Title: FENTANYL REDUCES HYPERGLYCEMIA IN PEDIATRIC PATIENTS UNDERGOING HYPOTHERMIC CARDIOPULMONARY BYPASS

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Introduction: Hyperglycemia has been reported in pediatric patients undergoing cardiac surgery with deep hypothermia (1). This may pose a danger of increased cerebral damage to those who undergo surgery with profoundly hypothermic circulatory arrest (PHCA) (2). Despite the removal of glucose-containing solutions from both maintenance intravenous (IV) and cardiopulmonary bypass (CPB) clear priming fluids, hyperglycemia occurs in most pediatric patients during CPB, and is thought to be a neuroendocrine response (3). Other factors which might be important include the administration of citrate-phosphate-dextrose - adenosine (CPDA-1) blood, corticosteroids, and narcotic analgesics. We have studied a group of children to assess which of these factors may influence the blood glucose during CPB.

Methods: With appropriate institutional approval, the records of 22 patients (mean age 4 yrs 8 mos, range 2.5 mos - 15 years) undergoing surgery under either hypothermic CPB (n=15) or PHCA (n=7) were reviewed retrospectively. No dextrose was infused in either prebypass IV fluids or in the clear priming fluid for CPB. Blood glucose levels were noted immediately after the induction of anesthesia (control), immediately after initiation of CPB (CPB #1), within 30 minutes of cessation CPB (post CPB), and upon arrival in the Intensive Care Unit (ICU). The doses of fentanyl and of solumedrol per kg body weight administered prior to termination of CPB were calculated. The doses of dextrose contributed by CPDA-1 blood and by any vasoactive infusions during post CPB blood sampling were calculated in mg/kg/min. The effects of these exogenous sources of dextrose, and of doses of fentanyl and solumedrol on blood glucose levels were studied by multiple regression analysis.

Results: The mean blood glucose levels rose from 92.3 mg/dl ± 25.2 (S.D.) (control) to 108.9 mg/dl ± 23.4 (CPB #1) to 174.7 mg/dl ± 33.3 (post CPB) to 216 mg/dl ± 42.9 (ICU). No correlation was demonstrated between the volume of CPDA-1 blood used in the prime and post CPB glucose levels. No correlation was found between the dosage of solumedrol and blood glucose levels. Post CPB glucose levels showed a significant inverse relationship with the total dose of fentanyl administered before and during CPB. (See Fig 1.)

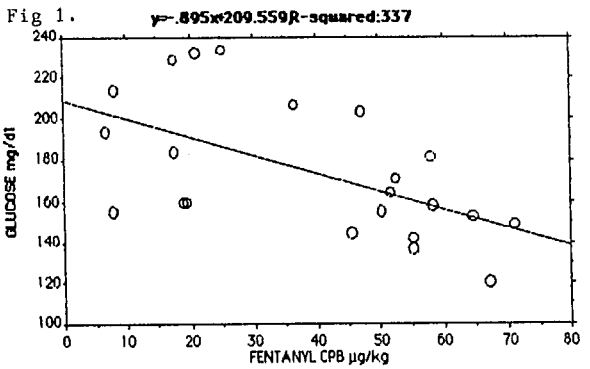
Discussion: Because increased neurologic deficit has been associated with elevated blood glucose levels in asphyiated primates (4) and in pediatric patients after PHCA (2), it would seem prudent to avoid hyperglycemia during procedures in which impaired cerebral perfusion may occur, such as during PHCA or CPB. This can be partly achieved by the elimination of dextrose containing solutions from the fluid therapy regime. In addition it is necessary to block the neuro-endocrine response to surgery, CPB, and hypothermia, which tends to release endogenous glucose stores. Fentanyl, which in adequate dosage has been demonstrated to decrease the stress response in other circumstances, appears to provide such protection. Although it is yet to be determined at what level an elevation in blood glucose may contribute to neurologic deficit, levels of 150 mg/dl (4) and of 216 mg/dl (2) have been implicated. It appears that levels above 200 mg/dl can be avoided in pediatric patients undergoing hypothermic CPB or PHCA by:

1) avoiding glucose containing solutions in both maintenance IV fluids and in the CPB clear priming solution, and

2) the administration of fentanyl in doses of at least 50 mcg/kg.

The effectiveness of glucocorticosteroids in preventing post-operative complications following hypothermic CPB is controversial; however, the administration of solumedrol does not appear to result in significant hyperglycemia in these patients.

Fig 1.



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