Effects of xylitol- and/or glutamine-supplemented parenteral nutrition on septic rats

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1. The effects of parenteral nutrition with or without xylitol and/or glutamine supplementation were studied in septic rats after 4 days of treatment.
2. Septic rats treated with xylitol- and/or glutamine-supplemented parenteral nutrition survived sepsis significantly better than other parenteral nutrition-treated septic rats: the cumulative percentage of deaths over 4 days in septic rats treated with xylitol–glutamine-supplemented parenteral nutrition was 9.5% compared with 54.5% in septic rats given parenteral nutrition without xylitol and glutamine, and 52.4% in septic rats treated with parenteral nutrition supplemented with glucose.
3. Xylitol- and/or glutamine-supplemented parenteral nutrition resulted in improved nitrogen balance in septic rats: the cumulative nitrogen balance over the 4 days of treatment was positive in the rats given xylitol-supplemented parenteral nutrition and more positive when rats were treated with xylitol–glutamine-supplemented parenteral nutrition, as compared with other groups of septic rats.
4. The rate of loss of intracellular glutamine in skeletal muscle was markedly decreased (P<0.001) in response to xylitol- and/or glutamine-supplemented parenteral nutrition in septic rats.
5. Hepatic protein and RNA contents were increased in septic rats treated with xylitol- and/or glutamine-supplemented parenteral nutrition. Similarly, protein and RNA contents were markedly increased in muscles of septic rats treated with xylitol- and/or glutamine-supplemented parenteral nutrition.
6. The rates of incorporation of leucine/tyrosine into liver/muscle proteins in vitro were increased and the rate of muscular tyrosine release was decreased in response to xylitol- and/or glutamine-supplemented parenteral nutrition in septic rats.
7. It is concluded that the administration of xylitol- and/or glutamine-supplemented parenteral nutrition is beneficial to septic rats and possibly to septic patients.

INTRODUCTION

Sepsis is associated with prolonged negative nitrogen balance, altered glucose dynamics, accelerated lipolysis and an increase in resting metabolic expenditure (for reviews, see [1–3]). These metabolic derangements may precipitate nutritional depletion in septic patients, even leading to death, unless appropriate nutritional therapy is provided [4]. Different energy (e.g. glucose, lipids) and nitrogen (e.g. branched-chain amino acids, glutamine) sources have been used to meet the need for nutritional support in response to sepsis and directed towards reducing protein wasting and improving survival rates (for reviews, see [5]).

Xylitol (C₅H₁₁O₃) is a five-carbon polyol and a normal intermediate product in the glucuronic acid–xylulose cycle [6, 7] and the pentose phosphate pathway [7]. It exerts a nitrogen-sparing effect without appreciable effects on insulin secretion (for a review, see [8]), and is metabolized primarily in the liver, where it is converted via an insulin-independent pathway to glucose 6-phosphate (approximately 70% conversion into glucose) [9, 10]. This sugar alcohol results in only moderate elevations in blood glucose [9] and insulin levels when administered intravenously in normal or traumatized patients (see [8]). Moreover, recently it has been found that xylitol disposal is increased after trauma [11]. Other studies have demonstrated a beneficial effect of xylitol-supplemented total parenteral nutrition (TPN) in stressed [12] and thermally injured rats [13], but the effects of xylitol-supplemented parenteral nutrition in combination with amino acids in response to sepsis is unknown.

Studies of amino acid release from skeletal muscle, coupled with measurements of visceral organ uptake, have demonstrated the central role that glutamine plays in interorgan nitrogen transport in response to sepsis (see [14–16]). Recently, a direct correlation between the intracellular glutamine concentration of skeletal muscle and the rate of protein synthesis was observed in sepsis, endotoxaemia and malnutrition [14, 17, 18]. The cause of intracellular glutamine depletion, however, remains obscure. A link between the existence of the glutamine pool in muscles and a carrier system for glutamine has been suggested [19]. Moreover, recent studies have demonstrated that glutamine-supplemented TPN is beneficial in surgical patients [20] and experimental animals with intestinal injuries (see [21]). More recently, studies from this laboratory have demonstrated the beneficial...