NATIONAL CENTER FOR CASE STUDY TEACHING IN SCIENCE

Creatine and the Case of the Aging Athlete

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Jan is an active and physically fit woman in her mid-forties. As a former competitive college rower, she enjoys challenging herself with vigorous training sessions. Over the past year, Jan has become more and more engaged in CrossFit training and has even considered signing up for a senior's competition. She is feeling very encouraged by how her body still responds to training and has felt motivated to eat a nutritious diet. As part of Jan's training regimen, she also is taking some basic supplements including a multivitamin, whey protein, and creatine monohydrate.

During a recent routine annual physical exam and checkup, Jan's primary care provider noted her improved fitness level. Her bodyweight was a few pounds heavier than from the previous year, but this was clearly from added muscle mass. Her blood pressure and heart rate were typical of a patient 15 years younger. Jan shared that CrossFit training was comprised of a variety of exercises including high intensity interval training, Olympic weightlifting, aerobic exercises, and a whole range of related exercises. Jan had joined a CrossFit gym near her home and was thinking about competing in a competition that was coming up in about six months.

After finishing with his physical exam, Jan's provider reviewed her blood work. Overall, her blood parameters seemed to be normal. Although her total cholesterol and LDS levels were on the high end (total cholesterol 205 mg/dL; LDS 175 mg/dL), her HDL values were above average (59 mg/dL). This made her cholesterol/HDL ratio 3.47, which generally indicates protection against cardiovascular disease. Jan's doctor explained that HDL levels are increased through aerobic exercise, so it made sense that with training her levels would be improved. The one parameter that was flagged as being out of the normal range was her serum creatinine levels. The blood report indicated that a normal creatinine concentration is 1.0 mg/dL and Jan's blood levels were 1.3.

Jan asked what an elevated serum creatinine might indicate and her provider explained that creatinine is used as an indicator of kidney function. When serum creatinine is elevated that can be sign of diminished filtration capacity of the kidneys. Although Jan's levels of 1.3 were not especially high, it might be something they should watch on subsequent blood tests. Jan thought of a family friend who had suffered through years of dialysis treatments before finally succumbing to his chronic kidney disease. Those memories sharpened her concerns about the possibility of some kind of kidney problems of her own.

Later that evening, Jan was reminded of the creatinine on her blood tests as she was taking supplements after a workout. Could the creatine monohydrate she had been using be related to the creatinine in her blood? As she thought more about it, Jan wondered whether consuming creatine as a supplement might have been the cause of her elevated serum creatinine. She couldn't quite remember why a friend had recommended creatine monohydrate in the first place—what was it supposed to do? Moreover, could this supplement be damaging her kidneys? As she went to bed that night, Jan decided she should call her doctor's office in the morning.

 Photo credit: Rebecca Koch at Crossfit Syndicate, U.S. Air Force photo by Gustavo Castillo, <https://commons.wikimedia.org/wiki/File:Heidemarie_Couch,_CIV_(2)_(14321527319).jpg>.

Questions

1. Why is serum creatinine used as a clinical indicator of basic kidney function? To what parameter of renal physiology is blood creatinine related? What properties of creatinine make it a useful measure of kidney function? How does the renal clearance of creatinine compare with that of other molecules such as glucose, sodium, or para-aminohippuric acid (PAH)?

2. What is a "normal" concentration of serum creatinine? Why would elevated creatinine levels in the blood potentially suggest a problem with the kidneys? Is elevated serum creatinine alone a reliable indicator of kidney function? Explain your reasoning.

3. What is the physiological role of creatine in skeletal muscle function? Why might creatine monohydrate be marketed as a nutritional supplement for muscle performance? Conduct a literature search to find scientific reviews of creatine as a nutritional supplement. Is there scientific evidence to support creatine as an effective ergogenic aid?

4. What potential relationship might exist between creatine monohydrate ingested as a nutritional supplement and the levels of creatinine found in the blood? Explain how these molecules are related to one another in the human body.

5. Does creatine monohydrate used as a supplement pose any risk of side effects? More specifically, does creatine consumption cause an increase in serum creatinine? What does the scientific literature suggest about whether the consumption of creatine monohydrate poses a risk of damaging the kidneys?

6. A number of disease states trigger a dramatic loss of skeletal muscle mass. These muscle wasting diseases are often a devastating side effect of muscular dystrophies, cancer, glucocorticoid treatment, aging, and chronic kidney disease. What impact might skeletal muscle wasting have on serum creatinine levels? How might these conditions impact blood concentrations of creatinine and affect the assessment of normal kidney function?

7. Should Jan feel concerned about her slightly elevated levels of creatinine? Should she be concerned about consuming creatine monohydrate as a supplement? What advice would you give to Jan about whether she should continue to use creatine?