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Review

Are low potassium diets increasing the risk for hypokalemia induced rhabdomyolysis

Amy Eldridge[1], *David Duriancik*[2]

[1]Dept HEV, Central Michigan University, Mt. Pleasant; [2]Biology Dept, University of Michigan – Flint, MI 48502

Summary. Rhabdomyolysis is a serious medical condition caused from degraded skeletal tissue leading to the release of intracellular protein and severe electrolyte imbalance. There are different causes of rhabdomyolysis that include alcohol and substance abuse, anorexia, gastrointestinal complications, medication induced, high intake of caffeine, muscular trauma, and intense exercise. The objectives are to identify diet history, current treatments used for hypokalemia, and recommendations for future prevention of hypokalemia. With rhabdomyolysis being diagnosed once a patient has been hospitalized, it is vital for clinicians to consider other circumstances that may increase the risk for hypokalemia induced rhabdomyolysis.

Key words: rhabdomyolysis, hypokalemia, low potassium, diet history

Background

Rhabdomyolysis is a serious medical condition with approximately 26,000 diagnoses annually in the United States (1). Rhabdomyolysis is a breakdown of skeletal muscle fibers which causes the release of intracellular protein as well as an electrolyte imbalance (2, 3). Myocytes are cells found in skeletal muscle and play an important role in the contraction of tissue. Myocytes use sodium potassium adenosine triphosphatase (ATPase) pumps to regulate calcium used in muscle contractions. When skeletal muscle becomes damaged it changes the balance of blood supply to myocytes leading to discordance with ATPase pumps. For patients that have trauma to skeletal tissue, rhabdomyolysis sets in once normal blood supply is returned to the tissue. Once this reperfusion occurs, the increase of electrolytes, fluids, and white blood cells results in inflammation and production of free radicals leading to increased tissue damage. This leads to a disruption in cellular transport and induces the leaking of intracellular contents including potassium. This leaking of intracellular contents from skeletal tissues is filtered in the glomerulus and can increase the risk for acute kidney injury (1).

Rhabdomyolysis may be causes by, alcohol and substance abuse, anorexia, gastrointestinal complications (i.e. short bowel syndrome, celiac disease, and malabsorption), medication, high intake of caffeine, muscular trauma, and intense exercise (1, 3, 4). During intense exercise, potassium is released from muscle tissue to assist in arteriolar vasodilatation during normal function (5). Common risks of muscle tissue damage-induced elevated serum potassium are acute kidney injury, hypokalemia, and muscle weakness or even muscle paralysis (6). Medical professionals use reported symptoms, i.e. muscle cramping or pain, and labs markers to diagnose rhabdomyolysis within the athlete population including elevated serum creatine kinase (CK) and muscle weakness. In an acute setting, the labs markers used are serum CK and serum potassium. A normal upper limit for CK is 1000 U/L and 3.5-4.6mmol/L for potassium (1, 7).

Objectives

The objectives of this review are to identify diet history in relation with hypokalemia induced rhabdomyolysis current treatments used to correct hypokalemia during hospitalization, and if any patient's discharge recommendations were provided for future prevention of hypokalemia.

Methods

Search strategy

Articles were obtained through PubMed using keywords; see Appendix 1 for number of citations. Keywords used included rhabdomyolysis, acute kidney injury, protein intake, creatine supplement, potassium depletion, potassium, potassium repletion, and skeletal muscle. Searches were limited to English only, peer-reviewed and full-articles. The articles were not filtered by the year the article was published until later during full review of each article. At that time, all articles that were 10 years and older were excluded.

Inclusion Criteria

The quantitative articles used included subjects 16 years of age and older that included serum potassium biomarkers and were diagnosed with rhabdomyolysis and hypokalemia The minimum age was determined due to the high number of adolescents and young adults diagnosed with rhabdomyolysis from exercise or athletic regiments. Due to the lack of experimental or controlled studies completed in this area, criteria of the type of research could not be used. The main outcome or results of the articles used was if the clinicians were able to, normalize the serum potassium levels for hypokalemia induced rhabdomyolysis See figure 1 for the flowchart of study searches and selection.

Results

The overall search using different keywords resulted in 10,834 articles. After the screening and gathering of available articles, 86 were relevant. Using the inclusion criteria mentioned above, only 18 articles remained. Out of the 18 articles, 14 articles discussed epidemiological data.

All of the articles in Appendix 2 discuss patients in a clinical setting that have rhabdomyolysis due to exercise, medication, diet, and gastrointestinal issues. The main commonality with all the studies is the analysis of serum potassium along with serum CK. Serum potassium levels of 1.1-2.2 mEq/L for all patients were considered to be in the hypokalemia range. The few studies that did address diet related issues noted a very low potassium diet due to cola and licorice consumption (2,4,7,8,9). Gastrointestinal related conditions addressed the possibly of malabsorption issues due to the altered length of the gastrointestinal tract or through diseases that affect the absorption through the microvillus as seen with celiac disease or Crohn's (10).

Most of the case reports included intravascular fluid hydration with potassium repletion in conjunction with oral potassium repletion. Very few case reports used only a potassium supplement for repletion. Limitations to several of the articles included no specified amount of potassium repletion, the length of days potassium repletion was used, types of diets the patients were placed on during hospital duration, a list of comorbidities the patients may have had, and if any discharge plans to include diet education were provided to the patients for future prevention of hypokalemia (3).

Conclusions

Overall there is limited research evaluating the diet history for rhabdomyolysis patients and whether it increases the risk factors for hypokalemia induced rhabdomyolysis. Clinicians can start by following up with patients diagnosed with altered GI function or reduced length by analyzing diet history and serum potassium levels. These patients may benefit from a high potassium diet to increase the amount of potassium absorption. Patients placed on long term furosemide medication upon discharge from the hospital or from outpatients services may need increased monitoring of potassium levels and may need a high potassium diet or potassium supplement. Within the sports and athletic community, guidance and review of diets

for all age groups should address consuming a well-balanced diet focused on the specific sports or training regiments. Due to rhabdomyolysis being diagnosed once a patient has been hospitalized with other medical conditions, researchers and clinicians in all scopes of practice should work towards prevention by addressing dietary related issues, asking more diet related questions and providing education.

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Correspondence
Amy King
106 Wightman
Central Michigan University
Mt. Pleasant, MI 48859
Phone; 989-774-3097
Email: amy.king@sodexo.com

Appendix 1: Strategy for searches - PubMed

Search	Query	Number of citations
1	"rhabdomyolysis" [MeSH terms] OR "rhabdomyolysis" [All Fields]	8413
2	"rhabdomyolysis" [MeSH terms] OR "rhabdomyolysis" [All Fields] and "acute kidney" [MeSH terms] OR "acute kidney" [All Fields]	2024
3	"rhabdomyolysis" [MeSH terms] OR "rhabdomyolysis" [All Fields] and "protein intake" [MeSH terms] OR "protein intake" [All Fields]	17
4	"creatine supplement" [MeSH terms] OR "creatine supplement" [All Fields] and "renal" [MeSH terms] OR "renal" [All Fields]	74
5	"potassium depletion" [MeSH terms] OR "potassium depletion" [All Fields] and "rhabdomyolysis" [MeSH terms] OR "rhabdomyolysis" [All Fields]	266
6	"potassium replacement" [MeSH terms] OR "potassium replacement" [All Fields] and "rhabdomyolysis" [MeSH terms] OR "rhabdomyolysis" [All Fields]	18
7	"potassium repletion" [MeSH terms] OR "potassium repletion" [All Fields] and "rhabdomyolysis" [MeSH terms] OR "rhabdomyolysis" [All Fields]	4
8	"skeletal muscle" [MeSH terms] OR "skeletal muscle" [All Fields] and "rhabdomyolysis" [MeSH terms] OR "rhabdomyolysis" [All Fields] and "potassium" [MeSH terms] OR "potassium" [All Fields]	18

Appendix 3: Summaries of Studies

Article	n	Type of Study	Type of patients	RM Diagnosed	Intervention A	Intervention B	Outcomes	Comments
Balhara et al. 2014 (3)	1	CC	63 YOA female admitted with paralysis of upper extremities with past medical history of a bowel resection	Serum potassium 1.9 mEq/L and serum CK 10,993 U/L	intravenous hydration and 100 mEq of potassium	oral 120mEq potassium	Serum potassium and CK were corrected and discharged with a MVI	Diet recall or current per so intake was never discussed with patient
Chaudhry et al. 2011 (5)	1	CC	21 YOA female admitted with lower-extremity numbness	Serum potassium 2.2mmol/L and serum CK 11,089 U/L	No intervention addressed	N/A	N/A	Diet recall provided that patient was consuming 4 liters of cola and 2-3 bags of ice chips daily
Glancy et al. 2016 (11)	1	CC	33 YOA male admitted with paralysis of the legs	Serum potassium 1.7 mEq/L and serum CK 542 U/L	No amounts listed, just stated potassium was replete	N/A	Within 24 hours potassium was 4.7 mEq/L	Diet recall provided that patient was consuming 6-8 beers daily
Horwitz et al. 2015 (7)	1	CR	65 YOA male admitted for myalgia but was believed to develop rhabdomyolysis later on, muscle fatigue in lower extremities was noted	Serum potassium 1.5 mEq/L and serum CK 18,400 U/L	No amounts listed, just stated potassium was replete	N/A	Serum potassium returned to normal within 2 days and CK decreased gradually	Diet recall provided that patient was consuming 100gm of licorice
Jain et al. 2011 (12)	1	CR	18 YOA female admitted with abdomen pain and vomiting for 4 days which progressed to muscle weakness in all four limbs / noted same symptoms in the past 2 months	Serum potassium 1.9 mEq/L and serum CK 10,993 U/L	intravenous hydration and intravenous potassium No amounts listed	oral 120mEq potassium	Muscle weakness improved as serum potassium increased (10 days) and CK was corrected in 3 weeks	Diet recall or current per so intake was never discussed with patient

Appendix 3: Summaries of Studies

Article	n	Type of Study	Type of patients	RM Diagnosed	Intervention A	Intervention B	Outcomes	Comments
Kasap et al. 2010 (8)	1	SR	16 YOA male admitted nausea, vomiting, low urine output and muscle cramps for up to 3 days. Noted patient was diagnosed with malaise and anorexia 2 week prior	Serum potassium 2.2 mEq/L and serum CK 8,379 U/L	No intervention addressed	N/A	Serum potassium stabilized from Acute Kidney Injury after 3 weeks	Diet recall provided that patient was consuming a liter of cola of daily for the last 2-3 years
Kishore et al. 2007 (13)	1	CR	46 YOA female admitted with severe pain in legs and back	Serum potassium 1.4 mEq/L and serum CK 6,451 U/L	oral potassium and magnesium was started, No amounts listed	N/A	Serum potassium stabilized but decreased after discharge and was readmitted	Diet recall from re-admission found pt was consuming excessive alcohol and was later sent home with a MVI and a high calorie diet.
Martin et al. 2016 (14)	1	CR	High school student (no age provided) admitted with extraordinary back pain with blood in urine. Noted he is a competitive rower	Serum CK 141,000 U/L Noted with hypokalemia but no value	Corrected electrolytes (no values given)	N/A	No follow-up with outcome	Diet recall or current po intake was never discussed with patient
Sagun et al. 2012 (4)	1	CR	35 YOA male admitted with weakness of extremities	Serum potassium 1.93 mEq/L and serum CK 1521 U/L	No soft drinks allowed during hospital stay	intravenous 60 mEq of potassium for 2 days	Serum potassium and CK were corrected	Diet recall provided that patient was consuming 2.5 liters of cola daily for 20 years
Pena Porta et al. 2008 (10)	1	CR	38 YOA female admitted with weight loss, fatigue and muscle weakness. Last two months with loose stools and urine samples reflected normal potassium levels	Serum potassium 1.83 mEq/L and serum CK 7,489 U/L	intravenous hydration and with electrolyte replacement No amounts listed	oral 30mEq potassium	Serum potassium and CK were corrected within 17 days	Diet recall or current po intake was never discussed with patient but was sent home with a MVI.
Ruisz et al. 2013 (16)	1	CR	22 YOA female admitted with myalgia with vomiting and diarrhea - noted patient was also abusing furosemide 250mg daily for 4 months	Serum potassium 1.1 mmol/l and serum CK 15,966 U/L	intravenous hydration and potassium No amounts listed	N/A	Serum potassium was corrected within 5 days	Diet recall or current po intake was never discussed with patient
Templin et al. 2009 (9)	1	CC	47 YOA male admitted with muscle weakness of the lower extremities	Serum potassium 1.4 mmol/l and serum CK 26,794 U/L	intravenous hydration and potassium No amounts listed	N/A	Serum potassium was corrected within 5 days	Diet recall provided that patient was consuming 600gm of licorice weekly for 27 years
Tzvetanov 2009 (17)	1	CR	60 YOA male admitted with severe abdominal pain associated with tenesmus, and bloody diarrhea	Serum potassium 2.1 mEq/L	intravenous hydration and 700 mEq of potassium (total)	N/A	patient expired	Diet recall noted that patient had, loose stools, loss of appetite, weight loss for two months prior
Wen et al. 2013 (18)	2	CR	45 YOA female admitted with fatigue and limb pain and 44 YOA female admitted with fatigue and limb pain	Serum potassium 1.38 mEq/L and serum CK 4,907 U/L. Serum potassium 1.98 mEq/L and serum CK 8,531 U/L	No amount stated but high dose oral potassium supplement	N/A	Serum potassium corrected	Diet recall or current po intake was never discussed with patient

CR - Case Report, CC - Clinical Communications / RM - rhabdomyolysis