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Flow Cytomorphometry for Assessment of Red Blood Cell Storage Lesion

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During hypothermic storage, red blood cells (erythrocytes) undergo metabolic alterations, called storage lesions. These alterations are associated with changes in the cell membrane that alter the cell morphology and ultimately lead to cell lysis. As quality control, hemolysis is the gold standard to measure the deterioration degree of stored red blood cells. However, this measure is not standardized between laboratories and requires complex techniques.

This study proposes an automated system for morphological analysis of erythrocytes as alternative method to assess the degree of damage in stored red blood cells. For this aim, a microscope is coupled to a flow chamber to capture images of moving cells in situ in the flowing suspension. The continuous flow allows a quick exchange of cell samples providing a large data sets for statistical analysis. For morphological analysis, a custom made image processing algorithm is presented. The algorithm classifies the erythrocytes into one of three defined morphological classes (Discocytes, Echinocytes and Spherocytes) according to specific morphological feature values. The morphological classes represent increasing deterioration of stored erythrocytes. Morphological results were compared with biochemical measurements including hemolysis to validate the proposed method.

For data collection, samples of several red blood cell units were assessed for a storage period of 13 weeks. Rising percentages of spherocytes as well as morphological index, representing the average cell shape of the blood sample, correlated well with hemolysis levels. It was possible to define threshold levels for the percentages of spherocytes and morphological index in order to estimate the quality of the blood samples. Samples above/below these thresholds are in almost all cases also above/below the standard hemolysis threshold of 0.8%.

The results presented here show the viability of the proposed method for the assessment of red blood cell storage lesions, validated through the correlation with hemolysis levels. The proposed technique, called flow cytomorphometry proved to be a simple, fast and adequate method to evaluate erythrocyte storage lesions.