SUMMARY

Blood transfusion is a life-saving procedure and an essential tool in the field of medicine. However, although there have been advancements and developments in storage techniques and transfusion methods, the demand for blood always outweighs its supply. Moreover, the low availability of donors suggests that improving the efficacy of stored erythrocytes and their shelf life, could be useful in meeting the demand for blood.

Oxidative stress has been found to play a major role in the reduction of erythrocyte survival during storage and is critical to the formation of the storage lesion. The review of literature elucidates the utilization of antioxidants to combat the oxidative stress during storage. However, a comprehensive study of the oxidative stress markers in erythrocytes during blood storage has not been carried out. Hence, this study aims to investigate the role of various antioxidants during blood storage. The initial studies were carried out on rats and the antioxidant which proved beneficial, was investigated further in human samples.

Whole blood was obtained from male Wistar rats and stored in CPDA-1 solution, with and without antioxidants (Vitamin C, Curcumin, Caffeic acid, Vitamin E and L-carnitine). Every fifth day, the oxidant and antioxidant status of the erythrocytes were continuously assessed through the following markers: (i) Morphology and count (ii) Hemoglobin; (iii) Reactive oxygen species; (iv) Superoxides; (v) Antioxidant enzymes (superoxide dismutase, catalase and glutathione peroxidase) (vi) Total antioxidant capacity [cupric ion reducing antioxidant capacity (CUPRAC) and antioxidant activity (AOA)]; (vii) Ascorbic acid; (viii) Lipid peroxidation products (conjugate dienes and malondialdehyde); (ix) Protein oxidation products (advanced oxidation protein products, protein sulfhydryls and Band 3); (x) Osmotic fragility; (xi) Hemolysis and (xii) Glucose.

Controls (rat samples) showed an effective storage period of 10 days, following which the efficacy of the erythrocytes declined, owing to accumulation of the products of oxidative damage. All the antioxidants (vitamin C, curcumin, caffeic acid, vitamin E and L-carnitine) maintained hemoglobin and antioxidant capacity, scavenged superoxides, modulated antioxidant enzymes and, protected lipids and proteins from oxidative damage. The experimental groups (with antioxidants) - vitamin C (60mM),...
curcumin (30mM and 60mM), caffeic acid (10mM, 30mM and 60mM) and vitamin E (2mM and 10mM) exerted a protective effect on the erythrocytes and provided a better storage period up to day 15, when compared to controls.

L-carnitine (10mM, 30mM and 60mM) proved most effective in combating oxidative stress, as observed in our results of better morphology and efficient storage period of 20 days (L-carnitine > vitamin C > vitamin E > caffeic acid > curcumin). Therefore, further investigations of L-carnitine was carried forward for studies on human samples.

The storage of human blood elucidated that the oxidative damage occurred from day 25 of storage, in comparison to day 10 in rats. L-carnitine proved beneficial to the human erythrocytes at 10mM and 30mM, as it successfully ameliorated the effects of oxidative stress, up to a period of 35 days. Prolonged storage period of 55 days showed that L-carnitine could protect the erythrocytes partially, as it could not attenuate protein and lipid peroxidation completely. However, L-carnitine could maintain the antioxidant capacity, in terms of glutathione and ascorbic acid (Diagram 16).

Hence, L-carnitine can be utilized as an effective additive in storage solutions of whole blood. This study lays the foundation for further investigations on L-carnitine, in combination with other antioxidants, in improving the efficacy of erythrocytes during blood storage. This study also forms an effective model of the storage lesion and highlights the potential of antioxidants in the better management of stored blood.