Volume 3, Issue 3, 2025

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

RHABDOMYOLYSIS-INDUCED ACUTE KIDNEY INJURY (AKI) WITH AMPHETAMINE INTOXICATION. A CASE STUDY

Saeed Ahmad[*1], Dr. Salma Rattani[2], Khan Zeb[3]

[*1]*Assistant Professor, Institute of Nursing Science, Sarhad University of Science and Information Technology, Peshawar.*
[2]*PhD, BScN, Rm, RN, Associate Professor, Aga Khan University School of Nursing & Midwifery Pakistan.*
[3]*Assistant Professor, Institute of Nursing Science, Sarhad University of Science and Information Technology, Peshawar.*

[*1]saeednorize@gmail.com, [2]salma.rattani@aku.edu.pk , [3]khanzeb.ins@suit.edu.pk

DOI: https://doi.org/10.5281/zenodo.15412026

Keywords
Amphetamine intoxication, rhabdomyolysis, acute kidney injury, fluid resuscitation

Article History
Received on 06 April 2025
Accepted on 06 May 2025
Published on 14 May 2025

Corresponding Author: *
Saeed Ahmad
Assistant Professor, Institute of Nursing Science, Sarhad University of Science and Information Technology, Peshawar.

Abstract

Background: *Amphetamine intoxication is associated with severe complications, including rhabdomyolysis, a condition characterized by the breakdown of skeletal muscle, which can lead to acute kidney injury (AKI). Early recognition and management are critical to preventing severe outcomes.*

Objective: *To enhance healthcare professionals' understanding of the pathophysiology, clinical presentation, diagnostic process, and management of amphetamine-induced rhabdomyolysis and AKI.*

Materials and Method: *A case study providing patient history, clinical presentation, investigations, and management, added by a review of relevant literature.*

Conclusion: *Amphetamine-induced rhabdomyolysis and AKI require prompt recognition and management. Early intervention with aggressive fluid resuscitation can prevent complications, as demonstrated in this case. By understanding the clinical signs and underlying mechanisms of amphetamine-induced rhabdomyolysis, healthcare providers can improve diagnostic accuracy and implement timely interventions, reducing morbidity and preventing life-threatening complications.*

INTRODUCTION

Amphetamine is a highly addictive sympathomimetic drug that enhances the release and inhibits the reuptake of catecholamine (Schep et al., 2010). Amphetamine misuse is on the rise globally (Richards et al., 2017) and is now recognized as the second most commonly abused drug worldwide (Baradhi et al., 2019). Specific data on amphetamine addiction in Pakistan is unavailable; however, the most recent comprehensive report on drug use in the country, published by the United Nations Office on Drugs and Crime (UNODC) in 2013, revealed that approximately 6% of Pakistan's population—nearly 7 million people—were addicted to drugs. The highest rate of drug use was reported in Khyber Pakhtunkhwa, where up to 11% of the population consumed illicit substances (UNODC, 2013).

Amphetamine sympathomimetic action leads to physiological effects such as tachycardia, hypertension, vasospasm, and an increased risk of myocardial infarction (Kevil et al., 2019). Additionally, it directly affects myocytes, triggering seizures and hyperthermia through dopamine receptor stimulation. These combined mechanisms contribute to the development of rhabdomyolysis (Kevil et al., 2019).

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Rhabdomyolysis is a condition marked by extensive damage to skeletal muscles, resulting in muscle cell breakdown. It leads to elevated levels of creatine kinase, disruptions in electrolyte balance, acute kidney failure, and disseminated intravascular coagulation. Common triggers include physical trauma to muscles, deficiencies in muscle enzymes, electrolyte disturbances, infections, drug use, and exposure to toxins (Huerta-Alardín et al., 2004). It is a common complication linked to amphetamine toxicity in humans, with a prevalence of up to 42% in cases (Coco & Klasner, 2004; O'Connor et al., 2015; Williams & Thorpe, 2014). Following earlier studies, acute kidney injury (AKI) affects 10 to 50 percent of patients with rhabdomyolysis. AKI associated with rhabdomyolysis has a multifaceted etiology. Contributing factors include the direct toxic effects of myoglobin on renal tubules, vasoconstriction, the formation of intra-tubular casts, and renal ischemia resulting from reduced blood volume (Ahmad et al., 2021).

This report outlines a case of amphetamine-associated rhabdomyolysis in a young patient, accompanied by the onset of acute kidney injury, managed effectively only through supportive therapies.

Case Report:

A 24-year-old male, a known drug addict, came to the emergency department with complaints of flu-like symptoms, fever, and ants crawling on his body. His systemic examination was unremarkable. In the ER he also developed an episode of generalized tonic-clonic seizures for which he was given anti-epileptics and after that intubated. His urine toxicology was positive for amphetamine overdose. He was extubated in the ER when he remained in a stable condition. Post extubation he was admitted to a ward with fever and flu-like symptoms.

History:

According to the patient's mother, on the day of admission, he was found in an obtunded state, unresponsive, with insects crawling on his body and ants in his nostrils. He was immediately brought to AKU (Aga Khan University Hospital). The patient has a well-documented history of drug addiction, specifically to amphetamines. He also complained of flu-like symptoms and cough with hemoptysis. He has no other known co-morbidities.

His substance abuse began at the age of 14, and his family became aware of the issue when he was around 17. He primarily used "ice" (a street name for amphetamine), often consuming it at night while at home. His addiction persisted despite the family's attempts to address his addiction through repeated rehabilitation center admissions, with stays averaging six months since 2019. The patient's family history was not significant for any disease. The patient did not have any allergies to drugs or food.

Treatment:

The patient was treated as having acute kidney injury due to deranged RFTs, rhabdomyolysis, and chest infection. The patient was rehydrated with IV Ringer's lactate, Tabs Paracetamol, Folic acid, Neurobion, fexofenadine HCL, Iron with minerals and vitamins, and IV Tranexamic acid, Pipraciline/Tazobactum, and Ipratropium bromide nebulization.

Physical examination:

The patient had a heart rate of 112 beats/minute, Blood pressure of 107/60 mmHg, flu-like symptoms, depressed breathing, SPO2 of 70% on room air, and temperature of 39.7°C, GCS 3/15, and pupils 2mm bilaterally fixed. The abdomen was soft and non-tender. The cardiovascular assessment was normal (S1+S2+0). No edema was seen.

Investigations:

Table 1: Labs trend of the patient till discharge

Labs	Units	Day 1 (result)	Day 2	Day 3	Day 4	Day 6	Reference values
GLUCOSE	mg/dl	78	102	87	102	90	65-100
HB	mg/dl	10.4	-	9.8	9.5	10.3	12.3-16.6
WBC	x10E9/L	12	-	12.1	7	5.6	4.8-11.3
PLATELET	x10E9/L	302	-	212	229	309	154-433
FERRITIN	ng/ml	-	-	106	94.4	-	20-250

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

TIBC	mcg/dl	-	-	-	220	-	250-400
AST	IU/L	40	-	-	-	-	<35
ALT	IU/L	31	-	-	-	-	<45
ALP	U/L	132	-	-	-	-	40-129
CK	U/L	-	2452	1322	474	-	46-171
CRP	mg/L	-	94.50	-	-	136	0-10
T BIL	mg/dl	0.2	-	-	-	-	0.1-1.2
GGT	IU/L	20	-	-	-	-	<55
BUN	mg/dl	15	-	7	6	-	5-18
CR	mg/dl	2	1.5	1.3	1.0	1.0	0.9-1.3
eGFR	ml/min/1.73 m^2	38.72	55.97	>60	>60	>60	>60
Ca	mg/dl	7.7	-	7.9	8.7	-	8.6-10.2
Mg	mg/dl	2.4	-	1.4	-	-	1.6-2.6
Na	mmol/L	136	135	137	136	135	136-145
K	mmol/L	4.3	3.6	4.2	4.7	4.8	3.5-5.1
Cl	mmol/L	102	105	114	104	99	98-107
BICARB	mmol/L	16.7	23	24.5	24.6	24.5	22-29
PROCALC	ng/ml	0.06	-	-	-	-	
PH		7.52	7.43	-	-	-	7.35-7.45

URINE DETAIL REPORT		
SP GRAV		1.015
PH		6
PROTEIN	g/L	0.25 (1+)
GLUCOSE	mmol/L	17 (3+)
KETONE		1.5 (2+)
BLOOD	-/mcL	50 (3+)
RBCs	/HPF	03
LEU	/HPF	04
CRYSTALS	/HPF	+1
MUCOUS		+VE

TIBC: Total iron binding capacity; GGT: Gamma-Glutamyl Transferase; CK: creatine kinase; TBIL: total bilirubin; CR: creatinine; CA: calcium; NA: sodium; K: potassium; and CL: chloride; eGFR: Estimated glomerular filtration rate; PRO CALC: procalcitonin, Mg: Magnesium.

Discussion

This case report highlights the development of rhabdomyolysis due to amphetamine toxicity in a 24-year-old male. While rhabdomyolysis as a complication of amphetamine use is well-documented in the literature, the presentation in this patient emphasizes the early detection and multifaceted nature of the condition. Amphetamine toxicity was confirmed through a positive urine toxicology screen for amphetamines, alongside clinical and laboratory findings consistent with published reports of amphetamine-related complications. Studies have reported that rhabdomyolysis can occur in up to 42% of amphetamine users with toxicity, highlighting the need for early detection and management to prevent severe outcomes such as acute kidney injury (AKI) (Keltz et al., 2013)

According to a study conducted in the USA, nearly 20% of methamphetamine users were found to have rhabdomyolysis. Intervention was only necessary for a small number (2.4%) of individuals with

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

rhabdomyolysis. (Richards et al., 2020). However, delays in diagnosing and treating rhabdomyolysis are closely linked to irreversible damage to the kidneys, which could result in further complications and mortality. Rhabdomyolysis presents as a clinical syndrome with skeletal muscle breakdown and release of muscle cell content such as creatine kinase (CK) and myoglobin. (Stanley et al., 2017). The elevated CK level is the most sensitive lab finding for detecting rhabdomyolysis (Huerta-Alardín et al., 2004), and clinically, the classic presentation of rhabdomyolysis includes a triad of symptoms, which include muscle pain, weakness, and dark urine. However, most individuals diagnosed with rhabdomyolysis did not exhibit all three of these particular symptoms. (Stanley et al., 2017).

Diagnosing rhabdomyolysis is more challenging due to the variety of causes that can lead to its manifestation. Hence, gathering a detailed medical history to diagnose promptly and provide appropriate treatment before complications develop is important. An elevated CK level is a crucial indicator of acute rhabdomyolysis due to muscle injury. Rhabdomyolysis is diagnosed if there is a five-fold increase in CK levels from its upper normal limit (Stanley et al., 2017). Rhabdomyolysis in this patient likely resulted from repetitive muscular activity during seizures and direct myocyte toxicity caused by catecholamine surge. However, despite the absence of dark-colored urine, elevated CK levels (2452) exceeding fourteen times the upper limit of normal level (46-171 U/L) was a hallmark of the condition. Around half of patients with rhabdomyolysis are believed to have dark-colored urine while experiencing the acute event (Stanley et al., 2017). Myoglobinuria (+1), as evidenced by the urine detailed report findings under microscopy, further validated the diagnosis. However, most cases of myoglobinuria may go undetected because it is rapidly metabolized and has a shorter half-life, with only a 25% sensitivity in diagnosing rhabdomyolysis (Stanley et al., 2017).

Amphetamine toxicity is often linked to hyperthermia, and it can lead to heat-induced damage to muscle cells. This process is not expected to happen in our case because the temperature recorded in this patient (39.7° C) is lower than the temperature (42° C) known to cause heat-related muscle damage. (Keltz et al., 2013).

Furthermore, Akmal et al. (1986) discovered that individuals with rhabdomyolysis and acute renal failure experience low calcium levels in the oliguric phase of ARF, and more than 30% exhibit high calcium levels during the diuretic phase. In addition, it was discovered in this study that every patient exhibited low levels of calcium when admitted, with a greater degree of hypocalcemia seen in individuals with rhabdomyolysis and ARF. In the same way, as in our situation, hypocalcemia was noticed at the beginning but did not become severe. These derangements were effectively managed with early intravenous fluid therapy and IV calcium gluconate, which likely prevented its progression to a more severe condition. Other electrolyte imbalances and deranged LFTs as complications of rhabdomyolysis, were notably not prominent in this case. Imaging, including a chest X-ray and CT head, was unremarkable.

In our patient, AKI was evident at admission, as indicated by elevated creatinine (2mg/dl) and reduced eGFR (38.72). The multifactorial etiology of AKI in rhabdomyolysis includes direct tubular toxicity from myoglobin, intra-tubular cast formation, renal ischemia, and oxidative stress (Keltz et al., 2013; Torres et al., 2015).Rhabdomyolysis results in the release of myoglobin into the bloodstream, which is subsequently filtered by the glomeruli and transported into the renal tubules (Bosch et al., 2009). So the presence of myoglobinuria adds credence to the involvement of myoglobin-mediated nephrotoxicity in this patient's AKI.

Most rhabdomyolysis cases do not require treatment. However, close monitoring of this condition is essential as it can be deadly if left unchecked. About 15% of individuals with rhabdomyolysis experience acute kidney failure, which is the most severe late complication associated with the condition. (Stanley et al., 2017). The primary focus of treatments is mostly supportive to avoid acute renal failure and complications. Prompt initiation of substantial fluid administration is crucial to prevent hypovolemia-induced acute renal failure caused by the movement of extracellular fluid into damaged muscle cells. It is believed that as much as 12% of fluid could be lost through this process. (Odeh, 1991).

Guidelines recommend maintaining a urine output of 200-300 mL/hour and monitoring CK levels to

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

ensure a downward trend, with cessation of aggressive hydration once levels fall below 1000 U/L (Sauret et al., 2002). Initially administer crystalloids; preferably normal saline at the rate of 1 liter per hour over 2 hours to rapidly correct volume depletion. Then reduce the rate to 500 mL per hour for ongoing hydration and prevention of myoglobin precipitation, adjusted based on clinical response, urine output, and electrolyte levels. This regimen is appropriate for adults with normal cardiac and renal function, ensuring adequate hydration without fluid overload. Regular monitoring of serum potassium, renal function, and urine output is crucial to guide therapy adjustments (Stanley et al., 2017).

Early fluid resuscitation played a key role in mitigating the effects of rhabdomyolysis, as evidenced by the rapid normalization of renal function parameters (Table 1) during the patient's hospital course. In this patient supportive measures, including aggressive hydration with intravenous crystalloids (Ringer Lactate) and symptomatic treatment for seizures and respiratory symptoms, were the main focus of management. The patient did not need forced diuresis, urine alkalinization, or renal replacement therapy, which indicates the success of the initial interventions. Beginning rehydration promptly aided in stabilizing renal function, lowering CK levels, and averting additional complications.

Historically, urine alkalinization with sodium bicarbonate was considered beneficial for reducing renal tubular obstruction. However, recent evidence has shown its limited efficacy in preventing AKI. Similarly, the administration of pharmacologic agents beyond crystalloid fluids has not demonstrated significant benefits in preventing AKI (Burgess, 2022). In addition to this, in cases where fluid resuscitation is contraindicated or ineffective, kidney replacement therapy (KRT) can play a vital role. Hemodiafiltration (HDF), with its high permeability, is particularly effective in clearing myoglobin due to its large molecular size (Burgess, 2022). While our patient demonstrated improvement with hydration alone, this modality remains crucial for patients with severe rhabdomyolysis and refractory AKI.

Conclusion

In conclusion, this case report underscores the importance of recognizing rhabdomyolysis as a severe complication of amphetamine toxicity. Healthcare professionals must maintain a high index of suspicion for rhabdomyolysis in patients presenting with suspected drug intoxication or overdose. Early diagnosis and prompt intervention with aggressive fluid therapy were pivotal in preventing the progression of AKI and ensuring a favorable outcome. This case emphasizes the need for vigilance in managing patients with amphetamine intoxication to avoid life-threatening complications. Timely management can prevent progression to AKI and ensure optimal recovery, as observed in this patient. Further studies are needed to explore the long-term outcomes of amphetamine-induced rhabdomyolysis and to optimize management strategies.

REFERENCES

Ahmad, S., Anees, M., Elahi, I., & Fazal, E. (2021). Rhabdomyolysis leading to acute kidney injury. *J. Coll. Physicians Surg. Pak*, *31*(2), 235-237.

Akmal, M., Bishop, J. E., Telfer, N., Norman, A. W., & Massry, S. G. (1986). Hypocalcemia and hypercalcemia in patients with rhabdomyolysis with and without acute renal failure. *J Clin Endocrinol Metab*, *63*(1), 137-142. https://doi.org/10.1210/jcem-63-1-137

Baradhi, K. M., Pathireddy, S., Bose, S., & Aeddula, N. R. (2019). Methamphetamine (N-methylamphetamine)-induced renal disease: underevaluated cause of end-stage renal disease (ESRD). *BMJ Case Reports CP*, *12*(9), e230288.

Bosch, X., Poch, E., & Grau, J. M. (2009). Rhabdomyolysis and acute kidney injury. *N Engl J Med*, *361*(1), 62-72. https://doi.org/10.1056/NEJMra0801327

Burgess, S. (2022). Rhabdomyolysis: An evidence-based approach. *J Intensive Care Soc*, *23*(4), 513-517. https://doi.org/10.1177/17511437211050782

Coco, T. J., & Klasner, A. E. (2004). Drug-induced rhabdomyolysis. *Current opinion in pediatrics*, *16*(2), 206-210.

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Huerta-Alardín, A. L., Varon, J., & Marik, P. E. (2004). Bench-to-bedside review: Rhabdomyolysis–an overview for clinicians. *Critical Care*, *9*, 1-12.

Keltz, E., Khan, F. Y., & Mann, G. (2013). Rhabdomyolysis. The role of diagnostic and prognostic factors. *Muscles Ligaments Tendons J*, *3*(4), 303-312.

Kevil, C. G., Goeders, N. E., Woolard, M. D., Bhuiyan, M. S., Dominic, P., Kolluru, G. K., Arnold, C. L., Traylor, J. G., & Orr, A. W. (2019). Methamphetamine use and cardiovascular disease: in search of answers. *Arteriosclerosis, thrombosis, and vascular biology*, *39*(9), 1739-1746.

O'Connor, A. D., Padilla-Jones, A., Gerkin, R. D., & Levine, M. (2015). Prevalence of Rhabdomyolysis in Sympathomimetic Toxicity: a Comparison of Stimulants. *J Med Toxicol*, *11*(2), 195-200. https://doi.org/10.1007/s13181-014-0451-y

Odeh, M. (1991). The role of reperfusion-induced injury in the pathogenesis of the crush syndrome. *N Engl J Med*, *324*(20), 1417-1422. https://doi.org/10.1056/nejm199105163242007

Richards, J. R., Hamidi, S., Grant, C. D., Wang, C. G., Tabish, N., Turnipseed, S. D., & Derlet, R. W. (2017). Research Article Methamphetamine Use and Emergency Department Utilization: 20 Years Later.

Richards, J. R., Wang, C. G., Fontenette, R. W., Stuart, R. P., McMahon, K. F., & Turnipseed, S. D. (2020). Rhabdomyolysis, Methamphetamine, Amphetamine and MDMA Use: Associated Factors and Risks. *J Dual Diagn*, *16*(4), 429-437. https://doi.org/10.1080/15504263.2020.1786617

Sauret, J. M., Marinides, G., & Wang, G. K. (2002). Rhabdomyolysis. *Am Fam Physician*, *65*(5), 907-912.

Schep, L. J., Slaughter, R. J., & Beasley, D. M. G. (2010). The clinical toxicology of metamfetamine. *Clinical Toxicology*, *48*(7), 675-694.

Stanley, M., Chippa, V., Aeddula, N. R., Rodriguez, Q., & Adigun, R. (2017). Rhabdomyolysis.

Torres, P. A., Helmstetter, J. A., Kaye, A. M., & Kaye, A. D. (2015). Rhabdomyolysis: pathogenesis, diagnosis, and treatment. *Ochsner J*, *15*(1), 58-69.

UNODC. (2013). *Drug use in Pakistan 2013*. Retrieved from https://www.unodc.org/documents/data-and-analysis/statistics/Drugs/Drug%20use/Drug_use_in_Pakistan_2013.pdf

Williams, J., & Thorpe, C. (2014). Rhabdomyolysis. *Continuing Education in Anaesthesia, Critical Care & Pain*, *14*(4), 163-166.