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 Title : HEMODYNAMICS AND OXYGEN AVAILABILITY DURING ACUTE HEMODILUTION IN CONSCIOUS MAN  
 Authors : N.R. Fahmy, M.D., H.P. Chandler, M.D., D.G. Patel, M.D., and D.G. Lappas, M.D.  
 Affiliation: From the Anesthesia and Orthopedic Services of the Massachusetts General Hospital and the Departments of Anaesthesia and Orthopaedics, Harvard Medical School, Boston, Massachusetts 02114

### Introduction

Since 1960, hemodilution has been in extensive clinical use because of (1) avoidance of immunological and infective hazards of homologous blood transfusion; (2) biochemical changes which bank blood undergoes during storage; (3) improved rheological properties of diluted blood allow better tissue perfusion; and (4) blood conservation (economical advantage). Nevertheless, surprisingly few studies explored its physiologic consequences in man. We report the effects of acute hemodilution on hemodynamics and oxygen transport in conscious man (no previous reports) to eliminate the known modifying effects of anesthesia.

### Methods

Six patients aged from 23 to 69 years scheduled for total hip replacement with hemodilution were studied. Patients with cardiopulmonary or renal disease were excluded. Peripheral arterial, pulmonary arterial, and two peripheral venous catheters were inserted. Before induction of anesthesia, approximately 3 units (1475±108 ml) of blood were collected in plastic bags (containing acid-citrate-dextrose) via the arterial catheter, simultaneously replaced with lactated Ringer's solution in volume three times the blood withdrawn to maintain normovolemia.

Measurements were performed before and after hemodilution, and at the end of operation. Measurements included systemic arterial, central venous and pulmonary arterial and wedge pressures, cardiac output (thermodilution), heart rate (ECG), arterial and mixed venous P<sub>O</sub><sub>2</sub>, P<sub>CO</sub><sub>2</sub>, pH and O<sub>2</sub> content, lactate and pyruvate, 2,3 DPG, P<sub>50</sub>, total plasma proteins, hematocrit, hemoglobin and coagulation studies (PT, PTT, fibrinogen and platelet count). At end of operation, 20 mg furosemide were given to enhance diuresis.

### Results

Hematocrit was lowered from 42 to 26.3% by withdrawing 1475±108 ml blood. Intraoperative blood loss averaged 1049±111 ml; it was replaced by lactated Ringer's solution and the patient's own blood was re-infused toward the end of the procedure. No homologous blood was required and no postoperative complications occurred. Urine output at end of operation was 1150±142 ml.

Cardiac output increased significantly (P<0.01) after hemodilution and at end of operation due to an increase in stroke volume; heart rate did not change significantly. Systemic vascular resistance decreased significantly (P<0.01) with hemodilution. Right atrial pressure increased significantly (10.1±2.4 to 15.1±3.0; P<0.05), but systemic and

pulmonary arterial and wedge pressures did not change significantly.

Arterial and mixed venous O<sub>2</sub> content decreased substantially, but arterio-venous O<sub>2</sub> content difference was unchanged following hemodilution. 2,3 DPG levels and P<sub>50</sub> were unchanged. Blood lactate and pyruvate levels were not significantly changed. Fibrinogen concentration and platelet count decreased significantly.

### Discussion

Our results indicate that an acute decrease of hematocrit was adequately compensated for in conscious man. The major compensatory response was an increase in cardiac output due to an increase in stroke volume. A decrease in blood viscosity resulting from hemodilution would lead to a parallel decrease in systemic vascular resistance. This, together with an increased venous return, account for the augmented stroke volume.

Systemic oxygen transport (cardiac output X arterial O<sub>2</sub> content) was maintained by compensatory increase in total blood flow. Blood volume, although not measured, was presumably maintained with hemodilution, since cardiac output increased and heart rate was unchanged. Overall tissue perfusion and oxygenation were well maintained as evident from unchanged lactate and pyruvate and A-VDO<sub>2</sub>. There was no increased bleeding tendency.

Our data indicate that acute hemodilution was well tolerated by all patients and suggest that this technique can be used safely in elective hip replacement and can (by providing fresh autologous blood) help reduce homologous blood transfusions, thereby decreasing the incidence of immunological and infective transfusion risks. Our experience has now been extended to include 47 patients, who did not require homologous blood transfusion during their entire hospitalization.