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Pediatric Rhabdomyolysis: Management Considerations and Treatment Algorithm-Case Study

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ABSTRACT

Rhabdomyolysis in pediatric patients presents unique challenges due to its varied etiology, clinical presentation, and management strategies. We present a case of an 8-year-old male with viral-induced rhabdomyolysis, characterized by severe myalgia, weakness, and dark urine. Laboratory investigations revealed markedly elevated creatine kinase levels and myoglobinuria, confirming the diagnosis. The patient was managed with aggressive fluid resuscitation, electrolyte monitoring, and supportive care, leading to a gradual resolution of symptoms and normalization of laboratory parameters. Our discussion section provides an algorithm for the management of rhabdomyolysis. While future research should focus on comparative studies to delineate optimal fluid maintenance strategies in pediatric rhabdomyolysis, enhancing evidence-based management protocols.

Keywords: Rhabdomyolysis, Myoglobinuria, Creatinine kinase, Acute kidney injury

INTRODUCTION

Rhabdomyolysis is releasing skeletal muscle contents into the circulation when there is insult to it. These contents are responsible for the clinical presentation that the patient presents with. References to rhabdomyolysis can be traced back to biblical times. However, it wasn't until the London bombings in World War II that the connection between rhabdomyolysis and acute kidney injury (AKI) was identified in victims of crush injuries [1]. This was followed by lot of other reports from other wars, one of them published in 1955, reported a mortality rate of approximately 80% to 90% was found in casualties with post-traumatic renal insufficiency in World War II and in the Korean war [2]. Until that time, only crush injuries was the reported as a cause of rhabdomyolysis, later it was found that nonphysical injuries can also result in rhabdomyolysis.

Despite the significant increase in incidence and the high mortality associated with rhabdomyolysis, there remains a lack of established guidelines for its management in both adult and pediatric populations. In this article, we present a pediatric case of viral-induced rhabdomyolysis and outline the algorithm we employed for its management. Our findings highlight the need for a comprehensive systemic approach to diagnosing rhabdomyolysis and determining the optimal timing for diagnostic tests. Additionally, we discussed fluid management strategies, emphasizing the importance of tailoring fluid types and rates to the individual patient.

CASE PRESENTATION SECTION

Patient Presentation

The patient presented with tactile fever, dry cough, vomiting (including one episode of blood-tinged vomit), and non-bloody, non-bilious loose stools with poor feeding. Symptoms progressed to bilateral knee pain, difficulty walking, and proximal upper limb weakness. Initially treated with antibiotics and antihistamine at a private clinic, with no improvement. Tested positive for influenza A upon arrival at our hospital's emergency department.

Physical Examination

The patient appears lethargic but alert, with normal growth parameters **(Table 1)**. Capillary refill time is less than 2

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seconds, with sunken eyes and normal conjunctiva. Warm, dry, pink skin without rashes. Normocephalic with mildly erythematous tympanic membranes and moist oral mucosa. No scleral icterus or lymphadenopathy. Lung and cardiac examinations are normal. Abdomen is soft, mildly tender, without distention or organomegaly. Severe pain on limb movement with 2/5 power in lower limbs and 3/5 in upper limbs. Brisk deep tendon reflexes and impaired gait due to pain.

Table 1. Growth Parameter.

Parameter	Value	Percentile
Weight	31 kg	74th percentile
Length	151 cm	99th percentile

Investigation

PCR done at the day of admission showed a positive result for influenza A (done in private and repeated in our emergency department). Negative other viral panel including negative influenza B, negative Epstein-Barr Virus (EBV) and negative COVID19.

Complete blood count (CBC) done on the admission day was normal except for low White Blood Cells (WBC) 4.33 x10(3)/mcL (normal 5.00-13.00). Blood Culture was done and revealed no growth. Blood gases showed respiratory alkalosis with pH 7.556 (normal 7.35-7.45), PCO2 was 22.4 (normal 35-45) and HCO3 19.4 [normal 22-26]. C-reactive protein (CRP) was 1.20 mg/L which goes more with the picture of viral infection.

Renal function tests (RFT) revealed normal kidney function with the following readings: Sodium Level: measured at 138 mmol/L, which is normal compared to the reference range of 136-145 mmol/L. Potassium Level: Recorded as 4.5 mmol/L, within the normal range of 3.50-5.10 mmol/L. Chloride Level: Noted at 100 mmol/L, falling within the reference range of 98.0-107.0 mmol/L. Creatinine: Present at 32.3 umol/L, within the normal range of 27.00-62.00 umol/L. Uric Acid: Measured at 127.40 umol/L, which is low compared to the reference range of 208.00-428.00 umol/L. Glucose Random: Recorded as 6.8 mmol/L, within the normal range of 3.9-11.1 mmol/L. Urea Level: Noted at 3.33 mmol/L, falling within the reference range of 2.50-6.40 mmol/L.

Total serum Creatinine Kinase (CK) was 23,449 IU/L (normal 39-308 IU/L) which is morbidly high.

Urine dipstick showed brown sample with normal urobilinogen and +3 blood, +1 protein. Urine analysis showed dark yellow clear urine with +2 ketones and +3 protein to be the only abnormality in the analysis. No WBC, Red Blood Cell (RBC) or hemoglobin in the urine sample has been found. Urinary tract infection has been ruled out by having negative leukocyte esterase and negative nitrite test. Furthermore, urine culture showed no growth.

A provisional diagnosis of viral induced rhabdomyolysis was made, and the patient was admitted for management and further investigation.

Progress Through Admission

Progress throughout admission and the management plan for the patient is shown in **Table 2**. While CK can be tracked in **Figure 1** that shows the level of creatinine kinase of the patient throughout the management journey. clear improvement of the creatinine kinase level was after the first day of admission and that goes back to the shift of the fluid from 1.5 maintenance to double maintenance.

DISCUSSION

A treatment algorithm for pediatric patients with rhabdomyolysis has been developed based on reported cases and supporting evidence for the management of this condition. While it is not an officially verified algorithm, it is a proposal that we have utilized in our facility to manage this complex condition. The algorithm is depicted in **Figure 2**.

Prior to initiating management, it is crucial to identify emergent situations that necessitate admission to the Intensive Care Unit (ICU). These include severe electrolyte disturbances, the presence of arrhythmias, or acute kidney injury requiring dialysis. In the absence of these red flags, the patient should be admitted to the ward for fluid management and monitoring [3,4].

Beginning with the choice of fluid, there is no empirical evidence favoring the use of Ringer's Lactate over Normal Saline (NS). Based on case reports, the majority of patients were treated with Normal Saline. The addition of Sodium Bicarbonate is only indicated in the presence of acidosis. There is no comprehensive literature review that either supports or contradicts the use of mannitol in the treatment of pediatric rhabdomyolysis [3,4].

Table 2. Progress of admission and the management plan for the patient.

Day	Clinical Assessment	Laboratory Tests	Management Plan
0	• Admission for viral induced rhabdomyolysis	• PCR: Influenza A positive. Negative for other viruses. CBC: WBC low. • Blood gases: Respiratory alkalosis • Normal RFT. • High CK 23, 449IU/L. • Urinalysis: Proteinuria, hematuria.	• Start him on 1.5 fluid maintenance of Dextrose 5% + Normal saline with encourage oral intake • Start acetaminophen 465 mg q6h • Oseltamivir 60 mg BID • Avoid non-steroidal anti-inflammatory drugs (NSAIDs) or any nephrotoxic agents • RFT, CK to be sent daily
1	• Afebrile, stable vitals • Muscle pain persists • Complained of abdominal pain • Urinary output over 24 h: 4 ml/kg/h	• Blood gases normalizing • Renal function stable • CK raising to 23,767.00 IU/L • A repeated CK in the evening showed further increase to 29,384.00 IU/L • Electrocardiogram was normal • Ultrasound for the abdomen to rule out complications and as the patient complained of abdominal discomfort, the study was unremarkable	• Change the fluid maintenance to double maintenance • Encourage oral in take with vital monitoring • RFT and CK to be repeated tomorrow
2	• Muscle weakness improving • Urinary output maintained as 4ml/kg/h	• Renal function normal • CK dropping to 14,855IU/l	• Continue double maintenance • Send for Amylase, Lipase, and liver function tests (LFT) with next prick • RFT and CK to be repeated after two days
3	• Muscle pain subsiding, walking with support • Urinary output was maintained as 3.5 ml/kg/h	• Total protein falls within the normal range • Albumin levels are low • Additionally, the bilirubin total and alkaline phosphatase are within normal limits as well as the lipase levels • Both ALT (alanine aminotransferase) 418.00 U/L (exceeding the normal range of 7.00-55.00 U/L) and AST (aspartate aminotransferase) elevated at 940 U/L (significantly surpassing the normal range of 15-37 U/L)	• Stop oseltamivir and repeat the LFT afterward • Continue the same management plan for the fluid therapy • Repeat CK with RFT tomorrow
4	• Significant improvement, he can walk and move normally	• CK was 2,531.00 IU/L • Electrolytes and RFT were normal • Repeated LFT showed improvement in the ALT (322.30) and significant decrease in the AST (446) • CBC with bleeding profile revealed normal results and disseminated intravascular coagulopathy can be ruled out	• Discharge him • Follow-up after 3 days to check normalization of the CK
Follow-up	• Patient is well, no complaints	• The CK was 284 IU/L which is within the normal range	• No further genetic test is required as his rhabdomyolysis attack was provoked with known case

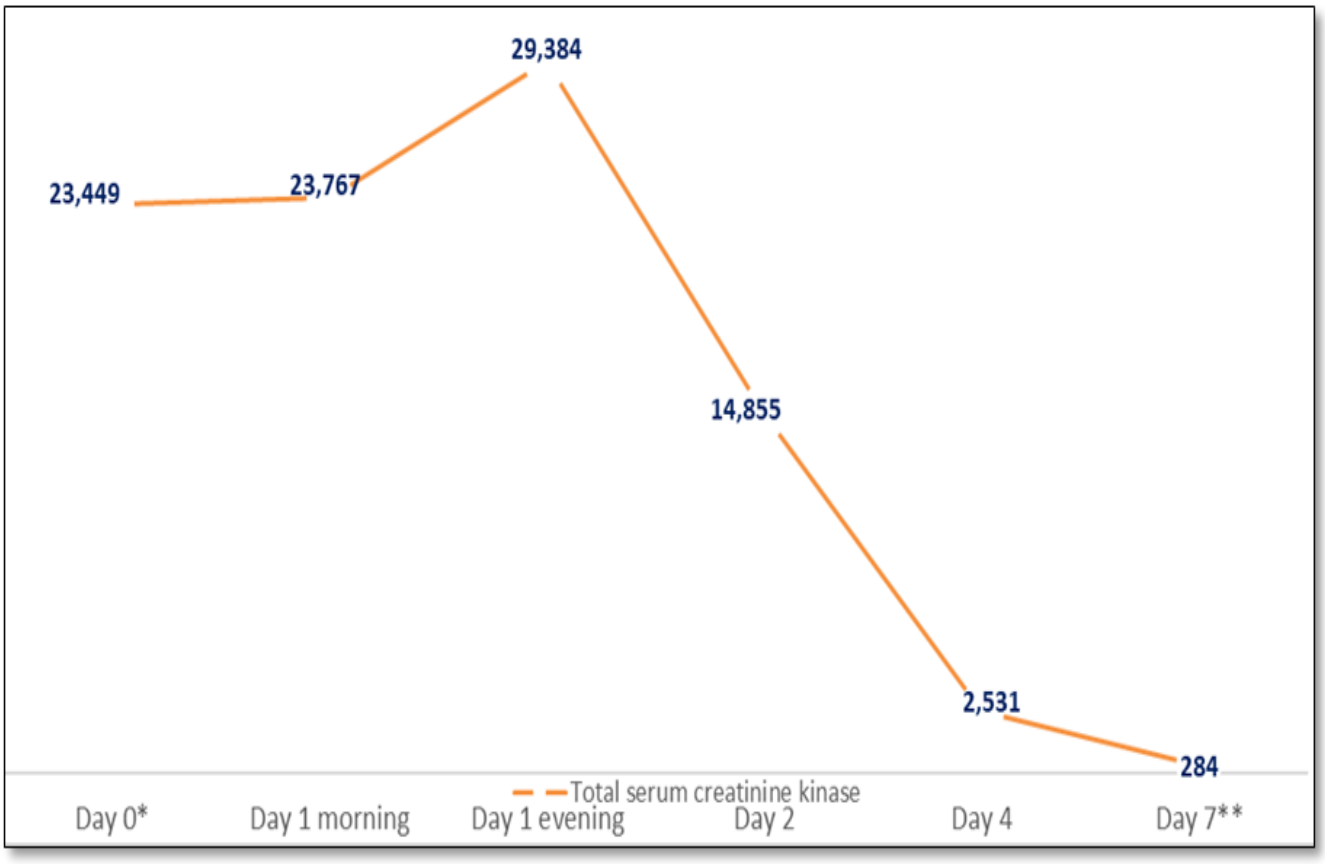

Figure 1. Traces the level of creatinine kinase throughout admission.
**Day 0 is the day of admission which was the first encounter with the patient*
***Day 7 was the last encounter with the patient, which was after discharging him from our facility and followed up 3 days afterward in the OPD department*

In pediatric patients, fluid administration commences with a bolus of 20ml/kg, followed by a transition to double maintenance. Additional boluses can be administered as required. In the presence of cardiac complications or acute kidney injury, consultation with a pediatric cardiologist and/or nephrologist is advised for potential adjustment of the fluid regimen to 1.5x maintenance. The efficacy of the treatment should be gauged by monitoring clinical improvement and the patient's urine output. The target urine output is set at 3 to 4 times the normal urine output, equating to 3-4ml/kg/hr. If the patient fails to achieve this output or exhibits signs of acute kidney injury, consultation with a pediatric nephrologist is recommended [4,5].

Evaluation for potential complications of rhabdomyolysis is crucial. In the event of Compartment Syndrome, consultation with a pediatric surgeon is advised. In cases of Disseminated Intravascular Coagulopathy (DIC), a pediatric hematologist should be consulted for the administration of fresh frozen plasma [6].

Monitoring of creatinine kinase and renal function tests should be conducted at least every two days to track the patient's progress. Discharge should only be considered when the following criteria are met: the patient is asymptomatic, with normal electrolyte levels, normal creatinine and renal function tests, and demonstrates a good urine output indicative of a decreasing trend in creatinine kinase levels. No patient should be discharged if the creatinine kinase level is equal to or exceeds 5,000 U/L, as this is the minimum level of CK associated with Acute Kidney Injury (AKI) [4,7].

A follow up appointment should be scheduled three days post-discharge in the outpatient department (OPD) if the creatinine kinase levels were not normal at the time of discharge. In cases where there is a positive family history of rhabdomyolysis or recurrent episodes of rhabdomyolysis (more than one episode), the patient should be referred to the Neurology Clinic & Genetics Clinic for further evaluation of potential underlying conditions [4].

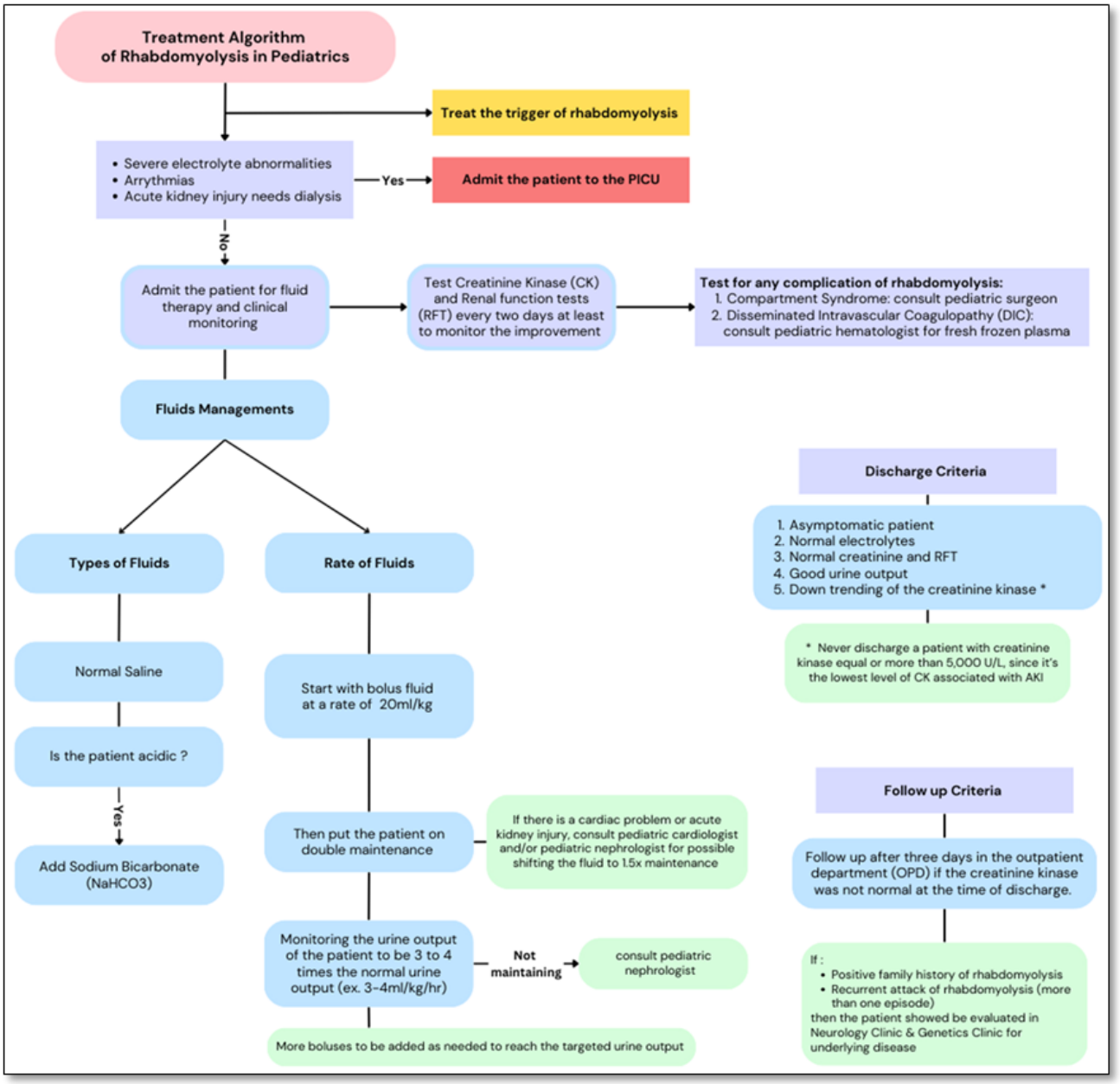

Figure 2. Treatment algorithm for pediatric patients with rhabdomyolysis.

CONCLUSION

In summary, while our proposed treatment algorithm for pediatric rhabdomyolysis provides a systematic approach, it's important to note that it hasn't been officially validated yet. Identifying severe cases needing ICU admission is crucial, while fluid management with Normal Saline and, if needed, Sodium Bicarbonate, are central to treatment. More research is needed to understand the role of mannitol in this context.

Careful monitoring of fluid intake and kidney function is vital for gauging treatment effectiveness. Complications like Compartment Syndrome or DIC require specialized attention. Regular checks on creatinine kinase and kidney function are essential, with discharge criteria focusing on symptom relief and declining creatinine kinase levels.

Future research endeavors could include comparative studies to evaluate the efficacy and safety of different fluid maintenance strategies, specifically comparing 1.5 maintenance versus double maintenance in pediatric patients with rhabdomyolysis. This would involve assessing outcomes such as rates of renal recovery, electrolyte disturbances, fluid overload, and overall length of hospital stay.

By conducting randomized controlled trials or prospective cohort studies, researchers can gather robust evidence to determine which fluid maintenance regimen optimally supports renal function while minimizing complications in this patient population. Additionally, investigating the impact of fluid management strategies on creatinine kinase clearance and the resolution of muscle injury would provide valuable insights into the optimal management of rhabdomyolysis in children.

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