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Military-Specific Care Clinical Community & Environmental Medicine Working Group

DHA Practice Recommendation:
Initial Management of Exertional Rhabdomyolysis
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Initial Management of Exertional Rhabdomyolysis

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Initial Management of Exertional Rhabdomyolysis, Version 1.0

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Purpose

This Practice Recommendation (PR) is intended to provide a synopsis of care recommended to assist providers in the prevention, assessment, and initial management of Exertional Rhabdomyolysis (ER). The guidance in this document is applicable to Service members as well as beneficiaries or others who may suffer from ER. Separate PRs are available for the inpatient management of ER and for the management of a patient with recurrent or high-risk ER. This PR is based on Clinical Practice Guidelines (CPG) constructed jointly between the U.S. Military and the Uniformed Services University of the Health Sciences, which was originally published in November 2017 and revised in May 2020. The original CPG can be found on the Warrior Heat- and Exertion-Related Event Collaborative website located at https://www.hprc-online.org/resources-partners/whec.

Specific warfighter management questions can be directed to an Ask-the-Expert function at https://www.hprc-online.org/ask-the-expert.

Diagnosis

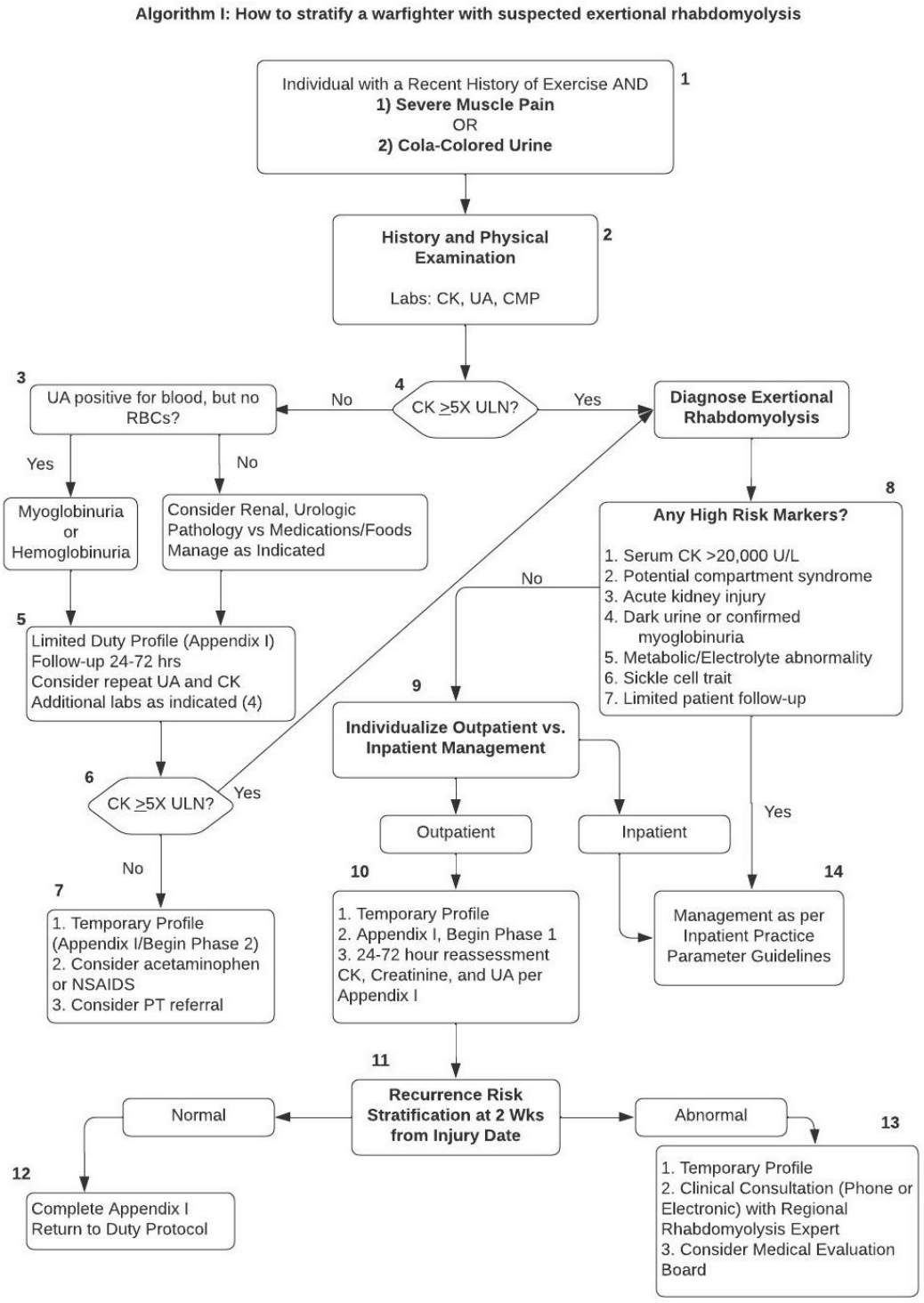
Introduction and Definition

ER is a condition frequently seen in the setting of military training and operations; it frequently occurs when the level of exertional stress is greater than the warfighter is recently accustomed.[1] It is defined as severe muscle symptoms (pain, stiffness, and/or weakness) AND laboratory evidence of myonecrosis (creatine kinase (CK) level $\geq$ 5x the upper limit of normal) in the setting of recent exercise. This condition can be precipitated by a number of factors, often working in tandem, and is commonly co-morbid with exertional heat illness, in particular, heat stroke.

ER remains a serious and prevalent illness among warfighters. In 2018, there were 545 incident diagnoses of rhabdomyolysis likely associated with physical exertion or heatstress.[1] During the surveillance period of a recent study (2014-2018), the rates of incident diagnoses of ER increased from 30 per 100,000 person-years (p-yrs) in 2014 to 40.8 per 100,000 p-yrs in 2016. This decreased slightly in 2017 to 39 per 100,000 p-yrs before increasing again in 2018 to 42 per 100,000 p-yrs.[1]

Although the majority of warfighters who experience ER recover and will be safely returned to duty, some may experience sequelae, while others may be at increased risk for future recurrences. These recurrences may limit the warfighter's effectiveness and potentially predispose to serious injury, including permanent disability, and death. Importantly, an untimely recurrence may compromise a unit's mission.

Clinical Management[36]



Annotations to Algorithm I
**Abbreviations Legend: Creatine Kinase (CK); Urinalysis (UA); Comprehensive Metabolic Panel (CMP); Red Blood Cells (RBCs); Upper Limit of Normal (ULN); Non-Steroidal Anti-Inflammatory Drugs (NSAIDs).*

1. Post-Exercise Muscle Pain or Cola-Colored Urine. Muscle pain usually presents within the first 24 hours and peaks at 72 hours after strenuous, prolonged, or non-familiar exercise training, in particular after a significant amount of eccentric exercise (e.g., push-ups, pull-ups, squats, or participation in unaccustomed conditioning exercises). Delayed onset muscle soreness (DOMS) can be a symptom of physiologic muscle breakdown and is best described as muscles that become sore and stiff, usually one to three days after a bout of moderate to strenuous exercise. ER and DOMS can have overlapping symptoms, but key symptoms and findings of ER which help distinguish it from typical physiologic muscle breakdown and/or DOMS include:

- Pain and tenderness to palpation usually severe or out of proportion to what one would normally expect from the activity;
- Muscle swelling;
- Significant limitation in active and passive range of motion;
- Weakness, especially when the hip and shoulder girdle muscles are involved;
- Presence of cola-colored urine; and
- Persistent or worsening pain and soreness for more than 5-7 days after the precipitating activity.

It should be noted that on rare occasions a warfighter might present with cola-colored urine in the absence of severe muscle pain. This may represent a metabolic myopathy, especially if recurrent or occurring after a low exercise load. However, the full differential diagnosis for dark urine must be considered. These warfighters should undergo the same initial diagnostic evaluation as an individual with a classic presentation of ER.

The clinician's judgment is critical in determining the severity of muscle pain and myonecrosis. The diagnosis of ER is obtained by combining the subjective and objective exam findings in the presence of laboratory CK levels in excess of 5X the upper limit of normal (ULN). The ULN is defined by each laboratory, but is usually about 200 U/L. However, studies in both warfighters and athletes have demonstrated that high CK levels (up to 175X ULN) can be tolerated without any symptoms or evidence of acute kidney injury (AKI) in some individuals, leading some experts to suggest a minimum CK laboratory threshold for ER in physically active individuals to 50X ULN for improved specificity.[2] It cannot be overemphasized that SYMPTOMS, co-morbidities (e.g., acute kidney injury), and clinical judgment should drive management.

2. History, Physical Examination and Diagnostic Testing. The medical provider should perform a focused history and physical examination to confirm a diagnosis consistent with physiologic muscle breakdown (ICD-10: M62.9 – Disorder of muscle, unspecified), ER (ICD-10: M62.82 – Rhabdomyolysis), or other causes for cola-colored urine such as exercise-induced hemolysis. Additional ICD-10 Y "cause" coding can be considered as appropriate; such actions will assist with future epidemiologic efforts:

- Y92.13 – Military base as the place of occurrence of the external cause
- Y37.90XA – Military operations, unspecified
- X50.0 – Overexertion from strenuous movement or load (lifting weights)
- Y93.02 – Activity – running, etc.

The provider should specifically inquire about and document the use of medications (e.g., statins, antipsychotics, stimulants)[3], dietary supplements (e.g., performance enhancing, weight loss, muscle building, stimulant/caffeine-containing products), and energy drinks, as well as ask about current sleep patterns, nutritional habits, and whether a co-existent illness is present, as these are known contributors to ER. Note: if dietary supplements are suspected to have contributed to the pathogenesis of ER, the provider is encouraged to submit an adverse event report to the Food and Drug Administration Safety Reporting Portal, located at https://www.safetyreporting.hhs.gov/SRP2/en/Home.aspx?sid=40d91272-9119-45cc-b91e-56684b830bca.

If the history and examination indicates or renders an alternate diagnosis, further evaluation and a work-up should be directed appropriately. Otherwise, the possibility of severe muscle injury should be evaluated at this point with a serum CK, blood chemistry profile (including potassium, bicarbonate, calcium, phosphorus, blood urea nitrogen [BUN], and creatinine), and a urinalysis (UA) with microscopic examination. Urine or serum myoglobin should be considered if available at the treatment facility. Current evidence suggests that while pathognomonic for muscle injury, serum myoglobin has low sensitivity and should not be utilized for the diagnosis of ER. Serum myoglobin typically peaks around 3 hours after exercise and returns to baseline within 6-24 hours. Serum myoglobin has proven very useful in the prediction of those who will develop AKI from crush-induced rhabdomyolysis. However, there are no data to support its application to patients with ER.[4,5]

3. Evaluating Patients with Dark or "Cola-Colored" Urine. Dark or "cola-colored" urine is relatively uncommon but may be observed with greater frequency following exercise. When evaluating patients presenting with dark urine, a thorough history and examination are critical as one considers the full differential diagnosis. While an onset of dark urine within 24 hours following a bout of strenuous exercise is highly suggestive of ER, other etiologies must also be considered.

High-intensity or prolonged exercise often results in benign, self-limited hematuria or hemolysis. Exercise-induced hemolysis is typically mild, with hemoglobin completely bound to haptoglobin in the blood and metabolized. However, in some cases, the hemolysis is more extensive, leading to hemoglobinuria and occasionally grossly dark urine.[4,6] The specific cause of erythrocyte rupture is complex, with contributions from membrane fragility due to hyperthermia, lactic acidosis, oxidative damage, and shear stress from forceful ground contacts ("footstrike hemolysis"). Similarly, exercise-induced hematuria is also common, but rarely presents as gross hematuria. Urinalysis with microscopy will reveal presence of variable quantities of intact red blood cells (RBCs).

One recent study found an incidence of exercise-induced hematuria of 12% among 491 otherwise healthy, 20-50 year-old male subjects after running five kilometers with a time limit.[7,8] When running the same

distance without a time limit, the incidence was only 1.3%, suggesting exercise-induced hematuria is strongly related to exercise intensity.

After a history and exam, urinalysis with microscopy must be performed. When urine sediment is red or dark, the differential diagnosis includes hematuria due to glomerular, non-glomerular, and urologic causes (e.g., exercise-induced hematuria, IgA nephropathy, thin basement membrane nephropathy, post-streptococcal glomerulonephritis, pyelonephritis, acute interstitial nephritis, urolithiasis, renal or urologic neoplasm). In cases of hematuria with red/dark sediment, the urinalysis should be repeated and, as indicated, the patient should be managed in consultation with a nephrologist or urologist. When the urine supernatant (top portion of a spun urine sample) is red or dark, one must consider hemoglobinuria (e.g., exercise-induced hemolysis), myoglobinuria (implies rhabdomyolysis), urine discoloration due to medications (e.g., phenazopyridine, rifampin, phenytoin), foods (e.g., beeturia, also blackberries, rhubarb, senna, food dyes), or porphyria (rare).

This algorithm includes branches for when the urinalysis is positive for blood in the absence of RBCs, which may represent myoglobinuria. It is possible, especially in the first 12 hours after strenuous exercise, that an individual will have a CK <5X ULN, but with myoglobinuria (myoglobin peaks before CK). In these cases, a CK and metabolic panel should be repeated in approximately 24 hours, and if CK ≥5X ULN, a diagnosis of ER is appropriate. As noted below (#4), the orthotoluidine portion of the dipstick turns blue in the presence of hemoglobin or myoglobin, so the differential diagnosis in these cases includes ER and exercise-induced hemolysis.

4. Diagnosis and Prognosis of ER. Although ER is a pathologic condition (and is, by definition, symptomatic), muscle breakdown of a lower degree is also a normal result of strenuous exercise (DOMS).[9,10,12] Whereas DOMS lasts only a few days and causes little disability, ER can be overwhelming and devastating, especially when associated with other variables such as dehydration, sickle cell trait, use of certain drugs, dietary supplements, caffeine or alcohol, excessive exercise, exertional heat illness, underlying genetic conditions, or other incompletely understood contributing factors. The potential devastating consequences of ER include compartment syndrome, renal failure, and death. Although uncommon, ER may reflect an underlying metabolic or myopathic process that predisposes the warfighter to severe and/or recurrent ER. Accordingly, significant clinical expertise is required when treating ER patients, evaluating potential complications from ER, and additionally determining how to stratify the individual's risk for recurrent ER. A multi-disciplinary panel of experts can be very helpful in the diagnostic and prognostic process.[11]

A diagnosis of ER is made when there are severe muscle pain symptoms and laboratory evidence of myonecrosis with release of muscle cell contents into the systemic circulation. While CK is the diagnostic gold standard, other cell contents are released including myoglobin, creatinine, organic acids, potassium, aldolase, lactate dehydrogenase (LDH), aspartate aminotransferase (AST), alanine aminotransferase (ALT) and/or hydroxybutyrate dehydrogenase. The skeletal muscle subtype CK-MM of the CK enzyme is abundant in skeletal muscle and released as a result of muscle destruction. When clinical evidence of exertional rhabdomyolysis is observed, such as severe muscle pain and weakness in the setting of recent strenuous exercise, then CK levels ≥5X ULN are accepted as evidence of significant muscle breakdown and generally considered consistent with a diagnosis of ER. The provider is reminded that CK elevations

occur for many other reasons, such as inflammatory myopathies and muscular dystrophies; therefore, elevated CK in the absence of exertion would not be considered ER. However, CK remains the accepted gold standard biomarker for diagnosis of rhabdomyolysis, and when there is a recent history of exercise, can be used to diagnose ER.[4,5,9]

Myoglobin is theoretically the best marker for ER because myoglobin does not appear in the blood or urine in the absence of muscle injury. Current evidence, however, suggests that while pathognomonic for muscle injury, serum myoglobin and myoglobinuria are not sensitive for ER. Therefore, they should not be utilized to make or rule out a definitive diagnosis of ER. Myoglobin has been demonstrated to be of value for the prognostication of those who may develop AKI in cases of traumatic rhabdomyolysis (especially crush injury). However, there are no data validating this application for patients with ER.[5,12]

Serum myoglobin is normally bound to plasma globulins and under healthy conditions only a small fraction reaches the glomeruli. Serum myoglobin is cleared rapidly by the kidney, with a half-life of 2-4 hours, maintaining a serum concentration of less than 3 μg/l.[5, 13-15] In the face of severe muscle damage, blood levels of myoglobin overwhelm the binding capacity of the circulating proteins, so free myoglobin reaches the glomeruli and is filtered into the renal tubules. Elevations in serum myoglobin occur before a rise in serum CK, but the elimination kinetics of serum myoglobin are more rapid than that of CK, which makes the often evanescent rise in serum myoglobin a less reliable marker of muscle injury. Diagnostic tests for urine myoglobin are often not readily available, and it may take more than 24 hours to obtain results. However, urine screening for rhabdomyolysis may be performed by dipstick if the urine sediment is also examined. The orthotoluidine portion of the dipstick turns blue in the presence of hemoglobin or myoglobin, so if the urine sediment does not contain erythrocytes, the positive dipstick reading may reflect the presence of myoglobin in the appropriate clinical setting. Of note, exercise-induced hemolysis is quite common and often results in hemoglobinuria, especially after long-distance running or marching (>8-10 miles, longer distances carrying greater risk).[6] Therefore, a urinalysis positive for blood, with absence of RBCs in the sediment, is neither sensitive nor specific for ER. It may be noted that for field expedient analysis, the supernatant (top portion) of the spun urine sample will typically be brown in myoglobinuria and pink in hemoglobinuria. However, urine myoglobin is somewhat unstable, making supernatant color a fallible marker. Altogether, using any indirect marker of myoglobinuria to diagnose ER or predict ER-associated AKI remains inconclusive.[13-15]

Athletes and warfighters consistently have higher baseline CK levels than non-active adults as a result of frequent exercise with normal ongoing muscle breakdown and repair.[16,17] In addition, gender and ethnic variation may contribute to unique baseline CK levels.[18,19] Studies have consistently noted that African American males and young athletic men have the highest baseline CK levels, and non-African American women have the lowest.[18-24] Although the case definition for pathologic ER is somewhat controversial, this guideline utilizes the following to enter the management algorithm:

- SEVERE muscle pain (see above for symptoms) and
- Laboratory evidence of muscle injury (CK level ≥5X ULN)

CK >5X ULN is a low threshold designed for **high sensitivity**. However, it has very **low specificity** for ER. Using this definition provides the greatest safety net in assisting the clinician in the initial work-up of

this challenging syndrome. Because finding a CK ≥5X ULN is not uncommon in exercising warfighters (in particular African American warfighters who may have baseline CK of 600 U/L).[18,20,24] it is important to emphasize that entry into this clinical algorithm requires the appropriate clinical picture, including severe muscle pain.

5. Management. The warfighter with a documented visit to the clinician with signs/symptoms consistent with DOMS (physiologic muscle breakdown: ICD-10: M62.9 – disorder of muscle, unspecified) should be placed on a temporary profile (https://www.usuhs.edu/champ-clinicaltools) with limited light duty, indoor if at all possible, for the rest of the day, no regular physical training, and a mandatory medical re-evaluation in 24-72 hours, with consideration for repeat UA and CK assessment. Oral rehydration should be encouraged (Appendix/Phase 1).

6. Urinalysis and CK. Patients who are initially diagnosed with DOMS (physiologic muscle breakdown; ICD-10: M62.9), as they do not meet the criteria for ER, should be reevaluated by a knowledgeable clinician within 24-72 hours. At this time, a repeat urinalysis and CK can be performed if clinically indicated (dark urine, no clinical improvement in pain). If the patient's symptoms have resolved, and the CK is <5X ULN, the warfighter may be gradually returned to duty as determined by the treating provider with guidance from the Appendix. Any warfighter who demonstrates clinical signs of ER (severe muscle pain, stiffness, weakness) and tests positive for CK greater than 5X ULN should be diagnosed with ER and further evaluated for high risk markers (see #8 below).

7. Temporary Limited Duty Profile. At the 24-72 hours follow-up, a warfighter diagnosed with physiologic muscle breakdown may continue on a limited duty profile for up to 72 hours, after which activities will be advanced as tolerated in accordance with the recommendations of Phase 2 of the Appendix (https://www.usuhs.edu/champ-clinical-tools). The provider should consider referral to physical therapy or an athletic trainer for rehabilitation or reconditioning as clinically indicated. Although consideration can be given to a short course of acetaminophen for pain relief, muscle pain serves as an important guide in return to activity and should not be masked. Excessive doses of NSAIDs and/or acetaminophen can result in nephro- or hepatotoxicity, respectively.[25] This risk may be heightened following the stress of significant exertional muscle breakdown.

8. Screen for Initial "High Risk" Markers. After diagnosing a warfighter with ER, the clinician must carefully screen for initial "high risk" markers that have been shown to place the patient at increased risk for complications. High risk markers are presented in Table 1 and Algorithm 1.

Currently, no clinical prediction rule exists for risk-stratifying patients with ER or for determining who will develop AKI.[26, 27] However, a peak CK of >5,000 U/L is reported to be 55% specific and 83% sensitive for predicting AKI with traumatic rhabdomyolysis.[28, 29] ER patients with mild symptoms and serum CK levels ≤20,000 U/L are considered at low risk and may be treated as outpatients. Outpatient treatment in such patients consists of oral rehydration, limited physical activity, and careful follow-up. A CK >20,000 U/L should be considered a high risk marker and triaged to a higher level of care for possible inpatient treatment.

ER can be associated with the development of acute compartment syndrome (ACS). ACS occurs when the tissue pressure within a closed muscle compartment (e.g., triceps, thigh) exceeds the perfusion pressure and results in muscle and nerve ischemia. Early signs of an ACS include severe pain worse with passive stretching, decreased peripheral sensation, and swelling. Paresis and the loss of a pulse are late signs. Clinical suspicion should be high, as surgical intervention for a fasciotomy may be required to prevent ischemic necrosis. An orthopedic or general surgeon should be consulted emergently if compartment syndrome is suspected.

Common metabolic abnormalities considered "high risk" include, but are not limited to, hyper- and hypokalemia, acidosis, hyperphosphatemia, and hyponatremia. If only mild in degree, these abnormalities do not, in and of themselves, warrant admission, but do necessitate close follow-up at a minimum, with immediate access to laboratory capabilities and proximity to an inpatient treatment facility. However, moderate to severe electrolyte and acid/base derangements do necessitate inpatient treatment. These "high risk" markers are a guide, and do not supersede clinical judgment.

The presence of any of the above "high risk" markers warrants triage/referral of the patient to a provider and/or setting familiar with the diagnosis and management of ER (e.g., neurologist, nephrologist, or sports medicine physician). This will likely include inpatient admission.

9. Individualize Outpatient Management. The warfighter diagnosed with ER, but without high risk markers, should be considered for outpatient management. There is significant controversy on using CK level as an admission criterion. Case reports reveal a wide CK range that has been successfully managed in an outpatient setting, with some expert opinions suggesting that oral hydration may be reasonable for athletes with CK levels of 20,000-50,000 U/L and no additional high risk features.[30,31] This guideline, however, recommends that in a military population, a CK level of 20,000 U/L or less without any high risk features, and reliable patient follow-up should be considered for outpatient management. Warfighters should be encouraged to monitor urine output with a goal of approximately 200 ml per hour, or 1 liter every 6 hours. The warfighter should be placed on quarters if possible, with follow-up evaluation within 24-72 hours. Follow-up evaluation should assess symptoms, any evidence of complications, and should include a repeat blood draw for CK and basic metabolic panel. If CK continues to downtrend, renal function remains normal, symptoms improve, and no complications emerge, then the warfighter should be re-evaluated as an outpatient until symptoms resolve and profiled accordingly. Any worsening symptoms, metabolic abnormalities, or increasing CK levels should prompt admission for management with IV fluids.

The decision to hospitalize the warfighter should be contingent upon factors such as metabolic abnormalities, acute kidney injury, social status (i.e., trainee, recruit, barracks dweller, and limited patient follow-up).

10. Profile and Follow-up. In regards to profiling, the warfighter should be placed on a limited duty profile that excludes strenuous field duty activities (e.g., extended marching, obstacle courses, and land navigation). It must also limit aerobic and anaerobic exercise per Appendix recommendations (Rhabdomyolysis- Low Risk Profile in the website, https://champ.usuhs.edu/sites/default/files/2020-11/hprc_whec_clinical_practice_guideline_for_managing_er.pdf, parallels the Appendix

recommendations). The warfighter should be re-evaluated in 24-72 hours. If CK is still elevated and/or the UA is still positive at this time, the limited duty profile should be continued with the patient being reevaluated at 24 to 72-hour intervals. When the CK value is <5X ULN and the UA has returned to normal, the warfighter should begin a graduated return to duty protocol per the Appendix. It is strongly recommended that a physical/occupational therapist or athletic trainer supervise the return to duty and reconditioning program. Potential contributing risk factors should be discussed, as well as mitigation strategies as applicable.

11. Recurrence Risk Stratification at 2 weeks from Date of Injury. To define the case as "high risk" for recurrence, at least one of the following conditions must exist[10]:

- Delayed clinical recovery (despite more than a week of activity restriction);
- Persistent CK elevation above 1,000 U/L, despite rest for at least 2 weeks;
- ER complicated by AKI that does not return to baseline within 2 weeks as evidenced by elevations in BUN/Creatinine;
- ER after low to moderate workload;
- Personal or family history of ER;
- Personal or family history of recurrent muscle cramps or severe muscle pain that interferes with activities of daily living or military performance;
- Personal or family history of malignant hyperthermia or family history of unexplained complications or death following general anesthesia;
- Personal or family history (if personal status unknown) of sickle cell disease or trait;
- ER complicated by drug or dietary supplement use:
  - Drugs increasing risk for ER: statins, antipsychotics (e.g., haloperidol), stimulants (amphetamines, methylphenidate)
  - Dietary supplements increasing risk for ER: Stimulants (e.g., excessive caffeine, synephrine, octopamine, yohimbine, ephedra)
  - For comprehensive information on dietary supplements, visit the Operation Supplement Safety website at https://www.opss.org.
  - Although supplements do not imply a medical condition that would necessarily warrant a MEB or detailed work-up, individual as well as unit education may be warranted.
- Personal history of significant heat injury; or
- CK peak > 100,000 U/L.

To define the case as "low risk" for recurrence, all of the following conditions must be met:

- None of the "high risk" conditions should exist;
- A full clinical recovery within 1 week (symptoms and exam findings normalized);
- All laboratory values normalized within 2 weeks with exercise restriction; and
- **At least one** of the following conditions must also exist:
  - Physically trained warfighter with a history of very intense training;
  - Known participation in a singular extreme conditioning program prior to event;
  - No personal and family history of ER or previous reporting of exercise-induced severe muscle pain, muscle cramps, or heat injury;

- Existence of other ER cases in the same training or operational unit event
- Identifiable period of sleep and/or nutrition deficit;
- Concomitant viral illness or other infectious disease.

12. Complete Appendix. Return to Duty Guidelines for Physiologic Muscle Breakdown and Low Risk Warfighters with Exertional Rhabdomyolysis**.**

13. Abnormal at Two Weeks after injury. If at two weeks after injury, clinical indicators (laboratory values, physical exam findings) remain abnormal, the warfighter should be referred to or discussed with an appropriate specialist (e.g., neurologist, nephrologist, sports medicine physician) or regional ER expert for further management and potential evaluation for an underlying disorder that may predispose to recurrent injury. The evaluation may include, but is not be limited to: EMG, muscle biopsy, caffeine-halothane contracture test, genomic/proteomic testing, and/or exercise challenges (See Appendix). Return to duty and profiling are individualized based on results of testing and presented in Management of the Warfighter with Recurrent or High Risk Exertional Rhabdomyolysis Practice Parameter.

14. Manage as per Inpatient Practice Parameter Guideline. Patients with CK levels >20,000 U/L or any significant high risk markers, may require further testing and observation in an inpatient setting.[15,28,29,32] Accordingly, higher level of care should be considered and the patient should be managed as per Inpatient Management of the Warfighter with Exertional Rhabdomyolysis Practice Parameter.

Table 1. High-risk Markers

▪ CK >20,000 U/L
▪ Suspicion for potential compartment syndrome
▪ Acute Kidney Injury (See Kidney Disease Improving Global Outcomes (KDIGO) criteria, available at https://kdigo.org/guidelines/)
▪ Metabolic abnormality (e.g., hyperkalemia, hyperphosphatemia, acidosis)
▪ Sickle cell trait carrier
▪ Limited patient follow-up (e.g., warfighter lives alone)

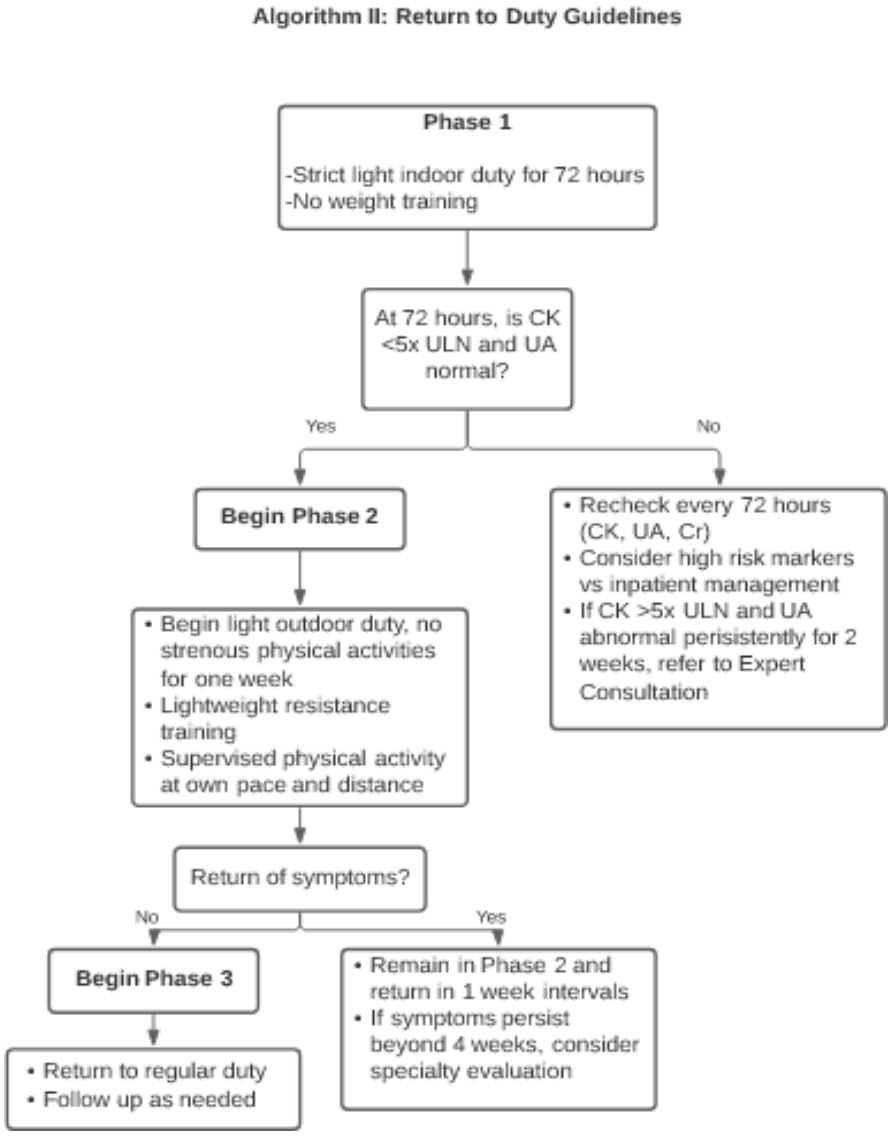
Prevention

Multiple preventive measures exist for reducing the risk of developing ER. The first measure is to develop a basic understanding of proper exercise warm-up as this has been shown to reduce the risk of musculoskeletal injury.[33] Additionally, increasing exercise levels over time can be protective as opposed to sudden exposure to specific exercises such as high intensity, longer duration, and weight-bearing exercise (eccentric contraction and downhill running).[34] Next, individuals with communicable disease or viral diseases including diarrhea or vomiting should reduce, modify or avoid physical activity to prevent possible development of ER.[35] Environmental factors should also be considered. Taking precautions to avoid exertional heat illness can subsequently reduce the risk of developing ER. Modifying gear or uniform to aid in heat dissipation and providing a cooling mechanism should be considered in settings of high heat or humidity.

Return to Duty Guidelines

At the 24-72 hours follow-up, a warfighter diagnosed with physiologic muscle breakdown may continue on a limited duty profile for up to 72 hours, after which activities will be advanced as tolerated in accordance with the recommendations of Phase 2 of the Appendix. The provider should consider referral to physical therapy or an athletic trainer for rehabilitation or reconditioning as clinically indicated. Although consideration can be given to a short course of acetaminophen and/or non-steroidal anti-inflammatory drugs (NSAIDs) for pain relief for outpatient cases, muscle pain serves as an important guide in return to activity and should not be masked. Additionally excessive doses of NSAIDs and/or acetaminophen can result in nephro- or hepatotoxicity, respectively.[27] This risk may be heightened following the stress of significant exertional muscle breakdown. If the warfighter is on special duty status (e.g., flight, dive, special operations), consultation with specialist in this area is recommended before returning to full duty.

Appendix. Return to Duty Guidelines for Physiologic Muscle Breakdown and Low Risk Warfighters with Exertional Rhabdomyolysis



Phase 1 Annotations:

- Strict light duty for 72 hours (recommend indoor duty if at all possible) and encourage oral hydration, salting of food to taste;
- No weight training;
- Must sleep seven to eight consecutive hours nightly;
- Must remain in thermally controlled environment.

Phase 2 Annotations:

- Advancing light duty, no strenuous physical activities, lightweight resistance training;

- Follow-up with care provider in one week;
- Progression to Phase 3 occurs when there is no significant muscle weakness, swelling, pain or soreness with supervised Phase 2 exercise. If myalgia persists without objective findings beyond 4 weeks, consider specialty evaluation to include psychiatry.

Phase 3 Annotations:

- Return to regular outdoor duty and physical training;
- Follow-up with care provider as needed.

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Potential Conflicts of Interest

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