Introduction:
Acute changes in PCO2 are buffered by non-carbonic weak acids (ATOT), i.e., albumin, phosphates and hemoglobin. Aim of the study was to describe acid-base variations induced by in-vitro PCO2 changes in critically ill patients’ blood and isolated plasma, compare them with healthy controls and quantify the contribution of different buffers.

Methods:
Blood samples were collected from patients admitted to the ICU and controls. Blood and isolated plasma were tonometered at 5 and 20% of CO2 in air. Electrolytes, pH, blood gases, albumin, hemoglobin and phosphates were measured. The Strong Ion Difference (SID) was calculated [1] and non-carbonic buffer power was defined as $\beta = -\Delta \text{HCO}_3^-/\Delta \text{pH}$ [2]. T-tests and linear regression were used for analysis.

Results:
Seven patients and 10 controls were studied. Hemoglobin, hematocrit and albumin were lower in patients (p<0.001), while SID and phosphates were similar. PCO2 changed from 29±4 to 108±13 mmHg, causing different blood pH variations in patients and controls (0.43±0.06 vs. 0.36±0.02, p=0.03). Patients had lower blood and plasma $\beta$ (20±5 vs. 30±4, p<0.001 and 2±2 vs. 4±1, p=0.03, respectively). Figure 1 shows changes in [HCO3-] and SID induced in blood by PCO2 variations. In both populations, 82±12% of [HCO3-] change was due to SID variations, while only 18±12% to changes in ATOT dissociation. A significant correlation between hematocrit and $\Delta$SID was observed in the whole study population (Figure 2).

Conclusion:
The $\beta$ of ICU patients was lower, likely due to reduced albumin and hemoglobin concentrations. Similar PCO2 increases caused therefore greater pH variations in this population. Electrolyte shifts, likely deriving from red blood cells [3], were the major buffer system in our in-vitro model of acute respiratory acidosis.

References:
2. Van Slyke DD J Biol Chem 52:525-570, 1922

Image 1:

Changes in SID and bicarbonate concentration induced in...
whole blood by acute in vitro PCO2 variations.

Image 2:

Regression between hematocrit and SID variation observed in the whole study population.