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Title: Is the vitamin C content of red blood cells a more stable indicator of body ascorbate status?

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Introduction:

Vitamin C, also called ascorbate, is an essential vitamin for normal growth and development. It is water soluble so it is found in blood and (when it's not needed) is excreted in urine. Because humans lack the ability to synthesize their own vitamin C they rely fully on dietary intake. Normal human vitamin C concentrations are between 50-80μM in plasma, while concentrations below 20μM are considered clinically deficient. Vitamin C may help overcome many illnesses and infections, and more recently links between vitamin C and cancer are being established. A previous study in our group reported concentrations of vitamin C in high grade tumours as suboptimal; another study suggested that vitamin C deficiency could progress tumour spread. Earlier studies had suggested that cancer patients may have lower plasma vitamin C levels compared to healthy controls. This highlights the need for vitamin C to be monitored and managed in a clinical setting, especially in cancer patients. Currently vitamin C would be measured in the plasma component of whole blood, but plasma is susceptible to recent dietary intake, making it difficult to define the body's true ascorbate status. It means that patients are required to fast, which may be particularly challenging for cancer patients. Unlike white blood cells which accumulate high levels of vitamin C via a vitamin C transporter in their membrane, red blood cells lack the transporter. Because of this, the vitamin C levels in red blood cells may be more stable and less influenced by recent dietary intakes.

Aim:

The aim of this study is to determine whether measuring vitamin C in red blood cells can provide a more stable indication of body vitamin C status; to monitor any kinetic effects such as a lag in the uptake of vitamin C into the red blood cells; and to optimize a method of measuring vitamin C in red blood cells that may eventually bypass the need for fasting blood samples.

Method:

Ten healthy volunteers were recruited to each provide four blood samples throughout the day following a night of fasting. The first blood sample was to be the fasting sample so volunteers had to go without breakfast. They were then supplied with the daily recommended supplement of vitamin C (200 mg), and returned every 2 hours for further blood draws over a period of 6 hours. The blood samples were spun to separate the main components of blood isolating the red blood cells and plasma, which were stored frozen until further analysis. Vitamin C detection was done by HPLC, a technique that allows the biomolecules within the blood samples to be separated so that vitamin C concentrations can be measured

Results:

We found higher levels of vitamin C in the plasma compared to the red blood cells at baseline. In addition, red blood cell levels showed less variance than plasma following the vitamin C intake. Vitamin C concentrations tended to peak sooner in plasma than in the red blood cells indicating a delay in red blood cells vitamin C uptake. A reducing agent was required for the red blood cell samples to recover all the vitamin C, indicating that there were factors causing oxidation of vitamin C during the processing of samples. These factors may include too much free iron, temperatures above 4°C, and light. Further optimization of the method is underway, including addition of a metal chelator to the samples.

Conclusion:

Our study indicates that body ascorbate status may be better represented by red blood cells. There is potential for less variable readings though there may be some kinetic effects that need to be further investigated. Although red blood cells tend to have a lower concentration of vitamin C than plasma, they are likely to more closely reflect the trends of vitamin C around the body. This may be beneficial when measuring vitamin C levels in patients who are feeling poorly, so that they do not have to stop eating for 12 hours in order to have their ascorbate levels tested.