

Title: METABOLIC CHANGES DURING THE ANHEPATIC PHASE OF LIVER TRANSPLANTATION  
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**Introduction.** Liver transplantation offers a unique opportunity to observe changes in essential metabolic parameters during a time when the body is functioning without its major metabolic organ. Previous authors<sup>1-3</sup> have described profound hypoglycemia during the anhepatic phase presumed secondary to an absence of hepatic gluconeogenesis and glycolysis. In addition severe metabolic acidosis requiring massive doses of sodium bicarbonate has been described<sup>1-3</sup> and attributed to the failure to metabolize lactic acid. Since these issues are important for clinicians providing anesthesia for liver transplantation as well as for basic scientists interested in hepatic regulation of acid-base balance and glucose homeostasis we undertook the following study.

**Materials and Methods.** Twenty-eight consecutive patients undergoing orthotopic hepatic homotransplantation were reviewed following approval by the Institutional Review Board. All patients received nonglucose containing crystalloid solutions (Plasmalyte<sup>R</sup>) and blood products as necessary to maintain intravascular volume. Two patients who received glucose and insulin for treatment of hyperkalemia were excluded. None of the subjects received steroids until after revascularization and none were on hyperalimentation at the time of the operation. Arterial blood samples were drawn for glucose, potassium, and arterial blood gases when deemed clinically necessary by the anesthesiologist. Bicarbonate was administered when necessary to maintain pH 7.30.

**Results.** The anhepatic period lasted from 50 to 137 minutes (93±21 min, mean±SD). Serial blood glucose determinations were done in all patients. Mean glucose value was 169±52 mg%. The lowest value recorded was 89 mg% with a high of 317 mg%. By linear regression analysis there was no significant change in glucose over time. Intravenous sodium bicarbonate was administered to 9/28 patients, (33±60 meq) to correct for increasing metabolic acidosis. Excluding these patients, pH and HCO<sub>3</sub> remained stable during the anhepatic period (pH 7.40±.08, HCO<sub>3</sub> 19±2.7) and the 9/28 patients requiring supplemental bicarbonate therapy did not exhibit progressive metabolic acidosis. These results are summarized in table 1.

TABLE 1

| Time(min) | Glucose(mg%) | pH       | HCO <sub>3</sub> |
|-----------|--------------|----------|------------------|
| 0-30      | 169±50       | 7.40±.07 | 19.1±2.8         |
| 30-60     | 162±44       | 7.39±.08 | 19.1±2.6         |
| 60-90     | 179±68       | 7.43±.09 | 19.2±2.6         |
| 90        | 152±22       | 7.38±.07 | 17.8±2.2         |
| TOTAL     | 169±52       | 7.40±.07 | 19.0±2.7         |

Transfusion requirements are described in table 2.

TABLE 2  
 TRANSFUSION REQUIREMENTS (units/hour)

|                     | MEAN    | MAX | MIN |
|---------------------|---------|-----|-----|
| Packed RBC          | 2.1±2.3 | 9.6 | .5  |
| Fresh Frozen Plasma | 2.2±1.9 | 8.4 | .5  |
| Platelets           | 1.8±1.0 | 3.8 | 0   |

**Discussion.** This data suggests that supplemental glucose during the anhepatic phase of liver transplantation is not required. That the anticipated hypoglycemia did not occur may be due in part to decreased glucose utilization secondary to hypothermia (31-33°C) combined with the ongoing infusion of dextrose containing blood products. Blood products have an estimated glucose of 200-350mg% (see table 2).

Metabolic acidosis requiring large quantities of exogenous sodium bicarbonate is uncommon. Massive blood loss with appropriate volume replacement may provide rapid clearance of accumulating lactic acid thus reducing the need for bicarbonate therapy.

We conclude that nonglucose containing crystalloid solutions should be used during anesthesia for liver transplantation without fear of developing significant hypoglycemia. Boluses of 50% dextrose are not required and may cause unacceptable hyperglycemia. Frequent sampling of blood sugar is unnecessary and only adds to the cost of the operation. Metabolic acidosis is easily controlled with small doses of sodium bicarbonate in the absence of other conditions which also cause metabolic acidosis.

**References.**

1. Aldrete JA, Goldman E, and de Campo T: Anesthetic implications in hepatic transplantation. *Anesthesia and the Patient with Liver Disease*. pp 111-122.
2. Farman JV: Anaesthesia in the presence of liver disease and for hepatic transplantation. *Brit J Anaesth*, 44, 946-952, 1972.
3. Calne RY, Williams R: Current problems in surgery, Liver Transplantation. Vol XVI, No. 1, Jan, 1979.