Plasma carnitine levels during total parenteral nutrition of adult surgical patients[1-3]

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ABSTRACT Plasma levels of total carnitine remained unaltered in surgical patients fed intravenously up to about the 20th day of feeding. After that day there was a gradual decline in the levels. When oral feeding was recommended, levels rapidly returned to normal. It is concluded that adult patients can maintain plasma levels of carnitine much longer than newborns when no exogenous carnitine is supplied. *Am J Clin Nutr* 1982;36:569–572.

KEY WORDS Total parenteral nutrition, total carnitine, acylcarnitine

Introduction

Carnitine is essential for optimum fatty acid oxidation (1). Lack of carnitine or an absence of carnitine acyltransferase gives rise to a well-defined clinical picture characterized mainly by intolerance to long-chain fatty acids (2). In the human neonate and the neonatal rat, carnitine synthesis from its precursors (lysine and methionine) is poorly developed (3). Hence it is to be expected that feeding a diet low in carnitine content would lead to a relative carnitine deficiency in newborn mammals. This has been shown to be the case in neonates fed a soybean formula (4) or fed intravenously (5, 6) as judged from decreasing blood and urinary levels of both total and acylcarnitine.

In man, carnitine synthesis from γ-butyrobetain occurs in liver and kidney only (3). Hence one might expect decreased synthesis in patients suffering from hepatic or renal failure, even if a sufficient amount of lysine and methionine is present in the diet. We do not know whether endogenous carnitine synthesis can cover the daily requirements.

In the study presented here it was asked whether total parenteral nutrition (TPN), which supplies minimal amounts of carnitine (5), would result in decreased plasma carnitine levels in adults as it does in the newborn.

Materials and methods

A total of 47 patients of both sexes, aged 20 to 70 yr, was studied. Nineteen of these patients were followed for more than 30 days after the start of TPN. In the other 28 patients, blood samples would be obtained only once or twice during treatment. These have not been included in the tables, even though values obtained on any particular day of infusion were within the range of those found for the same day in the group of 19 patients. **Table 1** surveys the patient population.

Patients on TPN were fasting, except for water. They received their TPN mixture continuously via a central vein catheter, and were given either high, moderate, or low lipid intakes. All patients received 75 g of crystalline amino acids daily, as either Aminosyn or Travasol 10% (**Table 2**).

Blood samples were taken in the morning, usually before the daily Nutralipid was added to the infusion. Total and free plasma carnitine were determined in 100 μl of plasma as described previously (5). Plasma levels of β-hydroxybutyrate were determined according to Persson (7). The "Student's" *t* test and ANOVA followed by Duncan's multiple range test were applied for statistical analysis.

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Results

Most of the patients maintained their original body weight through TPN. One lost 6 kg (from 71 to 65 kg) and one 5 kg (52 to 47).

Total carnitine levels in the plasma were normal at the start of TPN and, on the whole, remained unchanged up to the 15th day of infusion. After that day, the levels commenced to fall and by day 40 had fallen by an average of 32.6 ± 5.46% ($p < 0.001$). As soon as TPN was interrupted and oral feeding had started, plasma levels increased again within 2 to 3 days (**Table 3**).

Acylcarnitine levels did not change appreciably during iv feeding (Table 3) and, on the whole, were rather low indicating that fatty acid oxidation was not occurring at a high rate.

Levels of β-hydroxybutyrate were very low but occasionally reached values above 0.1 μmol/l. This occurred when acylcarnitine levels were also high, again confirming the positive correlation between levels of ketone and acylcarnitines (8).

Figure 1 shows three patients in whom there was a profound fall of plasma carnitine levels as TPN was continued. All three patients had gastrointestinal problems. None received any Intralipid.

An interesting case is shown in **Figure 2**. The very low levels of both total and acylcarnitine found on the 20th day of iv feeding suddenly trebled, body weight rose, yet the patient died 5 days after the last blood sample was taken. No data on β-hydroxybutyrate were available. However, these changes suggest that the patient was increasing his rate of fat utilization and muscle breakdown.

One patient with cancer of the esophagus was fed intravenously for 82 days. His total carnitine level decreased from 41 μmol/l on day 47, to 27.3 on day 61, and was the same on day 83. However, another patient whose small bowel had been removed a year previously and who had since been feeding herself intravenously only had levels of 8 and 5.8 for total and acylcarnitine, respectively.

TABLE 1
Survey of the patient population studied

	No of patients
Cancer of esophagus	9 (3)*
Crohn's disease	10 (5)
Multiple trauma	5 (1)
Gastrointestinal fistulas	15 (6)
Pancreatitis	5 (2)
Others	3 (1)
Total	47

* Patients included in Table 3 are in parentheses.

TABLE 2
Composition of intravenous mixture

High lipid	
Aminosyn 10% or Travasal 10%*	750 ml/day
Dextrose 20%	750 ml/day
Nutralipid 10%†	1500 ml/day
Moderate lipid	
Aminosyn 10%	750 ml/day
Dextrose 20%	1750 ml/day
Nutralipid 10%	500 ml/day
Low lipid	
Aminosyn 10%	750 ml/day
Dextrose 20%	2250 ml/day
Nutralipid 10%	500 ml 3 times/wk

* Abbot Hospital Products, IL.
† Pharmacia, Quebec, Canada.

TABLE 3
Plasma levels of total and acylcarnitine in the course of total parenteral nutrition in surgical patients*

Days†	1	5	10	15	20	30	40	>40	After
Total	44.25^{ae}	41.4^{abc}	44.0^{ace}	36.6^{ab}	34.2^{bd}	37.3^{bc}	27.1^{d}	25.1^{d}	52.8^{e}
	±1.5	±2.0	±3.1	±3.4	±3.3	±2.8	±1.5	±4.2	±4
	(19)‡	(15)	(12)	(15)	(15)	(17)	(10)	(5)	(6)
Acyl	8.6	11.9	7.2	9	7.2	6.3	6.8	9	9.2
	±1.7	±3.6	±0.8	±1.3	±1.03	±1.3	±1.6	±2	±1.2

* Means ± SE (μmol/l). Figures in the same row not having the same superscript differ from each other for at least $p < 0.05$.
† Days on TPN. After: 1 to 2 days after cessation of TPN and start of oral feeding (bouillon and iv dextrose).
‡ Number of patients in parentheses.

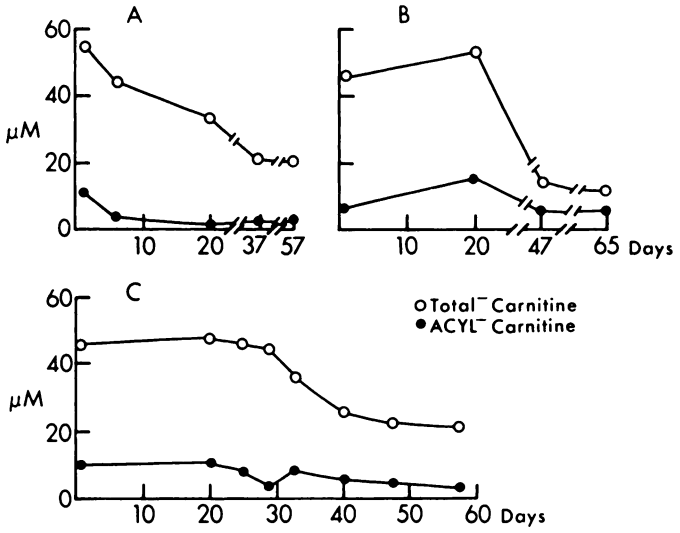

FIG. 1. Plasma levels of total and acylcarnitine in three patients fed intravenously without Intralipid. *Ordinate* concentration of total (*white symbols*) or acylcarnitine (*black symbols*) in μmol/l. *Abscissa*, days on TPN. *A*, *B*, *C* represent different patients.

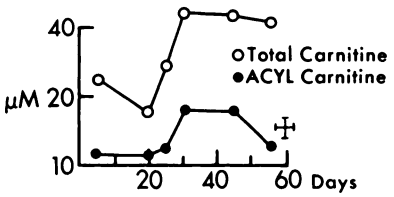

FIG. 2. Plasma levels of total and acylcarnitine in a patient who died 2 days after the last determination. *Symbols* as in Figure 1.

Discussion

Our data show that in contrast to newborn patients, adult subjects are capable of maintaining plasma carnitine levels for a considerable length of time without being supplied with any exogenous carnitine. In other words, adults are capable, to a large extent, of synthesizing their own carnitine and this is not the case for the newborn. This is confirmed by the data of Hoppel and Genuth (9) who showed a rise in total plasma carnitine levels in response to a 4-day fast. Nevertheless, even in the adult, there comes a time when endogenous synthesis apparently is not sufficient to maintain stable carnitine levels. This usually occurs between days 20 to 40 of the iv feeding schedule. In some patients it occurs sooner, probably because they have smaller carnitine stores; in others it occurs later, very probably because their stores of carnitine are greater. The eventual decrease in the total carnitine levels seen in all cases is probably related to the inability of the tissues and particularly the liver to maintain a sufficiently high rate of carnitine synthesis as suggested by Rudman et al (10) and may reflect undetected liver damage.

It should be stressed, however, that plasma level of total carnitine need not necessarily reflect the actual ability of the body to synthesize this substance. In pregnant women, for instance, plasma levels of carnitine fall to very low values (11), yet excretion into the urine of the substance increases during pregnancy suggesting that there is another control mechanism at work. Unfortunately, we were not able to collect urines for carnitine determinations in our patients. There were two reasons for this: one was the difficulty of organizing such a collection. More importantly, however, muscle breakdown occurs after surgery. This breakdown lasts for quite some time and hence data obtained in such a situation would be difficult to interpret.

We may conclude that adult patients who have been fed intravenously for less than 30 days usually do not require any carnitine supplement.

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