

The nutritional fate of the undernourished surgical patient in convalescence

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Patients requiring intravenous nutrition possess a wide variety of metabolic and nutritional abnormalities before therapy is started (Woods & Marston, 1977; Newton *et al.* 1979). However, little information is available concerning the alterations in nutritional measurements occurring either during the process of intravenous feeding or during convalescence.

The purpose of this study was to compare nutritional and metabolic measurements in a group of undernourished surgical patients before and immediately after a course of parenteral feeding, and during convalescence.

Patients and methods

Patients were referred before parenteral feeding by the clinicians responsible for their care, the decision to use this therapy having been made on clinical grounds. Informed consent was obtained from each patient and the study was approved by the local hospital Ethics Committee.

Each patient was given an intravenous feeding regimen which provided 0.23 g nitrogen/kg body-weight per d. The provision of energy was on the basis of 0.843 MJ (200 kcal)/g infused N.

Twelve patients were studied before the start and immediately after the completion of parenteral feeding. Where possible further measurements were made one month after the end of parenteral feeding.

The diagnoses and other clinical details are shown in Table 1. All patients were seriously ill catabolic subjects.

Measurements were made of weight, mid-upper arm circumference and skinfold thickness at four sites (biceps, triceps, suprailiac, subscapular) using Holtain callipers (Weiner & Lourie, 1969).

Arm muscle circumference (AMC) was calculated from the formula (Gurney & Jelliffe, 1973):

$$\text{AMC} = \text{Arm circumference} - \pi \times \text{triceps skinfold}$$

Fat, as a percentage of total body-weight, was calculated from the formulae of Durnin & Rahaman (1967). Fat-free mass (FFM) was calculated from the formula:

$$\text{FFM} = \text{Total body-weight} - \text{weight of body fat}$$

Table I. *Clinical details of patients studied*

Male	9
Female	3
Mean age (years)	56.3
Mean duration of parenteral feeding (d)	14.4
Diagnosis:	No.
Carcinoma of oesophagus	1
Carcinoma of stomach	1
Carcinoma of colon	2
Carcinoid tumour	1
V.I.P. adenoma	1
Crohn's disease	2
Portal hypertension	1
Gastric ulcer	1
Biliary fistula	1
Dietary insufficiency	1

Venous blood was taken after an overnight fast and a 4 ml portion was deproteinized with ice-cold perchloric acid. The protein-free extract was assayed for lactate, alanine, 3-hydroxybutyrate and glucose, using automated enzymatic analysis (Lloyd *et al.* 1978). Plasma samples were assayed by automated analysis (Technicon, MTII) for total protein, albumin, triglyceride, and cholesterol. Plasma

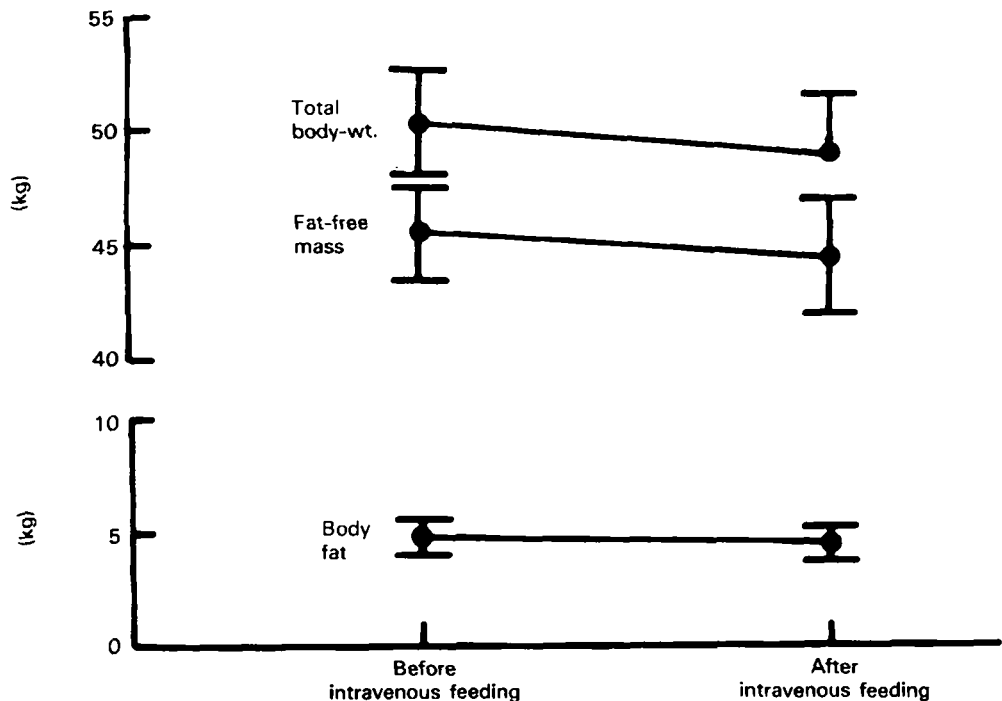


Fig. 1. Anthropometric measurements before and immediately after intravenous feeding. Values are means with their standard errors represented by vertical bars for twelve patients. In no case is there a statistically significant difference between the pre- and post-feeding values.

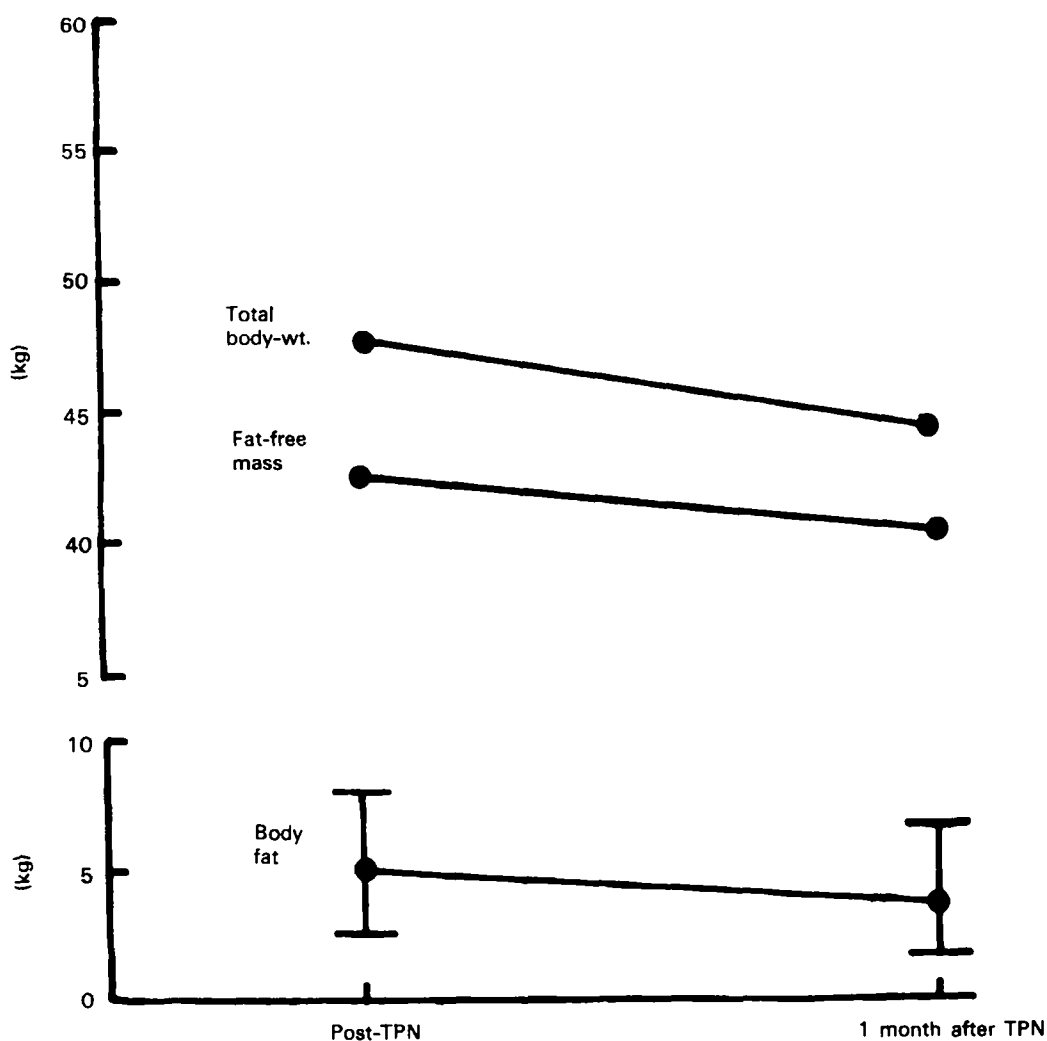


Fig. 2. Anthropometric measurements made immediately after end of parenteral feeding together with those made 1 month later. Values are means with their standard deviation (where given) represented by vertical bars. Changes in total body-weight and fat-free mass were not significant. Change in body fat was significantly different ($P < 0.01$).

non-esterified fatty acids were measured by a colorimetric method (Duncombe, 1964).

Statistical analysis was performed using Wilcoxon's matched-pairs signed-rank test.

The effect of parenteral nutrition

Anthropometric measurements. Before the start of parenteral feeding, total body-weight, fat-free mass and body fat were low (mean values (kg) 50.3, 45.5 and 4.8 respectively). There were no significant changes in these variables comparing values before and immediately after parenteral feeding (Fig. 1). No significant

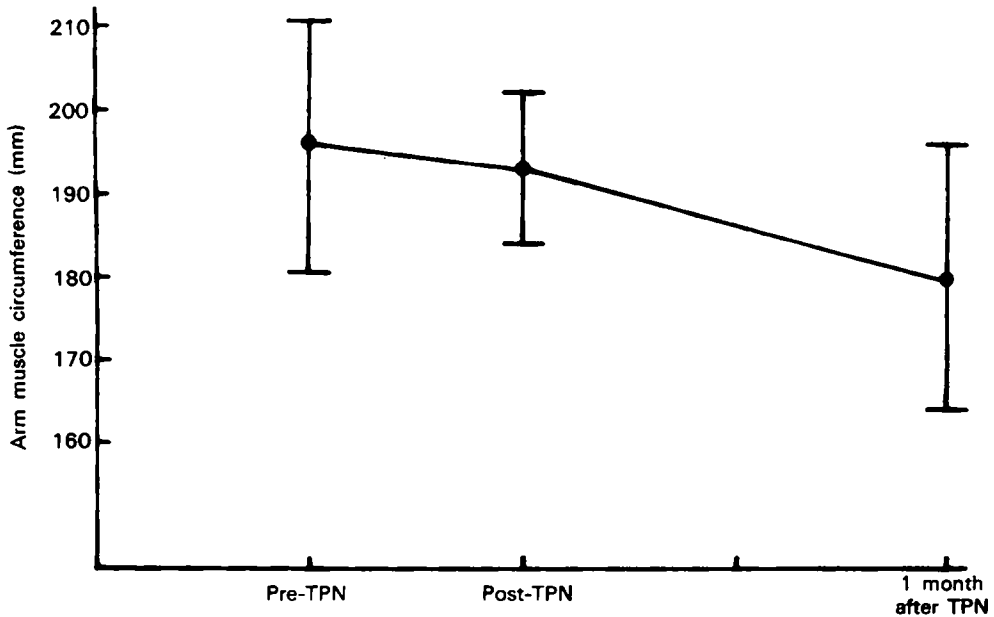


Fig. 3. Serial measurements of arm muscle circumference collected before and immediately after the end of parenteral feeding and one month after cessation of the therapy. Values are means with their standard errors represented by vertical bars.

The difference between pre- and post-TPN values was not significant. Post-TPN values and those measured 1 month later differed significantly ($P < 0.05$).

changes occurred for total body-weight or fat-free mass comparing values immediately after parenteral feeding with those measured 1 month later, but the weight of body fat showed a significant decline (Fig. 2).

Arm muscle circumference similarly did not change during the period of parenteral feeding but fell significantly during the month after parenteral feeding (Fig. 3).

Biochemical measurements. Comparing values before and after parenteral nutrition, the only significant alteration was an increase in plasma cholesterol concentration (Table 2).

Discussion

The prevalence of undernutrition in hospital patients. Abnormalities of indices of protein nutrition occur very frequently in unselected surgical in-patients, some measurements being low in more than 50% of patients (Bistrian *et al.* 1975) (Table 3). Hill *et al.* (1977) confirmed that protein nutrition is frequently deficient in surgical patients, and also found frequent abnormalities of vitamin status (Table 4). Despite these observations, severe malnutrition in surgical patients is less common, Hill finding marked depression of nutritional indices in a group studied more than 1 week after major surgery. This group comprized 24% of all patients studied.

Table 2. *Biochemical measurements before and after intravenous feeding*

(The measurements refer to concentrations in whole venous blood or plasma. Values are means with their standard errors for twelve patients)

	Before IVN		After IVN		Statistical significance 2P*
	Mean	SEM	Mean	SEM	
Albumin (g/l)	30.0	2.1	30.8	1.5	NS
Total protein (g/l)	56.8	2.7	60.6	2.0	NS
Lactate (mmol/l)	0.99	0.14	0.91	0.16	NS
Alanine (mmol/l)	0.22	0.03	0.22	0.04	NS
Glucose (mmol/l)	5.70	0.40	5.50	0.80	NS
Triglyceride (mmol/l)	1.31	0.27	1.21	0.23	NS
Non-esterified fatty acids (mmol/l)	0.46	0.06	0.46	0.06	NS
Cholesterol (mmol/l)	2.52	0.23	3.99	0.63	<0.01
β-hydroxybutyrate (mmol/l)	0.20	0.07	0.09	0.03	NS

NS, not significant.
*Wilcoxon matched-pairs signed-rank test.

Table 3. *Undernutrition in unselected surgical in-patients*

(Percentage of patients with low values; <90% of standard values. From Bistrian *et al.* 1975)

Weight:height	Triceps skinfold	Arm circumference	Serum albumin*
21	56	48	54

*Serum albumin concentration <35 g/l.

Table 4. *Nutritional status in unselected surgical in-patients*

(Percentage of patients having low values; <95% limit for control group. From Hill *et al.* 1977)

Weight-loss	Arm muscle circumference	Serum albumin	Haemoglobin	Plasma transferrin	Leucocyte ascorbic acid	Red blood cell		
						Folate	Vit. B ₁₂	Vit. B ₆
33	30	26	20	41	34	24	20	6

Significance of undernutrition in surgical patients. There is considerable animal experimental evidence that undernutrition affects the response to surgical procedures. Vitamin C deficiency (Harwood *et al.* 1974) and vitamin A deficiency (Levenson *et al.* 1976) are associated with impaired wound healing which is reversible by vitamin repletion. Protein deprivation in rats causes a reduction in the tensile strength and collagen content of colonic anastomoses (Irvin, 1976). The colonic anastomotic strength of rats under these conditions can be improved by parenteral feeding with 30% dextrose and 5% amino acid solutions (Steiger *et al.* 1971).

In man, there is evidence that protein-energy malnutrition in hospital patients in developed countries is associated with impaired cell-mediated immunity (Bistran *et al.* 1975). Parenteral feeding has been shown to improve impaired T-cell function in malnutrition (Law *et al.* 1973).

Although controlled studies in uncomplicated procedures such as vagotomy and pyloroplasty have indicated the protein-sparing effect of parenteral feeding (Johnston *et al.* 1966; Hindmarsh & Clark, 1973), it has been more difficult to assess the effect of this therapy on post-operative recovery, especially in patients with malnutrition, sepsis, and complications of surgical operations.

Goode & Hawkins (1978) found that recovery after cardiac operations was more prolonged in patients who were malnourished pre-operatively (Table 5). However, in a controlled trial of pre-operative parenteral feeding in patients with oesophageal or gastric carcinoma, there were no significant differences in the length of hospital stay between the two groups studied (Williams *et al.* 1977). There was, however, a significant reduction in the incidence of wound infections in the group receiving parenteral feeding, but not in the incidence of other infections, anastomotic leakage or in mortality (Table 6). Moghissi *et al.* (1977) in a study of post-operative recovery in obstructive carcinoma of the oesophagus, found an improved rate of wound healing and less wound sepsis in patients fed intravenously (Table 7).

Table 5. *Nutrition and recovery after cardiac operations**

	Depletion of lean body mass pre-operatively (%)†	Time in hospital (d)	
		Mean	Range
Well-nourished (n 6)	—	16	14–19
Malnourished (n 4)	18.2	30	18–59

*From Goode & Hawkins, 1978.

†Measured by total body potassium.

Table 6. *Pre-operative parenteral feeding and morbidity†*

	Control group (n 36)	Treated group (Supplementary parenteral feeding) (n 38)
Deaths	8	6
Anastomotic leakage	4	2
Wound infection	11*	3*
Other infections	16	9

Statistical significance from control group; * $P < 0.05$.

†From Williams *et al.* 1977.

Table 7. *Wound healing and parenteral feeding**

	Control group	Treated group
Patients with healed wounds (%; 12 d post-operative)	20	100
Patients with wound sepsis (%)	20	0

*From Moghissi *et al.* 1977.

Little emphasis in such studies, however, has been given to the progress of malnourished patients over a period of time following the completion of parenteral feeding.

This preliminary study of serial measurements in a group of seriously ill patients has shown that anthropometric measurements of body fat and lean tissue did not alter significantly as a result of a course of parenteral nutrition. It is reasonable to suppose that if parenteral nutrition had not been used considerable further wasting of body compartments would have occurred. Thus, the regimen used was effective in preventing further nutritional deterioration. It is possible that the measurements taken immediately after parenteral nutrition were elevated owing to an increase in body water during therapy. The exact size of such an elevation, if it occurred, is difficult to assess.

Total body-weight, fat-free mass, body fat and arm muscle circumference all decreased during the month following parenteral feeding; these changes reached statistical significance for the latter two measurements.

The change-over to oral feeding was gradual. However, it is clear that in spite of this planned return to normal food intake the nutritional requirements of the patients were not satisfied. This may have resulted from a combination of poor appetite, altered gut function and the palatability of feeds. This finding underlines the necessity for careful supervision of this 'change-over' period and more information is needed concerning the return of gut function after intravenous feeding.

Changes in biochemical measurements were surprisingly few during parenteral feeding. It is possible that cholesterol may be a more sensitive or earlier indicator of nutritional repletion than changes in plasma protein concentrations.

Finally, more detailed and longer-term observations are needed in order to determine the most effective nutritional treatment of such patients during convalescence.

REFERENCES

- Bistrian, B. R., Blackburn, G. L. & Hallowell, E. (1974). *J. Am. Med. Ass.* **230**, 858.
 Bistrian, B. R., Blackburn, G. L., Scimshaw, N. S. & Flatt, J. (1975). *Am. J. clin. Nutr.* **28**, 1148.
 Duncombe, W. G. (1964). *Clin. Chim. Acta* **9**, 122.
 Durnin, J. V. G. A. & Rahaman, M. M. (1967). *Br. J. Nutr.* **21**, 681.
 Goode, A. W. & Hawkins, T. (1978). In *Advances in Parenteral Nutrition*, p. 557. [I. D. A. Johnston, editor]. Lancaster: MTP Press.

- Gurney, J. M. & Jelliffe, D. B. (1973). *Am. J. clin. Nutr.* **26**, 912.
- Harwood, R., Grant, M. E. & Jackson, D. S. (1974). *Biochem. J.* **142**, 641.
- Hill, G. L., Pickford, I., Young, G. A., Schorah, C. J., Blackett, R. L., Burkinshaw, L., Warren, J. V. & Morgan, D. B. (1977). *Lancet* **i**, 689.
- Hindmarsh, J. T. & Clark, R. G. (1973). *Br. J. Surg.* **60**, 589.
- Irvin, T. T. (1976). *Br. J. Surg.* **63**, 237.
- Johnston, I. D. A., Marino, J. D. & Stevens, J. Z. (1966). *Br. J. Surg.* **53**, 885.
- Law, D. K., Dudrick, S. J. & Abdou, N. (1973). *Ann. int. Med.* **79**, 543.
- Levenson, S. M., Crowley, L. V., Rettura, R., Kan, D., Gruber, B. A. & Seifter, E. (1976). In *Metabolism and the Response to Injury*, p. 256. [A. W. Wilkinson and Sir David Cuthbertson, editors]. London: Pitman.
- Lloyd, B., Burrin, J., Smythe, P. & Alberti, K. G. M. M. (1978). *Clin. Chem.* **24**, 1724.
- Moghissi, K., Hornshaw, J., Teasdale, P. R. & Dawes, E. A. (1977). *Br. J. Surg.* **64**, 125.
- Newton, D. J., Clark, R. G., Woods, H. F. & Connor, H. (1979). *Proc. Nutr. Soc.* **38**, 74A.
- Steiger, E., Allen, T. R., Daly, J. M., Vars, H. M. & Dudrick, S. J. (1971). *Surg. Forum* **22**, 89.
- Weiner, J. S. & Lourie, J. A. (1969). In *Human Biology: A guide to field methods*, p. 12. Oxford & Edinburgh: Blackwell Scientifia Publications.
- Williams, R. H. P., Heatley, R. V., Lewis, M. H. & Hughes, L. E. (1977). In *Clinical Parenteral Nutrition*, p. 52. [D. H. Baxter and G. M. Jackson, editors]. Chester: Geistlich Education.
- Woods, H. F. & Marston, A. (1977). In *Drug Interactions*, p. 251. [D. G. Grahame-Smith, editor]. London: MacMillan Press.