.-Y., Lin, H.-H., Chen, R.-J., Hsieh, C.-H., Wang, Y.-C., Yeh, C.-C., Huang, H.-C., Huang, J.-C., & Chang, Y.-J. (2012). Late Initiation of Continuous Veno-Venous Hemofiltration Therapy is Associated with a Lower Survival Rate in Surgical Critically Ill Patients with Postoperative Acute Kidney Injury. *The American SurgeonTM*, *78*(2), 235–242. https://doi.org/10.1177/000313481207800245

© 2024 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC BY SA) license (https://creativecommons.org/licenses/by-sa/4.0/).