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# PROCEEDINGS OF THE NUTRITION SOCIETY

## ABSTRACTS OF COMMUNICATIONS

*A joint meeting of The Clinical Nutrition and Metabolism Group of The Nutrition Society, and the British Association for Parenteral and Enteral Nutrition was held at Blackpool on 3–5 December 1996, when the following papers were presented.*

*All Abstracts are prepared as camera-ready material by the authors.*

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**Requirements of the general hospital population: experience with 977 consecutive patients.**

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Based on clinical intervention studies, patients who require nutritional support in a hospital were defined as 1) patients in a normal nutritional status experiencing a severely traumatic disease or treatment (Weisdorf *et al.* 1987; Moore *et al.* 1986; Grahm *et al.* 1989), or 2) significantly malnourished patients experiencing a moderately traumatic disease or treatment (Rana *et al.* 1992; Foschi *et al.* 1986; Bastow *et al.* 1983), or 3) patients disabled from malnutrition (Keys *et al.* 1950). Significant malnutrition was defined as 1) actual body weight $< 80\%$ of reference weight, or 2) recent weight loss $> 5\%$ of usual body weight, or 3) a history of dietary intake equivalent to $< 30\%$ of the usual diet for more than 2 weeks.

In a 4-years' period, 977 adult patients from medical or surgical stationary departments fullfilled these criteria among a total of 5.500 patient-calls due to inadequate intake and/or malnourishment. In this period the hospital had about 250.000 admissions. Energy requirement was calculated by the factorial method (WHO, 1985; Nielsen *et al.* 1993), including a surplus for weight gain (Forbes GB, 1990) in underweight patients. A stress factor was applied only in febrile or multitrauma patients. Feeding was undertaken by means of regular hospital food, a nutritious diet, liquid supplements, tube feeding or parenteral nutrition for an average of 4.5 weeks. Dietary intake and body weight were recorded 3-4 times weekly.

In patients with anorexia nervosa (initial body weight %: $67 \pm 2$), and in severely malnourished patients with benign disease only (initial body weight %: $74 \pm 1$), the average weight gain was as expected from energy balance (Forbes GB, 1990). In patients with a benign stress-catabolic disease (initial body weight %: $89 \pm 2$), weight gain was only 20% of that expected. Weight gain obtained *versus* weight gain expected from energy intake allows a calculation of an 'empiric disease-factor' of $1.22 \pm 0.04$ (mean $\pm$ SEM) for this group. In malnourished patients with malignant disease (initial body weight %: $87 \pm 1$), radiation- or chemotherapy could be carried out without further loss of body weight and the 'empiric disease-factor' was not significantly different from 1. On average, all these patient groups received the planned amount of energy. Patients undergoing bone-marrow transplantation (initial body weight %: $103 \pm 1$) experienced a minor weight loss due to slightly inadequate intake but their 'empiric disease-factor' was close to 1.

In conlusion, nutritional therapy is feasible in a clinical setting among patients selected because of severe nutritional problems. The methods employed can identify groups of patients that require only provison of food and other groups of patients that in addition require treatment of a stress-catabolic state. According to our experience, provision of nutrients is the main problem within 'nutritional requirements' of stationary wards in a hospital.

Weisdorf SA, Lysne J, Wind D *et al.* Transplantation 1987; 43: 833-38. Moore EE & Jones TN. J Trauma 1986; 26: 874-81. Grahm TW, Zadrozny DB & Harrington T. Neurosurgery 1989; 25: 729-35. Rana SK, Bray J, Menzies-Gow N *et al.* Clin Nutr 1992; 11: 337-44. Foschi D, Cavagna G, Callioni F *et al.* Br J Surg 1986; 73: 716-19. Bastow MD, Rawlings J & Allison SP. Br Med J 1983; 287: 1589-92. Keys A, Brozek J, Henschkel A *et al.* 1950. The biology of human starvation. Minneapolis: University of Minnesota Press. WHO: Energy and protein requirements. Report of a Joint FAO/WHO/UNU Expert Consultation. Geneva: WHO, 1985: 90-8. Nielsen K, Kondrup J, Martinsen L *et al.* Br J Nutr 1993; 69: 665-79. Forbes GB. Am J Clin Nutr 1990; 52: 224-27.

**Nutritional requirements of the intensive care patient.** By RICHARD D. GRIFFITHS. *Intensive Care Research Group, Department of Medicine, University of Liverpool, L69 3BX*

Underfeeding and intermittent starvation is, sadly, the reality in the intensive care unit (ICU). Overfeeding carries excess risks and cannot make up for previous days of underfeeding. The reason for this is related to the type of patients seen in the ICU which comprise three feeding groups.

(1) Previously well nourished short-stay patients, post-operative or suffering a limited illness, who require short term support of organ function. Enteral feeding is practical but the ICU stay is rarely long enough for full feeding to be achieved and the requirements usually are no different from other post-operative patients. Many will exhibit a short lasting systemic inflammatory response. Early feeding aimed at maintaining gastrointestinal function is increasingly promoted.

(2) Patients with a functioning gastrointestinal system who are either, or will become, malnourished because of the severity and expected duration of illness. All such patients exhibit a systemic inflammatory response or are frankly septic. This is a smaller number of more severely-ill patients who stay longer on intensive care, or have been ill for some time before ICU admission. In most ICU enteral nutrition is the first choice for such patients. Early enteral feeding within the first 24 hours in modest amounts sufficient to maintain gastrointestinal function is possible with reduced infective morbidity seen in burn and trauma patients (for review see Heyland *et al.* 1993).

(3) A far smaller number of very ill patients have gastrointestinal failure accompanying the other organ dysfunction and enteral feeding is simply not possible or cannot be started. Parenteral nutrition for some time is the only option but estimating their requirements and achieving set nutrition targets is problematical (Green *et al.* 1995). Such patients are particularly at risk if currently-used conventional formulations are inadequate.

The energy or protein requirements for individual patients in groups (2) and (3) have proved difficult to either predict or measure with any practical reliability. Such patients are the true nutrition challenge. Clinical events constrain the options in many circumstances and the sicker the patient the harder it becomes to follow rules or achieve nutrition targets with any consistency. The characteristics of long catabolic illnesses are recurrent episodes of severe sepsis and a combination of organ failures and interventions not all occurring at the same time nor in the same sequence. In the severely-ill the apparent ineffectiveness of nutrition provision to maintain lean body mass or alter outcome means that a conservative approach to specific requirements is the norm to avoid the problems of overfeeding. An energy intake initially based on resting energy expenditure, measured or calculated on ideal weight, is becoming the norm. While there is some indication that glutamine-enriched feeds (Griffiths *et al.* 1996) may be of benefit, equal attention should be paid to consistent delivery of nutrition, which may mean a combination of enteral and parenteral nutrition, to avoid persistent underfeeding. A better appreciation of the changing and fluctuating clinical state during an ICU admission is needed so that requirements and route of nutrition may be tailored to the stage of the illness and recovery.

Green, C.J., Campbell, I.T., McClelland, P., Hutton, J.L., Ahmed, M.M., Helliwell, T.R., Wilkes, R.G., Gilbertson, A.A. & Bone, J.M. (1995). *Nutrition* **11**, 739-746.

Griffiths, R.D., Jones, C. & Palmer, T.E.A. (1996). *Proceedings of the Nutrition Society*, **55**, 158A.

Heyland, D.K., Cook, D.J. & Guyatt, G.H. (1993). *Intensive Care Medicine*, **19**, 435-442.

**Does the mode of feeding play a role in the pathogenesis of enteral feeding-related diarrhoea ?**

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Up to 25% of patients receiving enteral feeding develop diarrhoea, the pathogenesis of which remains unclear. Our recent studies have shown that continuous intragastric enteral feeding is associated with abnormal colonic motor activity (Bowling *et al.* 1993*a*) and a colonic secretory response (Bowling *et al.* 1993*b*). The aim of the present study was to investigate whether the mode of intragastric diet administration affects colonic motor activity.

Intraluminal pressure recordings in the unprepared distal colon were studied in two groups of six healthy volunteers using an established water perfusion technique. Continuous recordings were made for 8.5 h; 3 h before and 5.5 h following the administration of a polymeric diet either by the oral or bolus tube-feeding route. Subjects in group 1 drank 250 ml of feed over 15 min 2-hourly for two instillations (70 kJ/min, 105 mgN/min). Subjects in group 2 were bolus fed, via a nasogastric tube, a standard polymeric feed of 250 ml over 15 min 2-hourly for two instillations (70 kJ/min, 105 mgN/min). The pressure records were analysed in 30 min epochs for the study segment (sum of four channels) activity index (AI, area under the curve: mmHg/min) by fully automated computer analysis.

None of the six subjects in group 1 developed diarrhoea, nausea or bloating. There was no significant difference in the AI before (AI 3376 (SE 209) mmHg/min) or after drinking the polymeric enteral feed (AI 3363 (SE 210), $P = 0.48$). In group 2 however, all six subjects developed diarrhoea. The fasting AI (2957 (SE 227) fell significantly with bolus tube feeding (2505 (SE 72)), $P < 0.05$) associated with subjects developing diarrhoea.

Drinking boluses of a standard polymeric enteral feed did not suppress colonic motility whereas bolus feeding of the same nutrient loads via a nasogastric tube suppressed colonic motor activity and was associated with a high incidence of diarrhoea. While these findings suggest that the feed itself is not the cause of enteral feeding-associated diarrhoea, they do suggest that the cephalic phase response associated with taste and swallowing may play an important role in preventing an abnormal colonic motor response to intragastric enteral feeding.

Bowling T.E., Raimundo A.H. & Silk D.B.A. (1993*a*). *Gastroenterology* **104**, A610.
Bowling T.E., Raimundo A.H. & Silk D.B.A. (1993*b*). *Lancet* **342**, 1266 - 68.

**Endoluminal brushing of central venous catheters a highly sensitive and specific technique for the in-situ diagnosis of catheter related sepsis.** By B.M. DOBBINS, P. KITE , M.J. TIGHE, W.N. FAWLEY, D. THOMAS, M.H. WILCOX, I.G. MARTIN and M.J. McMAHON, *The General Infirmary at Leeds and University of Leeds, Great George Street, Leeds LS1 3EX*

A novel endoluminal brush has been designed to diagnose catheter related sepsis (CRS) without the need for catheter removal. The brush is a sterile, closed system which is passed along the catheter to sample the lumen from hub to tip for bacteria. After removal the brush tip is mixed in 1 ml phosphate-buffered saline and 10 and 100 ml aliquots are spread onto blood agar for quantitative culture. For comparison, following catheter removal catheter tips were cultured semi-quantitatively by the Maki (M) and modified Cleri (C) methods to detect both external and internal bacterial colonization respectively. We report our experience with this technique in 230 patients with central venous catheters of mixed types, being used primarily for total parenteral nutrition.

| | Brush | Maki | Cleri | Total |
|---|---|---|---|---|
| Catheter-related sepsis | 21 | 18 | 15 | 22 |
| Catheter colonization | 32 | 70 | 32 | 76 |
| Negatives | 177 | 142 | 177 | 132 |

CRS, defined as significant catheter colonization (M>15cfu;C>100cfu/ml; Brush>100 cfu/ml) and positive peripheral blood cultures (taken before brushing) with the same organism, occurred in eighteen, fifteen and twenty-one patients respectively. Catheter colonization is defined as a positive catheter culture in the absence of a positive peripheral blood culture, and therefore not implicated as a source of systemic sepsis. Total values represent catheter related sepsis or catheter colonization diagnosed by any of the three techniques described. This gave sensitivities for the diagnosis of CRS (number of technique result positives / total number of CRS results) for Maki, Cleri and brush techniques of 82, 75 and 95%, and specificities (number of technique result negatives / total number of non-CRS results) of 66, 84 and 84% respectively. The Maki method is highly sensitive at detecting extraluminal catheter colonization, but appears too non specific for the diagnosis of CRS. We conclude that the brush technique is more sensitive than conventional methods for the diagnosis of CRS, and does not rely on catheter removal to confirm a clinical suspicion of CRS.

**The immune response to invading bacteria is impaired in neonates receiving parenteral nutrition.** By Y. OKADA, N. KLEIN, H.K.F. VAN SAENE, A. REYNOLDS and A. PIERRO, *Institute of Child Health and Great Ormond Street Hospital for Children, London WC1N 1EH.*

Total parenteral nutrition (TPN) exerts nutritional benefits, however, its effects on the immune system remain unclear. Septicaemia, one of the major complications of TPN, is commonly caused by coagulase negative staphylococci (CNS). TPN-related liver dysfunction significantly increases the risk of septicaemia.

The aim of the present study was to test the hypothesis that TPN and liver dysfunction alter the host defence mechanisms against invading potential pathogens.

Thirty-nine studies were performed on twenty-six surgical infants (age <6 months) not receiving antibiotics. Patients were divided into three groups: (a) long-term TPN (>2 weeks; *n* 17, eight patients); (b) short-term TPN (<2 weeks; *n* 13, twelve patients); (c) normal enteral diet (*n* 9, nine patients). Patients on TPN were studied from 5 days post operation. Infants on enteral diet were studied before minor operations. An *in vitro* whole blood model was used to measure the host bactericidal activity against CNS. Bacterial viability was measured after 45 min challenge with CNS using the Miles-Misra technique. Phagocytosis of viable CNS was measured by flow cytometry.

| | Long-term TPN† | | Short-termTPN† | | Enteral diet | |
|---|---|---|---|---|---|---|
| | Mean | SE | Mean | SE | Mean | SE |
| Phagocytosis (%) | 25·1** | 3·0 | 42·6 | 3·1 | 45·3 | 4·9 |
| Viability (%) | 64·2** | 6·1* | 29·4 | 2·9 | 34·8 | 3·5 |

** Mean values were significantly different from those for short-term TPN and enteral diet, $P<0·01$.

† Two patients were studied on short- and long-term TPN

These data show that patients on long-term TPN were more susceptible to CNS infection. During the study three patients on long-term TPN developed septicaemia caused by CNS. TPN duration and liver function significantly influenced the host capacity to kill CNS *in vitro* as demonstrated by the following correlations:

| *predictive variable* | *dependent variable* | *equation* | *r* | *P* |
|---|---|---|---|---|
| TPN duration (d) | viability CNS (%) | y=31·17+0·71x | 0·7 | 0·00001 |
| TPN duration (d) | phagocytosis CNS (%) | y=42·82–0·35x | –0·6 | 0·0003 |
| alkaline phosphatase (U/L) | viability CNS (%) | y=5·77+0·16x | 0·8 | 0·00001 |

We conclude that: (1) long-term TPN in infancy affects phagocytosis and killing of CNS *in vitro*; (2) these important host defence mechanisms are influenced by the duration of TPN and/or by the liver function; (3) these findings may explain the high rate of septicaemia caused by CNS in infants on TPN.

**Early aggressive enteral nutrition (aEN) is associated with a reduction in major complications and length of hospital stay (LOS) in major burns.** By STEPHEN J. TAYLOR and SHEILA B. FETTES, *Department of Nutrition and Dietetics, Frenchay Hospital, Bristol BS16 1LE*

Major burn injury is associated with a high incidence of major complications and mortality. This may be as a result of increased infection and the consequent catabolism (Saito *et al.* 1987). Aggressive EN has been found to reduce wound infection, mortality and LOS (Alexander *et al.* 1990). However, traditionally, EN was delayed until after the acute fluid resuscitation period because gastrointestinal function was thought to be impaired before this. An observational study was conducted to determine whether the delay before attempting aEN (>50% of estimated energy and N requirements: Schofield, 1985; Hildreth *et al.* 1989, 1990; Elia, 1990) improved clinical outcome in burned patients requiring intravenous fluid resuscitation. Associations were determined by multiple regression of clinical outcomes against the delay before: admission, attempting EN, and attempting aEN, and pre-burn morbidity, age (years), sex, burn size (%), full-thickness lesion (FTL) (%) and inhalation score.

| Outcome | Explanatory variable (only listed if $p < 0.05$) | $n$ | Statistic value | $p$ value | Model $r^2$ (%) |
|---|---|---|---|---|---|
| Death | Age | 106 | 3.971 | 0.000 | 39 |
| Complications excluding mortality (survivors only) | Delay before attempting aEN | 81 | 5.352 | 0.000 | 24 |
| | Burn size | | 2.199 | 0.031 | |
| | Inhalation score | | 3.439 | 0.001 | |
| Complications including mortality | Delay before EN | 106 | −2.410 | 0.018 | 27 |
| | Delay before attempting aEN | | 4.761 | 0.000 | |
| | Age | | 2.640 | 0.010 | |
| LOS (square root; survivors only) | Delay before attempting aEN | 81 | 2.602 | 0.011 | 52 |
| | Age | | 3.066 | 0.003 | |
| | Burn size | | 2.072 | 0.042 | |
| | FTL | | 2.837 | 0.006 | |
| | Inhalation score | | 2.976 | 0.004 | |
| Infectious complications | Delay before attempting aEN | 106 | 3.695 | 0.000 | 20 |
| | Burn size | | 3.303 | 0.001 | |
| | FTL | | −1.998 | 0.049 | |
| | Inhalation score | | 2.000 | 0.048 | |

The Table shows that the delay before attempting EN or aEN was not associated with mortality. However, the delay before attempting aEN was associated with major complications, particularly infection, and LOS. This confirms previous studies on trauma patients in which aEN was associated with a reduction in infectious complications but not mortality (Kudsk *et al.* 1992). These results imply that earlier EN may reduce major complications and LOS if it is aggressive.

In burn patients requiring IV fluid resuscitation, an attempt to meet >50% of the estimated energy and N requirements should be made within a few hours of admission to maximize any reduction in the incidence of major complications and LOS.

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Elia, M. (1990). *Medicine International* **82**, 3392- 3396.
Hildreth, M., Herndon, D., Desai, M., & Duke, M. (1989). *Journal of Burn Care and Rehabilitation* **100**, 523-526.
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Kudsk, K., Croce, M., Fabian, T., Minard, G., Tolley, E., Poret, A., & Kuhl, M. (1992). *Annals of Surgery* **216**, 503-513.
Saito, H., Troski, O., Alexander, J., Kopcha, R., & Heyd, T. (1987). *Journal of Parenteral and Enteral Nutrition*, **11**, 1-7.
Schofield, W. (1985). *Human Nutrion: Clinical Nutrition* **39** suppl. 1, 41.

**Food provision, wastage and intake in elderly hospital patients.** By ARLENE D. STEPHEN, CHARLOTTE L. BEIGG, EDITH T. ELLIOT, IAN A. MACDONALD and SIMON P. ALLISON, *Departments of Dietetics and Nutrition, Medicine, Physiology and Pharmacology, Queens Medical Centre, Nottingham NG7 2UH*

The Health of the Nation report *Nutrition Guidelines for Hospital Catering* (Department of Health 1995) recommends an energy intake of 7560-9242 kJ/d (1800-2200 kcal/d) for hospital patients. Reports of continuing weight loss during hospital admission suggest that this target is not being met (McWhirter & Pennington, 1994).

In the present study, the energy and protein content of the hospital menu was calculated using the portion weights that were measured on 600 meal trays. The percentage of food wasted from the meals that were sent at lunch and supper was calculated by weighing all the food left at lunch and supper over two menu cycles (28 d) on a twenty-two bedded elderly ward. By subtracting the whole ward waste from the total food delivered and adding a value for breakfast, drinks and snacks we have calculated the average food intake per patient on the ward. We also measured the individual intakes at breakfast, lunch and supper of twenty patients on the ward.

| | Breakfast | Lunch | Supper | Snacks | Total |
|---|---|---|---|---|---|
| Food provision (kJ) | 1365 | 2900 | 2980 | 1155 | 8400 |
| %Food wastage (by wt) | NC | 41% | 43% | NC | NC |
| Average intake | | | | | |
| Total energy (kJ) | 1365 | 1793 | 1411 | 1155 | 5724 |
| Total protein (g) | 11.7 | 17.2 | 13.1 | 6.0 | 48.0 |
| Individual intake (*n* 20) | | | | | |
| Mean energy (kJ/kg) | 15.7 | 27.2 | 24.1 | 17.8 | 84.8 |
| SD | 6.8 | 9.0 | 9.3 | NC | NC |
| Mean protein (g/kg) | 0.1 | 0.3 | 0.2 | 0.1 | 0.7 |
| SD | 0.0 | 0.1 | 0.1 | NC | NC |

NC, no calculation has been made

These results show that the food intake of our patients did not meet the recommended targets. Although the maximum obtainable from the normal menu, breakfast and snacks could be adequate, the high wastage rate of greater than 40% has serious nutritional and economical implications. The reasons for the high wastage rate included unpalatability, poor presentation and serving, changes in appetite or receiving food that was not ordered. Measurements on individual patients confirmed the low intake estimated from the whole ward wastage figures. Even assuming an intake of 1365 kJ at breakfast and 1155 kJ from drinks and snacks, the average intake of these elderly patients was still only 5724 kJ and on the individual measurements only 4303 kJ ,assuming snacks of 1155 kJ, (84.8 kJ/kg). Both these values are lower than the resting energy expenditure of many patients. A protein intake of 0.7 g/kg is also inadequate. It is not surprising, therefore, that many patients lose weight while in hospital.

Department of Health (1995). *Nutritional Guidelines for Hospital Catering. Health of the Nation Report.* Wetherby.
McWhirter, JP.& Pennington CR. (1994). *British Medical Journal*, **308**, 945-948.

**Intraoperative stress causes a different thermogenic and metabolic response in infants compared with children.** By L. FASOLI, Y. OKADA, P. QUANT and A. PIERRO. *Institute of Child Health and Great Ormond Street Hospital for Children, London WC1N 1EH*

The physiological response to intraoperative stress has not previously been studied in infants and children.

The aim of the present study was to investigate the effects of intraoperative stress (cold, general anaesthesia, and operative trauma) on energy metabolism and thermogenesis.

Ten infants (age <12 months) and eight children (age 12-30 months) who had a major abdominal operation were studied. Resting energy expenditure (REE), measured by computerized indirect calorimetry, and ambient and core temperatures were recorded for 2 h immediately before the operation and throughout the operative procedure. Physical activity was scored preoperatively to determine the resting time. Anaesthesia was standardized and endotracheal tube air leak eliminated. Operative stress score (OSS) was recorded. Energy intake was constant during the study.

Ambient temperature and OSS were similar in infants and children. There was a linear correlation between the predictive variable age of the patient (d) and the dependent variable percentage variation in REE during the operation (Δ-REE) ($y = -27{\cdot}71 + 1{\cdot}50x$; $r = 0{\cdot}7$; $P = 0{\cdot}0004$). During the operation infants reduced the REE but maintained the core temperature whereas children increased the core temperature (table).

| | *preoperative* | *45 min* | *60 min* | *75 min* | *90 min* |
|---|---|---|---|---|---|
| REE (kJ/Kg/d) | | | | | |
| infants | 234·9±12·3 | 177·5±15·8* | 190·7±12·6* | 202·8±16·1* | 189·8±17·7* |
| children | 210·1±11·3 | 220·8±10·8 | 227·0±12·3 | 234·6±14·1 | 239·5±21·1 |
| Body core temperature (°C) | | | | | |
| infants | 36·8±0·1 | 36·5±0·4 | 36·7±0·4 | 36·8±0·4 | 36·6±0·6 |
| children | 36·5±0·1 | 36·7±0·1* | 36·8±0·1* | 37·0±0·1* | 37·1±0·1* |

(* $P<0{\cdot}01$ *versus* preoperative)

In conclusion: (1) the physiological response to operative stress is age-related. (2) We speculate that infants reduce the metabolic rate to spare energy stores and increase the mitochondrial proton leak to maintain the core temperature. This may represent a protective survival mechanism.

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**Measurement of collagen turnover using [$^{15}$N] or [$^{13}$C] proline by continuous flow combustion mass spectrometry.** By M.J. RENNIE[1], S. DOWNIE[1], M. AHMED[2], J.N.A. GIBSON[2] and W. MEIER-AUGENSTEIN[1], [1]*Department of Anatomy & Physiology, University of Dundee, Dundee DD1 4HN and* [2]*Princess Margaret Rose Orthopaedic Hospital, Fairmilehead, Edinburgh EH10 7ED*

In a previous communication we described results of experiments carried out to determine the rate of bone collagen turnover using a flooding dose protocol with [$^{15}$N]proline (over 90 min) together with [15N]alanine given by a primed constant infusion (over 8-12 h) applied intra-operatively during hip replacement (Scrimgeour *et al.* 1993). Unfortunately methodological difficulties prevented us from measuring the label of hydroxyproline and instead we measured the 15N-labelling of proline and alanine isolated by preparative GC with off-line combustion and reduction of the proline N before isotope ratio mass spectrometry. Those studies resulted in values for bone collagen synthetic rate apparent proline labelling of between 0.2 and 0.7 %/h, depending on the type of bone. The values from alanine labelling calculated with either the plasma alanine or free bone alanine labelling taken to represent the precursor labelling, were about one tenth of this and could not be explained by possible difference in precursor labelling in chondrocytes. One possibility was that the flooding protocol had stimulated the synthesis process as it apparently does in muscle when essential amino acids are used to flood the free pool (Smith et al 1996). Because of the recent availability of capillary GC combustion isotope ratio mass spectrometry (GC-C-IRMS) in our laboratory we have now been able to measure the labelling of both [$^{15}$N]proline and [$^{15}$N]hydroxyproline in the same samples and have extended the work to measure the labelling of [$^{13}$C]proline and hydroxyproline in a separate series of studies in five further patients undergoing hip replacement. Amino and imino acids from bone collagen hydrolysates were separated as their t-butyldimethylsilyl derivatives, followed by on-line combustion and analysis of stable-isotope labelling (Europa Scientific Orchid).

The recent results suggest that GC-C-IRMS is a fast, convenient and robust method for measuring collagen synthesis using either $^{15}$N or $^{13}$C labels. The values from re-analysis of the previous $^{15}$N incorporation into alanine, proline and hydroxyproline provide, in collagen, values of 0.012 (SD 0.006 %/h). We also obtained similar values whether [$^{13}$C]proline or hydroxyproline was determined in hydrolysates of collagen. Because of the consistency of the results with the different tracers and labels we are confident that the values are more likely to be correct than those previously reported and that flooding with proline has no deleterious effect on bone collagen synthesis. The flooding dose proline method has obvious application to the study of nutritional and pathophysiological modulation of collagen metabolism in any tissue of the body which can be sampled.

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Smith, K., Reynolds, N., Downie, S. & Rennie, M. J. (1996). *Proceedings of the Nutrition Society* **55**, 152A.

**Cholecystokinin release and gall bladder contractility in neonates during parenteral and enteral feeding.** By G.JAWAHEER[1], M. JORDINSON[2], J. CALLAM[2], N.J. SHAW[1], D.A. LLOYD[1] and A. PIERRO[3], *[1]Fazakerley Hospital, Liverpool L9 7AL, Alder Hey Children's Hospital, Liverpool L12 2AP; [2]Hammersmith Hospital, London W12 0HS and [3]Great Ormond Street Hospital For Children, London WC1N 3JH.*

Cholecystokinin (CCK) has been used empirically in infants with parenteral nutrition-related cholestasis. However, the effect of parenteral and enteral nutrition on plasma CCK levels in infants has not previously been explored.

The aim of the present study was to determine the effects of continuous parenteral and bolus enteral feeding on plasma CCK8 levels and gall bladder (GB) contractility in neonates.

Fifteen neonates on continuous parenteral nutrition (PN) and nine neonates on bolus enteral feeds (20 ml/kg) were studied. GB volume was measured by ultrasound and plasma CCK8 by radioimmunoassay[1]. In the group on PN, both measurements were made at a random time 0 and followed 30 and 60 min later. In the group on enteral nutrition, they were made immediately before a bolus and at 30, 60 and 90 min after the bolus.

The results are expressed as median and range.

| Time(min) | Plasma CCK(pmol/l) | | Gallbladder volume($mm^3$) | |
|---|---|---|---|---|
| | Median | Range | Median | Range |
| Parenteral Nutrition | | | | |
| 0 | 5.4 | (0.6 - 16.7) | 1507.1 | (381.5 - 4001.7) |
| 30 | 5.0 | (0.2 - 19.3) | 1671.0 | (398.1 - 4187.9) |
| 60 | 4.6 | (0.4 - 30.0) | 1638.5 | (486.1 - 4187.9) |
| Enteral Nutrition | | | | |
| Before bolus | 4.5 | (0.2 - 12.3) | 387.3 | (167.6 - 1057.5) |
| 30 | 11.0** | (3.6 - 22.2) | 69.8* | ( 28.3 - 130.6) |
| 60 | 8.5* | (2.3 - 31.6) | 115.2* | ( 85.9 - 304.1) |
| 90 | 5.2 | (1.4 - 15.0) | 208.1 | (122.2 - 394.9) |

[Median values were significantly different from those for before the bolus: * $p < 0.05$ and ** $p < 0.02$].

In conclusion: (1) CCK8 levels remained unchanged during PN, explaining the absence of GB contraction. Similar CCK8 levels were found during PN and before bolus enteral feeding. (2) After bolus enteral feeding, CCK8 peaked at 30 min and returned to baseline by 90 min. Peak CCK8 concentration coincided with maximal GB contraction.

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**Plasma glucagon-like peptide-1 (7-36) amide (GLP-1) response in healthy volunteers to liquid phase, solid phase and meals of differing lipid composition.** By AUDREY E. BRYNES, GARY S. FROST, C. MARK B. EDWARDS, MOHAMMAD A. GHATEI and STEPHEN R. BLOOM, *Departments of Nutrition & Dietetics and Metabolic Medicine, Hammersmith Hospital, London W12 0HS*

GLP-1 is released from the 'L' cells of the ileum and colon in response to a mixed meal. It is the most potent known endogenous gut hormone stimulant of insulin secretion. GLP-1 also suppresses glucagon secretion, delays gastric emptying and is postulated to increase peripheral insulin sensitivity. It has been proposed as a novel treatment for non-insulin-dependent diabetes mellitus. The exact dietary component that stimulates the release of GLP-1 is controversial. The present study was designed to measure postprandial GLP-1, insulin, and glucose levels in response to: (1) solid (standard test meal, 2092 kJ, 52% carbohydrate, 15% protein, 34% fat) *v.* liquid (homogenized standard test meal), and (2) monounsaturated *v.* polyunsaturated *v.* saturated fat-based-soup (2176 kJ, 55% carbohydrate, 3% protein, 41% fat from 30ml olive oil, 30ml corn oil or 30g butter respectively).

Six healthy volunteers (two female, four male) aged 25.6 years (mean), BMI 23.7 kg/m$^2$ (mean) were recruited and studied in a randomized order on five separate occasions. A cannula was inserted into the antecubetal fossa before each meal. Blood samples were taken at -15, 0, 5, 15, 30, 45, 60, 90, 120, 150 and 180 min after the start of the meal. The meal was started at time 0 and consumed within 10 min on every occasion. Plasma was centrifuged and separated immediately and assayed for glucose, and GLP-1 and insulin using a specific radioimmunoassay.

The results were not normally distributed and are presented as the median with the range (Table). Comparison between liquid and solid meals was by Mann-Whitney U test. The Kruskal-Wallis test was used to analyse the three fat-containing soups. $P<0.05$ was taken as significant.

| | Peak GLP-1 response (min) | Area under curve 0-30 min | | | Area under curve 0-180 min | | |
|---|---|---|---|---|---|---|---|
| | | GLP-1 (pmol.min/l) | Insulin (nmol.min/l) | Glucose (mmol.min/l) | GLP-1 (pmol.min/l) | Insulin (nmol.min/l) | Glucose (mmol.min/l) |
| Solid meal | 60 | 47 (-1-408) | 2.5 (1.6-4.7) | 35.2 (25.3-49.5) | 1364 (554-1848) | 17.6 (13.7-25.5) | 214.9 (50.1-344.8) |
| Liquid meal | 15 | 571.0* (159-847) | 6.2* (3.5-11.8) | 42.5 (32.9-66.1) | 2469* (1422-3703) | 18.5* (15.9-35.8) | 273.8 (135-326) |
| Soups: | | | | | | | |
| Saturated | 15 | 277 (95-752) | 5.6 (3.0-10.0) | 57.3 (42.1-90.9) | 1309 (695-5039) | 23.2 (17.5-49.2) | 334.8 (134-617) |
| Polyunsaturated | 30 | 351.5 (155-496) | 5.2 (3.1-6.1) | 60.3 (25.5-81.2) | 1420 (509-2910) | 20.9 (15.8-29.5) | 256.8 (116-368) |
| Monounsaturated | 30 | 456.5 (45-614) | 5.7 (0.6-9.0) | 49.0 (0-96.5) | 1364 (-645-5054) | 25.1 (11.7-40.1) | 292.8 (-101-487) |

* Significantly different from solid meal, $P<0.05$.

The liquid form of the meal released significantly more GLP-1 than the solid form and this occurred earlier. The area under the curve for insulin was significantly greater for 30 or 180 min following the liquid meal. The glucose response to each meal was not different.

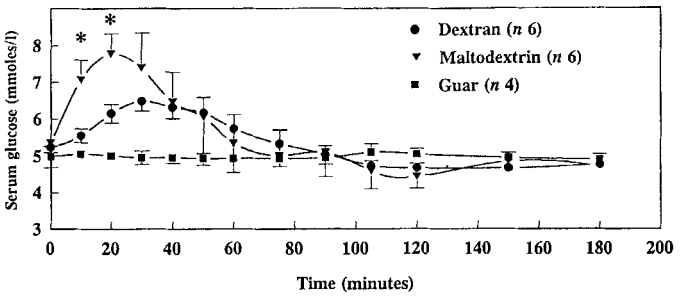
The type of fat in the soups produced no significant difference in GLP-1, insulin or glucose response over the first 30 min or 180 min. The lack of any effect on insulin at both time points indicates no alteration in the first or second phase insulin response.

This work demonstrates that the phase of a test meal has an influence on both time and amount of GLP-1 released. A liquid meal causes a greater release of GLP-1 than an identical isoenergetic meal in solid phase. Thus, we have shown that it is important in future studies comparing the effects of different macronutrients to control for this factor. Further larger studies are required to assess any differential effect of type of ingested fat.

**Differences in the glycaemic response to dextran and maltodextrin ingestion in man.** By GEORGE K. GRIMBLE, ERICA E. DENHOLM, SIMON M. GABE and EDWARD S. DEBNAM, *Addictive Behaviour Centre, Roehampton Institute London, London SW15 3SN and Department of Physiology, Royal Free Hospital School of Medicine, London NW3 2PF*

Starch digestion in man occurs mainly in the proximal small intestine. In the absence of luminal α-amylase, the rate of assimilation of large glucose polymers is limited by brush border hydrolysis (Jones *et al.* 1984), and oral α-amylase inhibitors cause starch malabsorption (Boivin *et al.* 1988). We have therefore investigated an alternative means of slowing glucose absorption, by use of dextran, whose α-1,6 glucose linkages are hydrolysed not by α-amylase (Grimble *et al.* 1992) but by brush-border isomaltase (Dahlqvist, 1962). Preliminary data (Debnam *et al.* 1996) suggest that dietary dextran overspills into the rat ileum and markedly upregulates the ileal Na glucose-linked transporter (SGLT1).

On three separate occasions, six fasted subjects consumed a 500 ml drink containing 50 g maltodextrin (DE6, SHS International), or 50 g dextran (40,000 daltons, Medisan AB) or 20 g guar gum (partially hydrolysed, Hercules Inc). Blood samples were taken before ingestion and at regular intervals for 3 h. Breath samples were taken hourly for 7 h for $H_2$ analysis (Grimble *et al.* 1988).




Values are means with their standard errors. * Mean values were significantly different from those for dextran, $P < 0.05$ (*t*-Test).

The alteration in linkage of the glucose polymer from α-1,4 (maltodextrins) to α-1,6 (dextrans) led to a significant slowing of glucose appearance in peripheral blood (*v.* maltodextrin) comparable to that after co-ingestion of a starch meal and an α-amylase inhibitor (Layer *et al.* 1986). Surprisingly, ingestion of guar gum provoked only a slight increase in $H_2$ excretion at 3 h ($H_2$: guar 18.2 SE 10.0 ppm) which did not differ significantly from the effects of the glucose polymers (maltodextrin 10.2 SE 3.4, dextran 11.0 SE 2.2 ppm). It is likely that slower peripheral blood glucose appearance represents glucose absorption at more distal intestinal sites in man, as we have shown in the rat (Debnam *et al.* 1996). Dietary dextran therefore represents a convenient means of slowing glucose absorption in patients with disorders of glucose metabolism (i.e. diabetes, glycogen storage disease).

Thanks are due to Drs Peter Buckley and Kay Sharp and to SHS International, for providing the glucose polymers and advising on formulation. Funded by HEFCE grant from Roehampton Institute London.

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**Measurement of total energy expenditure in patients with lung cancer and validation of the bicarbonate-urea method against whole-body indirect calorimetry.** By E. GIBNEY, G. JENNINGS, S.A. JEBB, P.R. MURGATROYD and M. ELIA, *MRC Dunn Clinical Nutrition Centre, Hills Road, Cambridge CB2 2DH*

The bicarbonate-urea method of Elia *et al.* (1995) has been validated in healthy subjects against whole-body indirect calorimetry over periods of 1-4 d and over a range of physical activity levels (PAL, or total energy expenditure (TEE)/BMR). Its validity in patients with disease is uncertain. The purpose of the present study was threefold: (a) to validate the technique in subjects suffering from unresectable small-cell lung cancer, (b) to assess the practicalities of using the technique under free-living conditions, (c) to test the hypothesis that TEE is not increased in patients with lung cancer, despite possible basal hypermetabolism, because of a decrease in physical activity. This hypothesis arose from our previous observations that many patients with lung cancer (especially those who respond to treatment) have an elevated BMR, but maintain weight over prolonged periods of time (Jebb *et al.* 1994).

The study involved eight subjects (five males, three females) with a mean age 68 (SD 12) years, weight 69 (SD 10) kg, height 1.65 (SD 0.10) m, and BMI 25.2 (SD 4.4) kg/m$^2$. Five of these subjects (three males, two females with a mean age 67 (SD 16), weight 71 (SD 12) kg, height 1.61 (SD 0.06) m, BMI 27.5 (SD 5.0) kg/ m$^2$), were studied in a whole-body calorimeter over >36 h and for a further 24 h at home. The other three subjects, who were studied whilst at home, were involved in two sequential daily measurements of TEE. All subjects were studied after at least 1 month of receiving radiotherapy or chemotherapy. In the preceding month their weight change varied from -1 to +2 kg. In calculating energy expenditure it was assumed that the energy equivalent of $CO_2$ was 535 kJ/mol (corresponding to RQ ~0.85) except in one subject where a value of 581 kJ/mol was used because she had very recently become anorectic and was in negative energy balance (RQ ~ 0.75).

Within the calorimeter the $HCO_3$-/urea tracer method predicted net $CO_2$ production as measured by indirect calorimetry (327.2 (SD 70.2) mol/d) by 102.1 (SD 3.4) % (mean difference 0.32 (SD 0.43) mol/d), and energy expenditure by 101.5 (SD 3.8)% of the measured calorimeter value (8.1 (SD 1.6) MJ/d; mean difference 0.11 (SD 0.31) MJ/d). The recovery of infused label as gaseous $CO_2$ was found to be 95.6 (SD 0.5) %. In free-living conditions the tracer method estimated energy expenditure to be 9.0 (SD 2.6) MJ/d (8.2 (SD 1.7) MJ/d in the five subjects who were also studied in the calorimeter). BMR was increased by a mean of 6% compared with the Schofield prediction (Schofield *et al.* 1985). The PAL ratio (TEE:BMR) ranged from 1.15 in a very sedentary subject, to 1.95 in a very active subject who took regular exercise (mean PAL ratio, 1.39 (SD 0.24). Seven out of the eight subjects had a PAL value of ≤1.4. These are considerably lower than the values of 1.5 - 1.7 suggested for moderately active subjects (Department of Health 1991) and by doubly-labelled water studies in subjects of similar age as the subjects studied here (Black *et al.* 1996). The subjects tolerated the subcutaneous bicarbonate infusion well, and this apparently did not interfere with the activities of daily living, or leisure activities. It is concluded that in this group of patients with lung cancer, the bicarbonate-urea method provides estimates of $CO_2$ production that are as good as those in healthy subjects (Elia *et al.* 1995), and that TEE is not increased because a small increase in BMR is counteracted by a reduction in physical activity.

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**The effect of flooding with the non-essential amino acid serine on human muscle protein synthesis.** By K. SMITH, N. REYNOLDS, A. PATEL and M.J. RENNIE, *Department of Anatomy and Physiology University of Dundee, Dundee DD1 4HN*

Previous studies investigating the effect of flooding with a variety of amino acids on the incorporation of constantly infused tracer amino acid into muscle protein have suggested that the existence or not of an increase in protein labelling may be specific to the type of amino acid used to flood. Thus leucine, valine, phenylalanine and threonine (all essential amino acids) increased tracer incorporation whereas arginine and glycine (both non-essential amino acids) had no effect (Smith *et al.* 1996*a*,*b*) . Consequently, we have now investigated the effect of flooding with another non-essential amino acid [1-$^{13}$C]serine, which may be more suitable due to its relatively small free pool size (unlike glycine) and its reasonable abundance in muscle protein (unlike arginine). Four healthy male volunteers (27 (SD 2.5) years, 80 (SD 6) kg), studied in the post-absorptive state, were given a primed (1 mg/kg body weight), constant infusion (1 mg/kg per h) of [1-$^{13}$C]leucine over 7.5 h. After 6 h, the subjects were given a flooding dose of [1-$^{13}$C]serine (0.05 g/kg, 20 Atoms %). Plasma samples were taken throughout for the measurement of amino acid concentration and $^{13}$C-enrichment in serine, leucine and α-ketoisocaproate (α-KIC) (taken to represent the leucine precursor pool for protein synthesis) by gas chromatography-mass spectrometry (GC-MS). Muscle was taken from the anterior tibialis (i) after 45 min, (ii) immediately before the flood and (iii) 90 min postflood for the measurement of [1-$^{13}$C] tracer incorporation into mixed muscle protein and labelling of the intracellular free amino acid pool. Intracellular amino acid labelling was determined by GC-MS. After extraction of the intracellular amino acids, the muscle protein was acid hydrolysed, the released amino acids were then isolated by cation exchange chromatography and leucine and serine collected after preparative GC. The carboxyl-labelled C was liberated as $CO_2$ by reaction with ninhydrin. Muscle leucine incorporation was measured by continuous flow-isotope ratio mass spectrometry (CF-IRMS) and serine by continuous flow-thermal desorption-isotope ratio mass spectrometry (Europa Scientific, UK). The rate of muscle protein synthesis during the preflood period, calculated from the incorporation of leucine tracer and the average plasma α-KIC enrichment, was 0.048 (SD 0.01) % per h. Despite the administration of the serine flood, synthesis was unchanged (0.048 (SD 0.02) % per h, NS). The synthesis rate calculated from [1-$^{13}$C]serine incorporation during the flood was similar. These results, along with previous data, and similar recent results with proline on alanine incorporation into muscle suggest that the stimulation of muscle protein synthesis by administration of a flooding dose is a general effect of the essential amino acids not exerted by non-essential amino acids, therefore serine may be a more appropriate choice of amino acid for flooding.

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**Changes in measures of fatigue in normal subjects following meals with varying amount of carbohydrate.** By A. CUNLIFFE[1], I. LAMPLOUGH[2], R. OBRA[2], O.A. OBEID[1] and J. POWELL-TUCK[1], *[1]Rank Department of Human Nutrition, St Bartholomew's and the Royal London Hospital School of Medicine and Dentistry, London E1 2AD, [2]Department of Nutrition and Dietetics, King's College London, London W8 7AH*

The present study was designed to assess the acute effect of diet of different carbohydrate (CHO) content on fatigue. The central component of fatigue was determined using a visual analogue scale (VAS: Lee *et al.* 1990) and flicker fusion frequency (FFF: Rammsayer & Netter, 1988), and the peripheral component using wrist ergometry (WE: Shaker H.A., 1993) and grip strength (GS: Klidjian *et al.* 1980). Healthy volunteers with a mean age of 29.7 (range 20-47) years and mean BMI of 23.1 (range 18.4-35.2) kg/m$^2$ were recruited. After an overnight fast subjects were tested before, and at hourly intervals for 4 h after, drinking one of three isoenergetic (1.67 MJ) liquid meals. The meals were: (1) normal CHO (NC) with 55%, 30% and 15% of energy as CHO, fat and protein respectively; (2) high CHO (HC) with 65%, 20% and 15% energy as CHO, fat and protein respectively and (3) pure CHO (PC). The meals were of similar volume and made up of maltodextrin (Maxijul), Calogen (gifts from SHS) and Promod (Abbott). The Table shows the mean percentage changes from pre-meal baseline for each test at hourly intervals, with baseline 0% change. ANOVA was used to separate the significance of the passage of time, the diet and their interaction.

| | | | Time (h) | | | | Analysis of variance | | |
|---|---|---|---|---|---|---|---|---|---|
| Test | Diet | n | 1 | 2 | 3 | 4 | Time | Diet | Interaction |
| VAS | NC | 9 | 46.8 | 38.1 | 28.4 | 10.3 | | | |
| | HC | 8 | 19.7 | 29.0 | 73.1 | 87.1 | NS | NS | NS |
| | PC | 10 | 52.2 | 42.4 | 117.5 | 107.1 | | | |
| FFF | NC | 9 | 1.09 | 0.67 | 0.74 | -1.16 | | | |
| | HC | 8 | -0.75 | -1.10 | -1.28 | -3.31 | NS | $P<0.03$ | NS |
| | PC | 11 | -2.61 | -2.81 | -4.18 | -4.10 | | | |
| GS | NC | 9 | -1.7 | -5.02 | -7.98 | -7.03 | | | |
| | HC | 8 | -3.75 | -5.69 | -3.64 | -2.77 | NS | $P<0.001$ | NS |
| | PC | 11 | -0.1 | 1.42 | -0.52 | 1.10 | | | |
| WE | NC | 9 | -6.7 | -4.17 | -9.22 | -26.4 | | | |
| | HC | 8 | -4.50 | 2.98 | 1.9 | 2.9 | NS | $P<0.03$ | NS |
| | PC | 11 | -13.8 | -15.5 | -14.1 | -10.88 | | | |

Subjective fatigue, as indicated by VAS scores, showed an increase with higher CHO content of the meal, but this did not reach statistical significance. Mean FFF scores fell significantly with increased CHO content of the meal. Thus, increasing CHO content of the meal increased objective central fatigue. Brief maximal voluntary effort as reflected by GS was significantly enhanced with increased CHO. Endurance of the HC group, as indicated by WE results, was significantly greater than the NC group. Thus, the CHO content of the diet appears to differentially affect the components of fatigue.

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**Lack of an effect on intravenous glucose tolerance of 3 months of dietary supplementation with fish oil and monounsaturates in healthy middle aged men.** By A.N. WIJENAIKE[1], R.T. JUNG[2], C. BOLTON-SMITH[3] and M.J. RENNIE[1]. [1]*Department of Anatomy and Physiology, University of Dundee, Dundee DD1 4HN* , [2]*Department of Medicine, Ninewells Hospital and Medical School, Dundee DD1 9SY* , [3]*Department of Cardiovascular Epidemiology, Ninewells Hospital and Medical School, Dundee DD1 9SY.*

To test the hypothesis that a diet rich in fish-oil polyunsaturated fatty acids and monounsaturates improves glucose tolerance we studied six healthy men aged 35 - 45 years, (mean 38 years) of BMI 21 - 28 kg/m$^2$ (mean BMI 25 kg/m$^2$). Subjects received 250 mg glucose/kg body weight as an intravenous glucose tolerance test (IVGTT) in the post-absorptive state before and after 3 months of dietary intervention. During this period each subject took 0.07 g Maxepa (Novex Pharma)/ kg body weight per d and replaced their usual fat spread with a high-monounsaturate spread (St Ivel's Mono). Thirty samples were taken at intervals over 180 min during the IVGTT; glucose was analysed using a Yellow Springs glucose analyser and plasma insulin was measured by radioimmunoassay. Compliance with diet was established by a rise in plasma eicosapentaenoic acid concentrations from 0.20(SD 0.08) to 0.94(SD 0.29) μg/ml. The areas under the glucose curve over time (IVGTT) calculated for each subject before and after dietary intervention showed no significant difference, i.e, before 1144 (SD 134) mmol.min/l and after 1158 (SD 91) mmol.min/l, $P$=0.52, paired two-sample Student's $t$ test). Basal concentrations of glucose were unchanged [5.16 (SD 0.27) vs 5.15 (SD 0.23) mmol/l, $P$=0.91] as were those of insulin [8 (SD 6) vs 6 (SD 4) μIU/ml, $P$=0.44 ]. Ratios of insulin:glucose remained unchanged basally [1.55(SD 0.99) vs 1.36(SD 0.70) mU/mmol $P$=0.71 ] and at peak insulinaemia [5.66(SD 2.52) vs 7.60(SD 3.58) mU/mmol, $P$= 0.35 ] .

These data suggest that at the dose studied there is no increase in whole body glucose tolerance or insulin action as a result of taking fish oil and increasing the proportion of monounsaturated fat intake.

**Comparison of electronic (Apple Newton MessagePad) and traditional paper visual analogue scales in studies of appetite and eating behaviour.** By R.J. STRATTON[1], D. HUGHES[2], R.J. STUBBS[2] and M. ELIA[1], [1]*MRC Dunn Clinical Nutrition Centre, Hills Road, Cambridge CB2 2DH* [2]*Rowett Research Institute, Greenburn Road, Blackburn, Aberdeen AB2 9SB*

Visual analogue scales (100 mm horizontal lines), traditionally completed at hourly intervals with paper and pen, are used to rate hunger, satiety and other symptoms in studies of appetite and eating behaviour. The errors inherent in, and the time consumed by, this method of data collection and processing led to the development of an application for use on a portable, pen-based electronic notepad (Apple Newton MessagePad, 535 g, 196 mm x 100 mm x 20 mm). This can be carried around by volunteers and contains the following functionality: hourly alarms to prompt the subject to complete the scales; all entries date and time stamped; incomplete and/or incorrect entry and back reference prevented; a help function; and facilities for entering food intake *ad hoc*, downloading questionnaires and uploading results directly to a computer. The aim of the present study was to compare the new electronic questionnaire with the traditional paper method and to assess which method volunteers preferred. Twelve healthy subjects, (seven female, five male, mean age 30 (SD 12) years, mean BMI 22 (SD 1.7) kg/m$^2$), in a randomized, crossover design, completed both the paper and the electronic questionnaires, one immediately after the other, hourly during waking hours, for 2 days. To assess the preference for the paper *v.* electronic method, thirteen healthy subjects (seven female and six male, mean age 32 (SD 13) years, mean BMI 23 (SD 2.2) kg/m$^2$), completed each method individually on consecutive days, in a random order, hourly during waking hours. Their preference was recorded by questionnaire. Statistical analysis was carried out using the method of Bland & Altman and Student's paired *t* test.

| Scale | Mean score (paper and electronic) | Bias (paper - electronic) | SD of difference | Number of observations |
|---|---|---|---|---|
| Hunger | 31 | 1.7* | 6.5 | 268 |
| Fullness | 50 | 1.6* | 7.4 | 268 |
| Desire to eat | 35 | 0.6 | 6.8 | 263 |
| How much can you eat now | 38 | 0.8 | 7.3 | 265 |
| Preoccupation with thoughts of food | 31 | -0.02 | 7.3 | 263 |

* Significantly different from zero ($P<0.05$).

There was no significant difference in the results obtained by the two methods except for hunger and fullness ratings. For these variables, the difference between the two methods increased by a small, non-significant degree with increasing score, (gradient <0.1, $r^2$ <0.01), indicating that the pattern of change and sensitivity of the two methods remained similar. Mean daily scores for each subject revealed mean and bias values similar to those presented in the Table with much smaller SD values (1.5 to 3.0 depending on the variable) and only the fullness rating remaining significantly different from zero. The preference questionnaire showed that of thirteen volunteers, seven (54%) preferred paper, five (38%) preferred electronic and one (8%) had no preference.

This study suggests that the electronic MessagePad should not be used interchangeably with the traditional paper method. With no objective measurement of hunger and satiety for comparison, it is not possible to distinguish which method is more accurate. Volunteers preference for the paper method should be considered against the greater accuracy and efficiency for the researcher of data processing with the new electronic method.

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**Investigation of protein metabolism *in vitro* using cultured skeletal muscle cells.** By R.G. ROBERTS, C.P.F. REDFERN and T.H.J. GOODSHIP, *Department of Medicine, University of Newcastle upon Tyne, Framlington Place, Newcastle upon Tyne NE2 4HH*

Malnutrition makes a significant contribution to morbidity and mortality in chronic renal failure (Kaminski *et al.* 1991). It is now well established that the metabolic acidosis that frequently accompanies chronic renal failure causes an increase in whole body protein degradation (Reaich *et al.* 1993). There is evidence to suggest that this is due to an increase in the activity of the ATP and ubiquitin dependent proteolytic pathway in skeletal muscle (Mitch *et al.*1994) but this has not been demonstrated in humans. We have used the L6 rat myoblast cell line together with primary cultures of human skeletal myoblasts to investigate this further.

Using [$^{14}$C]phenylalanine release to measure protein degradation (PD) in L6 cells we found that reducing the pH of the culture medium from 7.40 to 6.95 resulted in an increase in PD (expressed as log % of initial cellular $^{14}$C/h) from -3.4 x$10^{-3}$ to -4.4 x$10^{-3}$ (SE 0.3 x$10^{-3}$ for both conditions, $P$<0.05). As insulin is the major anabolic hormone in the body we were interested to see its effect in this system and we found that the addition of 100 nM insulin reduced PD at both normal and acid pH. In a separate experiment we found a dose-response relationship between PD and insulin with a just significant effect using 1 nM insulin. We obtained the same pattern of results with human myocytes.

We then used Northern Blotting in this system to investigate the ATP and ubiquitin-dependent proteolytic pathway. This pathway is the major cytosolic proteolytic pathway and we were interested to see if the genes for any of its components were up-regulated by acidification. In L6 cells we found that insulin reduced the expression of the main components of the pathway, ubiquitin (UbA and UbB), activating enzyme E1, conjugating enzyme E2 and proteasome component C2. After exposure for 8 h to insulin plus acidification the expression of UbB, E1 and E2 was higher than with insulin alone whereas the other genes were sensitive to insulin despite the acid pH. In these cells we were unable to find any independent effect of acid alone to increase gene expression. In the human cells we found that insulin reduced the expression of E2 but did not effect ubiquitin expression.

The regulation of this pathway by insulin supports the hypothesis that ubiquitin is important in acidosis. However in this system we were unable to demonstrate up-regulation of gene expression by acidosis. This may be because the genes are already highly expressed in these cultured cells or that the acidification needs to be for longer periods of time to better represent the *in vivo* situation of chronic acidosis. We believe that the responses of PD to insulin and acidification in these two cell types make them a suitable model for further study.

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**A comparison between saliva and plasma urea and creatinine concentrations, and changes in deuterated water and bromide after oral dosing.** By S.E. JENNINGS, G. JENNINGS, M. ELIA and N.J. FULLER, *MRC Dunn Clinical Nutrition Centre, Cambridge CB2 2DH*

Labelled water and bromide dilution techniques are frequently used to assess total body water (TBW) and extra-cellular water (ECW) space respectively. The enrichment of water in saliva is considered to reflect that in TBW so that saliva may be used routinely to assess TBW by dilution of deuterated water ($D_2O$). If the concentration of bromide in saliva could be used to predict plasma levels accurately, then venepuncture would not be necessary for ECW estimates. However, there is little information regarding the distribution of an oral dose of bromide in saliva compared with that of plasma. Similarly, if the concentration of urea or creatinine in saliva could be shown to reflect that of plasma then saliva could be used to predict plasma values, for example, in renal function tests and for correcting N balance calculations in metabolic studies; again, this will obviate the need for venepuncture. Therefore, the purpose of the present study was to assess the potential value of utilizing saliva for predicting plasma concentrations of urea, creatinine and bromide.

Characteristics of the ten male and eight female volunteers were : age range 41-62 years; weight 80.4 (SD 18.2) kg; height 1.73 (SD 0.08) m; BMI 26.7 (SD 5.2) $kg/m^2$. Each was given an oral dose of a mixture consisting of $D_2O$ and NaBr (0.04 g/kg and 0.75 mmol/kg body weight respectively). Plasma and saliva samples were obtained before (zero hour) and 4 h after dosing for measurement of changes in bromide concentration (spectrophotometric fluorescein method; Jennings & Elia, 1996) and enrichment of $D_2O$ (infra-red spectroscopy). The zero hour sample was used for measurement of urea (enzymic end-point technique) and creatinine (Jaffe reaction). The extent of agreement between plasma and saliva concentrations was assessed using bias (mean of plasma minus saliva values) and 95% limits of agreement.

| | Plasma concentration | | Bias | 95% limits of agreement | Saliva : plasma ratio (range) |
|---|---|---|---|---|---|
| | Mean | Change | | | |
| Urea (mmol/l) | 3.79 | | -1.02 | 3.33 | 0.53 - 1.86 |
| Creatinine (μmol/l) | 97.1 | | 41.7 | 39.2 | 0.15 - 0.89 |
| Deuterium (ppm) | | 622 | -1 | 23 | 0.97 - 1.04 |
| Bromide (mmol/l) | | 2.19 | 0.25 | 3.64 | 0.00 - 2.40 |

The Table shows that good agreement exists between saliva and plasma for changes in enrichment of water, as expected. However, there was substantial variability between saliva and plasma for urea, creatinine and bromide concentrations. It is concluded that changes in the enrichment of water in saliva may be used to predict closely those changes in plasma after oral dosing but that saliva measurements are unsuitable for predicting changes in plasma bromide concentration; the lack of agreement between saliva and plasma measurements also precludes the use of saliva for predicting plasma concentrations of urea and creatinine.

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**Monitoring the severity of cystic fibrosis using multi-frequency bioimpedance.** By B. H. CORNISH[1], L. C. WARD[2*], B. J. THOMAS[1] and R. SHEPHERD[3], [1]*Centre for Medical and Health Physics, Queensland University of Technology, Brisbane, Australia;* [2]*Department of Biochemistry, University of Queensland, St Lucia, Brisbane, Australia;* [3]*Department of Child Health, Royal Children's Hospital, Brisbane, Australia*

The severity of the disease cystic fibrosis (CF) and its associated complications can presently only be assessed by complicated, time consuming and very costly procedures which cannot be repeated frequently. Accurate assessment of nutritional status and progress of the disease in terms of nutrition and response to therapy is essential in the management of CF. However, with current techniques accurate assessment of nutritional status is frequently not possible, especially with children amongst whom there is a wide normal range of variables such as weight and height (Shepherd *et al.* 1991).

The aim of the present study was to investigate a novel non-invasive technique based on multi-frequency bioimpedance (MFBIA) measures for the quantitative assessment and monitoring of the severity of CF in children. The assessment of body composition by bioelectrical impedance measured at 50 kHz is an established procedure, however recent research (Piccoli *et al.* 1994) has suggested that various patient groups can be characterized by the resistive and reactive components of the measured impedance, normalized by the subject's height, obviating the need for reference to predictive equations. The authors (Cornish *et al.* 1993) have previously demonstrated that by measuring the bioimpedance over a range of frequencies (5 - 1000 kHz), and determining the impedance at the characteristic frequency, a more accurate prediction of body water can be obtained than by measures at a single frequency (e.g. 50 kHz).

The present study was conducted to determine if the combined advantages of measuring impedance at the characteristic frequency by MFBIA and the normalized resistance and reactance would provide a simple non-invasive method of monitoring CF. MFBIA measurements were recorded using an SFB2 impedance monitor (SEAC, Brisbane) from a group of CF patients (sixteen males, twenty-five females, aged 0.4 to 16.5 years), and also from a control group of healthy individuals (twenty-seven males, thirty-three females, aged 6 to 45 years). Plots of reactance / height *v.* resistance / height demonstrated a significant difference between healthy males and healthy females with no overlap of the 85% confidence intervals. However, a result of greater clinical importance was the very large significant difference in these indices between age-matched sub-groups of the healthy controls and CF patients with no overlap of the 95% confidence intervals of these two groups.

The results strongly suggest that normalized reactance and resistance, measured by MFBIA, provide a simple, fast, non-invasive index of body composition in CF, independent of population-specific prediction equations and may be useful for monitoring progress of the disease.

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**Comparison of complications of two different-sized percutaneous endoscopic gastrostomy tubes.**

By HAMISH D.DUNCAN, MARGARET BRAY, SUNEIL A.KAPADIA, TIMOTHY E.BOWLING, SIMON J.COLE, SIMON M.GABE, EMILY R.WALTERS AND DAVID B.A.SILK, *Department of Gastroenterology and Nutrition, Central Middlesex Hospital NHS Trust, Acton Lane, London NW10 7NS*

Percutaneous endoscopic gastrostomy (PEG) is used in the management of patients requiring long-term nutritional support. There is a range of different-sized PEG tubes used, with no information on effect of tube size on the incidence of complications such as tube blockage, peristomal infection and leakage.

This was a prospective randomized study to compare efficacy, complication rate and safety of 12 and 20 French gauge (FG) Corflo-Bower PEG tubes. The median length of follow-up in the two groups was similar (median (mode, range): 12FG, 168.5 (190, 1 - 190) d; 20FG, 190 (190, 2 - 190) d; P = 0.32). All PEG tubes were inserted by experienced endoscopists using the "pull technique". Prophylactic cefuroxime was given unless patients were already on antibiotics at the time of undergoing the procedure.

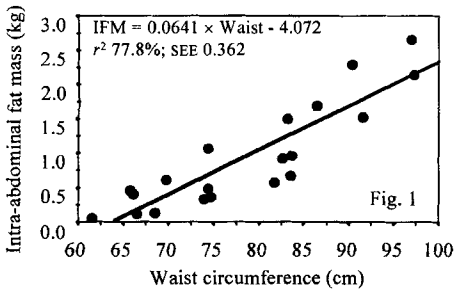
Fifty-two PEG tubes were successfully inserted, twenty-six in each group. Of the patients, 82.7% had suffered a cerebrovascular accident, the others suffered from dysphagia due to a variety of neurological causes, except one patient with an oesophageal tumour. There were no procedure-related deaths. The median (range) ages for the 12- and 20FG groups were 81.5 (50 - 92) and 77.5 (24 - 90) years respectively. There were no significant differences in the ages, number of peristomal infections (eight in the 12FG and twelve in the 20FG PEG groups), episodes of leakage (twelve in the 12FG and seventeen in the 20FG PEG groups), tube blockage (two in the 12FG and one in the 20FG PEG groups) or tube removal (deliberate/accidental) between the two groups. Blocked tubes were easily cleared and did not need replacing. One 12FG PEG insertion was unsuccessful on the first attempt due to the trocar supplied being too short for the cannula. Although we did not specifically address the question of ease of PEG insertion, subjectively the endoscopists preferred to use the smaller 12FG PEG tubes as they were easier and less traumatic to insert.

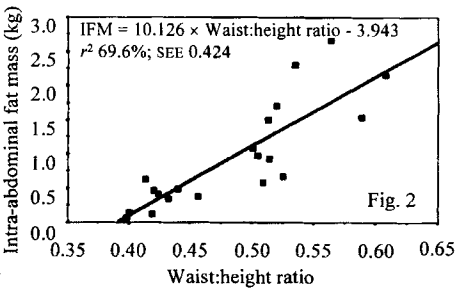
There was no statistically significant difference in the incidence of complications between the two different-sized PEG tubes; although there was a trend towards the 12FG PEG tubes having fewer complications. We conclude that the smaller 12 FG PEG tubes be used preferentially to the 20FG PEG tubes.

**Predicting intra-abdominal fat mass measured by magnetic resonance imaging (MRI) from waist circumference in women: the influence of height.** By THANG S. HAN[1], GERALDINE McNEILL[1], PANOS BARAS[2] and MARGARET A. FOSTER[2], *University Departments of [1]Medicine & Therapeutics and [2]Biomedical Physics & Bioengineering, Aberdeen AB25 2ZD*

Waist circumference, an index of intra-abdominal fat mass (IFM), is a risk factor for metabolic diseases (Pouliot *et al.* 1994). Lean *et al.* (1995) derived waist circumference action levels based on BMI and waist:hip ratio (WHR), for health promotion purposes. Ashwell *et al.* (1996) have suggested waist:height ratio, as a slightly more complex index, based on a single computed tomography scan as a measure of IFM. These indices must reflect IFM independently of body stature.

From a larger study of body composition and birth weight of 110 women (Han *et al.* 1995*b*), IFM was measured by MRI (Aberdeen Mark II, 0.08 T) in twenty women of mean age 34.4 (SD 10) years, BMI 25.2 (SD 4.5) kg/m$^2$, and height between 1.48 and 1.72 m. IFM was calculated using a truncated cone model, from four images at equal distances between the xiphisternum and the anterior iliac crest (Han *et al.* 1995*a*). Weight, height, waist midway between the lateral lower ribs and the iliac crests, and hip circumference at the widest part over the greater trochanters were made according to standard protocols (World Health Organization, 1989). Height explained 1.3% ($P = 0.394$) and 0.4% ($P = 0.312$) of the variance of IFM and waist respectively. Waist:height$^p$ ratios of different index powers (p) for height, WHR, and BMI (weight/height$^2$) were calculated. Fig. 1 shows that waist alone (waist:height$^0$) was related more closely to IFM than waist:height ratio (waist:height$^1$) (Fig. 2). The Table shows the correlations between anthropometric indices and IFM measured by MRI.




| | Waist:height$^p$ ratios of different index powers | | | | | | | WHR | BMI |
|---|---|---|---|---|---|---|---|---|---|
| | -0.50 | -0.25 | 0.00† | 0.25 | 0.50 | 0.75 | 1.00‡ | | |
| Adjusted $r^2$ (%) | 77.0*** | 77.8*** | 77.8*** | 77.1*** | 75.4*** | 72.9*** | 69.6*** | 28.6** | 70.4*** |

**$P$ <0.01, ***$P$ <0.001; †waist:height$^0$ = waist circumference alone; ‡waist:height$^1$ = waist:height ratio.

Waist circumference alone explained 78% of the variance in IFM, without any further improvement from waist:height$^p$ ratios of different index powers. BMI gave similarly good prediction, whilst WHR was the poorest predictor of IFM. Thus waist circumference alone is a valid, simple method for screening women who are at increased health risks from IFM accumulation.

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**Single frequency bioimpedance at 50 kHz predicts changes in body water in multiple organ failure.** By K. FOLEY,[1] M.A. KEEGAN,[1] D. HANCOX,[2] B.J. POLLARD[2] and I.T. CAMPBELL,[1] *[1]University Department of Anaesthesia, Withington Hospital, Manchester M20 2LR, [2]Department of Anaesthesia, Manchester Royal Infirmary, Manchester M13 9WL*

Single frequency bioimpedance predicts total body water (TBW) in individuals of normal body composition to within 1-3 litres (Hannan *et al.* 1995). In multiple organ failure (MOF) fluid retention occurs in an unpredictable fashion, sometimes amounting to 10-15 litres (Streat *et al.* 1987) but assessing the degree of fluid retention is difficult. Fluid balance charts are notoriously inaccurate (Roos *et al.* 1993) and daily weighing too hazardous for routine use. Changes in bioimpedance at 50 kHz are related linearly to acute changes in body weight in MOF but the relationship varies widely between individuals (Roos *et al.* 1993). We have derived a relationship between TBW and conductance (height$^2$/impedance - cm$^2$/Ohms) in twenty patients with MOF and in ten normal controls. Impedance was measured using a Holtain Body Composition Analyser (Holtain, Crymych, Dyfed). Changes in body water in seven patients with MOF, predicted from changes in impedance, were then compared with changes in body water in these seven individuals as deduced from acute changes in body weight.

The following equations were derived relating TBW (litres) and conductance (C):

Patients: $TBW = 0.27C + 27.7$ SEE = 7.6 litres

Controls: $TBW = 0.44C + 14.3$ SEE = 1.9 litres

There was no difference in slope or intercept between the patients and the controls.

Combined equation: $TBW = 0.28C + 26.8$

The correlation coefficient of body weight with impedance in the seven patients with MOF varied from 0.980 to 0.999, but the relationship varied between individuals as denoted by the CV of the slopes of the regression lines which was 34%. When changes in body weight were regressed against changes in body water predicted from the combined equation, the CV of the slopes decreased to 16%. When change in body water was predicted from change in impedance using the combined equation and compared with change in weight as measured, the impedance measurement underestimated the change in body weight/water by an average of 0.70 (SD 0.52) kg ($P<0.001$). The median weight change in these 7 patients was 7.6 (range 2.2-9.6) kg.

It is concluded that single frequency impedance at 50 kHz will predict change in body weight due to changes in TBW in patients in MOF with the same degree of precision as it does in normal individuals, but it appears to underestimate and is not precise enough to satisfactorily predict absolute values of TBW.

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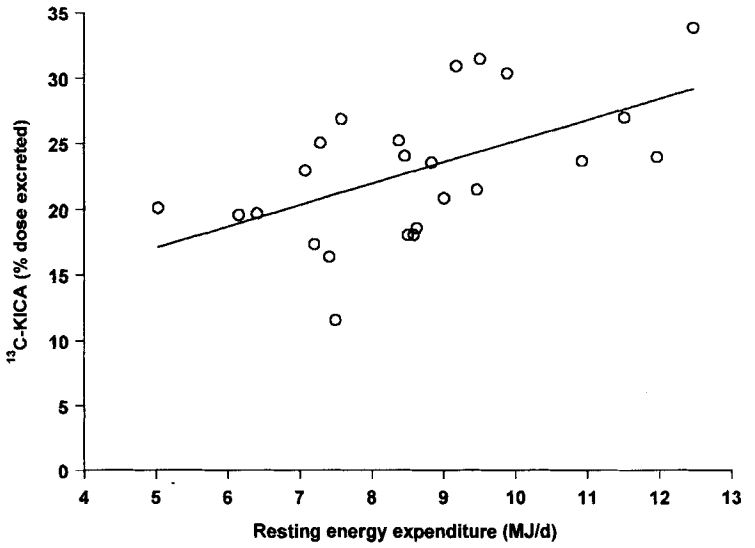
**The ketoisocaproic acid breath test as a test of mitochondrial function.** BY SIMON M. GABE[1,3], PHILLIP G. JOHNSON[2], ROGER WILLIAMS[3] and DAVID B.A. SILK[1], [1]*Department of Gastroenterology and Nutrition, Central Middlesex Hospital NHS Trust, London NW10 7NS,* [2]*BSIA, Brentford, TW8 0PP.* [3]*Institute of Liver Studies, Kings College Hospital, London SE5 9RS*

Ketoisocaproic acid (KICA) is a branched-chain keto amino acid which is decarboxylated in the mitochondria to Isovaleryl-CoA. By labelling KICA with $^{14}C$ or $^{13}C$, labelled $CO_2$ is produced which is expired in the breath and this has recently been used as an indicator of mitochondrial function in both control populations and in patients with alcoholic liver disease (Michaletz *et al.* 1989; Lauterburg *et al.* 1993; Witschi *et al.* 1994). The advantages of this test as an assessor of *in vivo* mitochondrial function are that it is non-invasive and easy to perform. However, no direct comparison has been made with *in vivo* cellular energy production, which is the ultimate product of mitochondrial metabolism.

Twelve patients, 7-55 d post liver transplantation were studied on two occasions. All patients received tacrolimus (FK506) as immunosuppression. The patients drank 200 ml orange juice containing 1 mg 2-keto(1-$^{13}C$)isocaproic acid ($^{13}C$-KICA)/kg and 20 mg L-leucine/kg. Baseline breath samples were taken and repeated at 10, 20, 30, 40, 50, 60, 80, 100 and 120 minutes after drinking the solution. $^{13}CO_2$ was measured in the breath samples by mass spectrometry and the percentage of the dose of $^{13}C$-KICA given was calculated. Indirect calorimetry (Deltatrac™) was performed over a 20 min period at the end of the test in a non-fasting state. The $CO_2$ production rate ($VCO_2$) and resting energy expenditure (REE) were recorded.

A direct linear correlation was seen between the $^{13}C$-KICA percentage dose excreted ant the REE ($r$ 0.56, $P$=0.005). This remained significant even after the REE was corrected for weight ($r$ 0.43, $P$= 0.04) or BMI ($r$ 0.48, $P$= 0.02). This confirms the utility of the $^{13}C$-KICA breath test and demonstrates that the decarboxylation of KICA can be used as an *in vivo* indicator of mitochondrial energy production.

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**Phenotypic changes in *Pseudomonas aeruginosa* Lipopolysaccharide grown in milk-based enteral feeds**. By HODGSON, I.[1,2], STEWART, J.[3] and FYFE, L.[1,2] [1]*Department of Dietetics and Nutrition, Queen Margaret College, Edinburgh EH12 8TS,* [2]*Centre for Food Research, Queen Margaret College, Edinburgh, EH12 8TS,* [3]*Department of Medical Microbiology, University of Edinburgh Medical School, Teviot Place, Edinburgh EH8 9AC*.

Contaminated enteral feeds have been implicated as reservoirs of opportunistic pathogens causing respiratory infections, acute and chronic enteritis and septicaemia in vulnerable patient groups (Anderton, 1993). *Pseudomonas aeruginosa* is a Gram -ve bacteria which has been shown to contaminate enteral feeding solutions (Allwood, 1981). This organism is associated with burns patients and acute and chronic infections of the respiratory tract in cystic fibrosis (CF) patients. The lipopolysaccharide (LPS) portion of the outer membrane of *P. aeruginosa* has an important role in its pathogenesis as it initiates a massive inflammatory cytokine release from mononuclear phagocytes causing inflammation and endotoxic shock (Proctor *et al*, 1995). In addition the O-polysaccharide side chains confers resistance to complement (Kronborg, 1995). The aim of this present work was to investigate the growth of *P. aeruginosa* in milk-based enteral feeds and determine the characteristics of the LPS.

*P. aeruginosa* was grown using batch culture methods in both nutrient broth and milk-based feeds such as Osmolite (Abbott, Maidenhead, Berks.) at 25°. Bacteria were enumerated at regular time intervals over a 24 hour period using the spread plate method (Jay 1992). In addition cells from 1 litre of each culture were harvested at 24 h and the LPS extracted using the hot water-phenol method (Hancock and Poxton, 1988). Polyacrylamide gel electrophoresis (PAGE) (Laemmli, 1970) and silver staining of gels (Hancock and Poxton, 1988 modified from Tsai and Frasch, 1982) was used to screen the extracted LPS for phenotypic changes.

*P. aeruginosa* was able to grow in nutrient broth at 25° from an initial inoculum of 2.00 log colony forming units (cfu)/ml to 3.91 log cfu/ml in 8 h and to 7.89 log cfu/ml in 24 h. Similarly, *P. aeruginosa* grew in the feed to 4.15 log cfu/ml at 8 h and to 7.53 log cfu/ml at 24 h. PAGE analysis of the LPS from the organisms showed significant changes in the profile of O-polysaccharide side chains between those grown in broth and the milk based feeds. This is the first report, to the authors knowledge, of phenotypic changes in the O-polysaccharide side chain of the LPS occurring as a result of growth in a food. It is possible that these alterations in the O-polysaccharide may change the virulence of the organism by increasing resistance to antibiotics, phagocytosis and serum complement inactivation. In addition these changes may be indicative of structural differences in other parts of the molecule that are responsible for the production of inflammatory cytokines and mediators (TNFα, $IL_1$, $IL_6$, $IL_8$ and nitric oxide) in human macrophages (Proctor *et al*, 1995). This present work shows that growth in milk-based enteral feeds may modulate the pathogenicity of *P. aeruginosa* by altering the structure and proportions of LPS molecules expressed on the cell surface. This may present an increased risk of infection to immunocompromised patients from *P. aeruginosa* contaminating feeds or endogenous to a patient's gastro-intestinal tract. It also highlights the need for a re-evaluation of preservation systems currently used in enteral feeds and an assessment of the implications of long-term enteral feeding with milk-based enteral feeds on the LPS of gut commensals.

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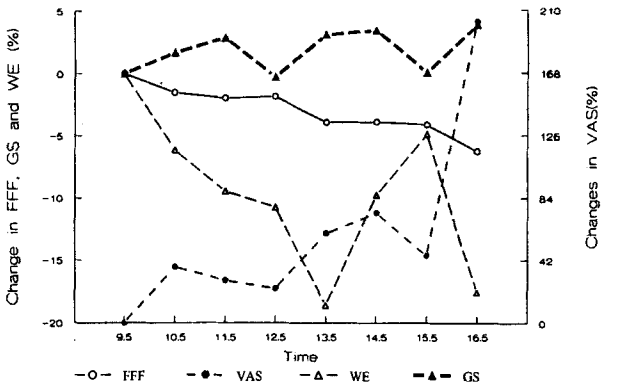
**Diurnal changes in measures of fatigue in normal subjects.** By A. CUNLIFFE, O.A. OBEID and J. POWELL-TUCK. *Rank Department of Human Nutrition, St Bartholemew's and the Royal London Hospital School of Medicine and Dentistry, Turner Street, London E1 2AD*

The sensation of fatigue can be divided into central and peripheral (McKenzie *et al.* 1992) as well as objective and subjective components. We have been working on the development of a number of simple tests of these components. The present study was conducted to establish the magnitude of changes in fatigue during the day before applying them in the context of clinical nutrition support or dietary manipulation. Sixteen healthy volunteers (nine males, seven females) eating their normal diet were followed for 8 h. The subjects had a mean age of 31.5 (range 20-47) years and mean BMI of 24.1 (range 20-35.2) kg/m$^2$. Subjective impressions of fatigue were recorded using a visual analogue scale (VAS: Lee *et al.* 1990). Objective measurements for central fatigue were made using flicker fusion frequency (FFF: Rammsayer & Netter, 1988), and for peripheral fatiguability, wrist ergometry (WE: Shaker H.A., 1993) and grip strength (GS: Klidjian *et al.* 1980) for maximum voluntary contractions. The Figure shows mean values for VAS, FFF, WE and GS, expressed as percentage changes from baseline (09.30 hours).




During the working day, a steady decline in FFF was observed; FFF scores during the last 4 h were significantly ($P$<0.05) lower than at baseline. This indicates an increase in central fatigue. Associated with this was an increase in subjective fatigue, as indicated by VAS score. At the final test (time 16:30 hours) the work done during WE was significantly lower ($P$<0.05), while that of GS was higher ($P$<0.05) than baseline. Both WE and GS fluctuated during the experimental period, though no apparent synergism was observed. Only WE appeared to change following lunch, taken between 12:30 and 13:30 hours. Different components of fatigue may vary in opposing directions from each other. Their individual measurement should add to the precision of testing of fatigue in the clinical setting.

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**The effect of surgical trauma on feeding behaviour in the rat.** By A.R. BOSAGH ZADEH and P.W. EMERY, *Department of Nutrition and Dietetics, King's College London, Campden Hill Road, London W8 7AH*

Reduced food intake is a common feature of the metabolic response to trauma. The aim of the present study was to determine whether this is caused by premature satiety (decrease in meal size) or reduced hunger (decrease in meal frequency). Eight female Sprague-Dawley rats were housed individually in Skinner boxes and trained for 4 d to obtain food pellets by pressing a lever connected to a recording device. Surgical hysterectomy was then performed under halothane anaesthesia. A 70 mm mid-line incision was made into the peritoneum and the uterus was removed but the ovaries were left intact. The muscle layer was sutured and the skin closed with stainless steel clips. The whole procedure lasted approximately 20 min. Feeding behaviour was monitored continuously from 3 d before surgery until 5 d after surgery.

| | Food intake (g/d) | | Food intake in dark hours (%) | | Meal size (g) | | Meal frequency (meals/d) | |
|---|---|---|---|---|---|---|---|---|
| Days after surgery | Mean | SEM | Mean | SEM | Mean | SEM | Mean | SEM |
| 0 | 19.3 | 1.1 | 66.6 | 3.4 | 1.5 | 0.2 | 12.8 | 0.7 |
| 1 | 2.8*** | 0.7 | 75.4 | 12.3 | 0.6** | 0.1 | 4.5*** | 0.7 |
| 2 | 12.3** | 0.9 | 58.0 | 2.8 | 1.0** | 0.1 | 13.4 | 0.7 |
| 3 | 14.5** | 0.7 | 61.8 | 3.5 | 1.1** | 0.1 | 13.1 | 0.7 |
| 4 | 14.7** | 1.6 | 66.0 | 5.7 | 1.2* | 0.1 | 11.8 | 0.7 |
| 5 | 14.8** | 1.1 | 70.9 | 4.0 | 1.1** | 0.1 | 13.5 | 0.9 |

Significantly different from Day 0, * $P<0.05$, ** $P<0.01$, *** $P<0.001$.

Day 0 represents the mean value for the 3 d before surgery. Hysterectomy caused a significant reduction in total food intake throughout the subsequent 5 d. Approximately two thirds of the food was eaten during the night, and this proportion did not change after surgery. On the first day after surgery the 85% fall in food intake was caused by decreases in both meal size and meal frequency. After this, however, meal frequency returned to normal while meal size remained low. Thus premature satiety appeared to be the main cause of decreased food intake after surgery. These results contrast with our previous findings in cachectic tumour-bearing rats in which the main cause of sustained anorexia was reduced meal frequency (Obeid &. Emery, 1992). Clearly the acute anorectic response to trauma is caused by different mechanisms from those which operate during the chronic cachexia of tumour growth.

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**The thiamin, riboflavin and pyridoxine status of a randomly selected population of patients admitted through a London Accident and Emergency department.** By C.P.JAMIESON, O.A.OBEID and J.POWELL-TUCK, *Rank Department of Human Nutrition, St Bartholomew's and the Royal London Hospital School of Medicine and Dentistry, London E1 2AD*

The aim of this study was to assess the incidences of B vitamin deficiencies amongst acute hospital admissions. Adult patients (*n* 110) were selected at random from those admitted via the accident and emergency department of the Royal London Hospital over 3 d. Patients' heights, weights and demographic details were recorded, venous blood samples taken at admission, and BMI (weight(kg)/(height(m))$^2$) values were calculated. Erythrocyte transketolase (ETK), glutathione reductase (EGR), and aspartate aminotransferase (EAA) enzyme assays were used to determine thiamin, riboflavin and pyridoxine deficiencies respectively. A deficiency state was diagnosed when the percentage activation with added coenzyme was greater than the conventionally accepted limits of 23%, 20% or 86% for ETK, EGR and EAA assays respectively. Length of hospital stay, in-patient mortality, and diagnoses were recorded at discharge. Of the patients studied, 77% were under the care of the department of general medicine, 15% general surgery and 8% orthopaedics. Treatment with B vitamin supplements was implemented according to the clinical judgement of the doctor in charge of the patient's care. Men comprised 56% of patients studied, 73% were Caucasian, 20% Asian and 7% Afro-carribean. The table shows the numbers of patients with specific deficiencies, the proportions of these subgroups with body mass indices less than the desired range of 20-25 kg/m$^2$ and mortality figures.

| | No vitamin deficiency | Thiamin-deficient | Riboflavin - deficient | Pyridoxine-deficient | Single deficiency/ marginal level | Multiple deficiencies |
|---|---|---|---|---|---|---|
| No. of patients (%) | 38 (35) | 10 (9.1) | 45 (41) | 38 (35) | 42 (38) | 24 (22) |
| No. of patients with BMI < 20 kg/m$^2$ (%) | 2 (5.3) | 1 (10) | 11 (24) | 8 (21) | 9 (21) | 6 (25) |
| Mortality (*n*) | 0 | 1 | 2 | 1 | 4 | 0 |

A total of sixty-six patients (60%) had at least one biochemical B vitamin deficiency. Seventeen patients (15%) had BMI values below the desired range and fifteen of these had a B vitamin deficiency. The majority of deficient patients, however, had BMI values within the desired range. Riboflavin deficiency was the commonest identified.

The median length of hospital stay was shorter in the biochemically deficient compared with the non-deficient group (6 d and 7 d respectively (not statistically significant)). The median age of the deficient group was, however, lower at 59 y compared with 69 y in the non-deficient group ($p$=0.002, Mann Whitney U test). The four deaths occurring in study patients were amongst those with single vitamin deficiencies. Four patients were admitted with alcohol-related disease and were the only group given vitamin supplementation. Of these, two were thiamin deficient and one had combined riboflavin and pyridoxine deficiencies. B vitamin deficiencies are common in the acute in-patient population and are not restricted to patients with protein-energy undernutrition. Younger in-patients are more commonly biochemically deficient.

**Total antioxidant status of patients receiving total parenteral nutrition (TPN).** **By MALCOLM BAINES and ALAN SHENKIN,** ***Department of Clinical Chemistry, Royal Liverpool University Hospital, Liverpool L7 8XP***

Many patients prescribed TPN may be metabolically compromised, due to a combination of major surgery and abnormal underlying pathology. Surgery may release tissue contents and pro-oxidants such as free iron into the circulation, whilst those patients with malignancy may have reduced albumin levels, an important plasma antioxidant. This study sought to assess the plasma antioxidant levels of TPN patients against a reference group. Ideally, this would be by measurement of the individual antioxidants, but this is difficult to achieve and impractical. We therefore investigated the use of a single measurement of total antioxidant status (TAS) in plasma using a commercially available kit.

Seventy subjects (fifty females,twenty males,age range 14-91 years) attending their GP for minor ailments were compared with twenty-eight patients (ten females,eighteen males) who had ben receiving TPN , including vitamins and trace elements, daily for a minimum of four days. Typically,these included those with major abdominal surgery, some for malignancy. Plasma from all subjects was analysed for routine biochemistry,including albumin and urate and TAS was measured by the degree of suppression by plasma of the stable radical cation,ABTS* (Randox Laboratories, Belfast,UK)

Reference males had a significantly higher mean TAS than females (1.58 *v* 1.45 mmol/l, $P<0.005$). The calculated reference ranges (mean$\pm$2SD) were 1.30 - 1.86mmol/l(males) and 1.11 - 1.79mmol/l (females). The observed range of plasma TAS in the TPN group was 0.96 - 2.27mmol/l, and twelve (ten male,two female) of the twenty-eight TPN patients (43%) had a TAS value below their respective reference range. In the TPN group there was a weak correlation between TAS and albumin ( $r = 0.318$, $P = 0.100$).

This study has demonstrated that a substantial proportion (43%) of TPN patients have a subnormal TAS level and may therefore be at risk of oxidative stress. A lowered plasma albumin may contribute to this situation, but is not a prime determinant. The maintenance of an adequate plasma TAS probably represents a balance between utilization, which may be increased in the TPN patient, and replacement with antioxidants such as ascorbate, vitamin E and sulphydryl amino acids in the TPN administration. Measurement of plasma TAS may be a guide to assess whether TPN patients should receive additional antioxidants, though further studies would be required to see if supplementation confers clinical benefit.

**Diurnal changes in circulating concentrations of selected micronutrients in patients receiving cyclic nocturnal enteral tube feeding.** By C. BALDWIN, J. SHAW, G. JENNINGS and M. ELIA, *Dunn Clinical Nutrition Centre, Hills Road, Cambridge CB2 2DH*

Information about micronutrient status in patients receiving artificial nutritional support (enteral tube feeding and parenteral nutrition) has sometimes been obtained by sampling blood during infusion of the feed and for variable periods of time after cessation of feed. The effect of starting and stopping feeding on the circulating concentration of micronutrients has been poorly documented. The purpose of the present study was to assess the extent to which circulating concentrations of two vitamins (vitamin C and riboflavin) and two trace elements (Cu, Zn) is influenced by the administration of enteral feeds.

The patients studied were eight metabolically stable patients (mean age 59 (sd 25) years) with swallowing difficulties (cerebrovascular accidents *n*3; persistent vegetative state *n*2; multiple sclerosis *n*1; cerebellar astrocytoma *n*1; supra nuclear palsy *n*1) who had been receiving cyclic nocturnal tube feeding for at least 2 months (1000-1500 ml over 12 h). The range of the stated feed composition of the three feeds used was as follows: (4184-6276 kJ/l with 49% energy from carbohydrate, 35% from fat, and 16% from protein; vitamin C, 50 mg/l; riboflavin, 1.1 mg/l; Cu, 1.5-1.7 mg/l; Zn, 10-11 mg/l). Blood was withdrawn from a venous cannula in the antecubital fossa at 0 h (at the end of the period of feeding, typically 08.00-08.30 hours) and at 3, 6 and 9-12 h after the end of feeding. No feed or food or drink (other than water) was administered during the entire period of the study. Plasma was used for all the measurements which are shown in the Table.

| | 0 h | | 3 h | | 6 h | | 9-12 h | |
|---|---|---|---|---|---|---|---|---|
| | Mean | sd | Mean | sd | Mean | sd | Mean | sd |
| Vitamin C (mg/l) | 3.7 | 1.5 | 3.9 | 1.7 | 4.1 | 1.8 | 4.2 | 2.1 |
| Riboflavin (μg/l) | 55 | 1.5 | 55 | 10 | 63 | 18 | 57 | 20 |
| Copper (μg/dl)(mg/l) | 1.19 | 0.1 | 1.23 | 0.10 | 1.24 | 0.11 | 1.21 | 0.13 |
| Zinc (mg/l)† | 0.56 | 0.04 | 0.67 | 0.17 | 0.72* | 0.16 | 0.75** | 0.12 |

Mean values were significantly different from 0 h: *$P$<0.02, **$P$<0.002 (paired $t$ test).
†$P$< 0.05 by ANOVA.

No significant changes were observed in the circulating concentrations of vitamin C, riboflavin or Cu, but the plasma Zn concentration increased significantly after cessation of the feed.

This study suggests that cessation of cyclic nocturnal enteral tube feeding does not produce a reduction in the circulating concentration of the above nutrients but the timing of blood sampling is important with respect to the circulating Zn concentration which significantly increases after cessation of feeding. The effect of starting and stopping enteral tube feeding on the circulating concentration of other nutrients needs to be assessed to identify any changes that are relevant to blood sampling.

The project is supported by a grant from Nutricia.

**A comparison of artificial nutritional support in hospital and community between two adjacent health districts.,** By C. BALDWIN[1], H. ROLLINS[2], O. E. DEWIT[1], S. COTTEE, G[1]. BOYLE[2], N. SIMMONDS[2], and M. ELIA[1], *[1]Dunn Clinical Nutrition Centre, Cambridge CB2 2DH ,and [2]Luton and Dunstable NHS Trust, Luton LU4 0DZ*

Home enteral tube feeding (HETF) is a rapidly expanding form of home care therapy. In one district (South Bedfordshire) the purchasers have been concerned with the growing costs associated with this form of therapy and have questioned its overall cost-effectiveness. As a result the purchasers now have to approve HETF before it is initiated. The purpose of this audit was to identify the types of patients receiving HETF more frequently in S. Bedfordshire (without a teaching hospital) compared with an adjacent district (Cambridgeshire, with a teaching hospital) so that plans for future studies on the cost effectiveness of this form of therapy could be initiated. The study also aimed to assess whether tube feeding in the community was more common than hospital feeding since this has important implications with respect to the distribution of resources between hospital and community. The same aims applied to parenteral nutrition (PN).

South Bedfordshire and Cambridgeshire provide healthcare services to populations of similar size (0.28 million and 0.29 million respectively). Both districts have a nutrition team of the same composition meeting once weekly. Luton hospital serving the S. Bedfordshire community has 635 beds, Addenbrooke's Hospital and the Rosie Maternity Hospital, the main hospitals in Cambridgeshire have 1206 beds. The point prevalence in July 1996 of enteral and parenteral nutrition in hospital and in the community is expressed in absolute numbers (Table) since the populations served by the two districts are very similar.

| | Point prevalence of artificial nutritional support | | | |
|---|---|---|---|---|
| | Hospital | | Community | |
| | Enteral | Parenteral | Enteral | Parenteral |
| S. Bedfordshire | 47* | 7 | 75≠ | 1 |
| Cambridgeshire | 55† | 18 | 47§ | 3 |

* Neonatal, *n* 25.
† Neonatal, *n* 20.
≠ Children, *n* 44; neonatal, *n* 0.
§ Children, *n* 23; neonatal, *n* 4.

There were two striking differences between the districts. First, the point prevalence of PN in hospital was threefold greater in Cambridgeshire than in S. Bedfordshire, which can be explained by the specialist services provided in Cambridgeshire such as liver and bone marrow transplantation and specialist surgery. Second, there was a higher point prevalence of HETF in S. Bedfordshire compared with Cambridgeshire (*n* 75 *v.* *n* 47) which could be almost entirely explained by more feeding in patients with cerebral palsy (CP) (19 *v.* 7) and cerebrovascular accidents (CVA)(14 *v.* 3). There was 60% more tube feeding in the S. Bedfordshire community than its hospital, whereas slightly less (15%) tube feeding occurred in the Cambridgeshire community compared with its hospital. Both districts undertook much less parenteral nutrition in the community than in hospital. These data have important resource implications.

The greater incidence of HETF in S. Bedfordshire compared with Cambridgeshire is likely to be due to different attitudes towards feeding patients with CVA and CP. It is unlikely to be due to a major difference in the incidence of these conditions in the two districts. The benefits, detriments and cost effectiveness of HETF in patients with CP and CVA require formal and urgent investigation.

**Home parenteral nutrition: how long do catheters last?** By J.P. McWHIRTER, N. REYNOLDS and C.R. PENNINGTON, *Department of Gastroenterology and Clinical Nutrition, Ninewells Hospital and Medical School, Dundee DD1 9SY*

Some patients with intestinal failure require home parenteral nutrition (HPN) via central venous catheters. Catheter survival is believed to increase with the experience of the treatment centre. Catheter complications remain a problem although there is little information about catheter survival and current recommendations (Sizer, 1996) are that HPN is restricted to centres with experience in this treatment.

The aims of the present study were to assess catheter survival in patients treated in a single centre, to determine the effect of continued experience on complication rates and to document the current catheter complication rate.

Complications leading to the loss of the catheter were prospectively documented in forty-seven patients during sixty-seven courses of parenteral nutrition. Patient data has been divided into three groups. Group 1 represents patients fed between 1980 and 1987; group 2 represents patients who completed treatment between 1988 until the present and group 3 are those patients who continue to receive HPN.

A comparison of complications and patient days of feeding is given in the Table. Patients in group 1 were fed with each catheter for a mean 275 (range 18-1036)d, those in group 2 for 531 (range 19-2078)d and group 3 for 750 (range 30-1432)d ($P<0.001$).

| Group | 1 | 2 | 3 |
|---|---|---|---|
| No. of patients fed | 16 | 18 | 12 |
| No. of courses of treatment | 23 | 31 | 12 |
| No. of catheters inserted | 29 | 33 | 14 |
| No. of patient days of nutrition | 5337 | 12893 | 9011 |
| No. of patients who lost catheters | 9 (56%) | 8 (44%) | 2 (16%) |
| Catheters lost / patient days | 14:5337 | 5:12893 | 2:9011*** |

*** Significantly different from groups 1 and 2 ($P<0.001$)

During period 1, fourteen of twenty-nine (48%) catheters were lost, four (14%) due to catheter related sepsis (CRS), four (14%) catheter related thrombosis (CRT), three (10%) because of catheter occlusion and three (10%) suffered mechanical problems. In period 2, five of thirty-three (15%) catheters were lost due to CRS, one (3%) CRT, one (3%) catheter occlusion and three (9%) mechanical problems. In the group of patients who continue to receive parenteral nutrition, two of fourteen (14%) catheters have been lost due to CRS. Of the courses of treatment which were terminated in period 1, twelve of twenty-three (52%) were because the treatment period had ended and eleven of twenty-three (48%) were due to catheter complications. In period 2, fifteen of thirty-one (48%) were stopped electively while sixteen of thirty-one (52%) were stopped because of catheter complications.

The patients in group 3 represent 23.6 patient years. Within that time there have been two episodes of catheter-related complications resulting in catheter removal, 0.08 episodes per treatment year.

The use of catheter care protocols and meticulous care allow prolonged use of central feeding catheters. This study lends support to the recommendation that patients requiring HPN are managed in centres experienced in this form of treatment.

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**The Interlink™ reduces the cost of cyclical parenteral nutrition.** By J.P. McWHIRTER, J. TAIT, and C.R. PENNINGTON, *Department of Gastroenterology and Clinical Nutrition, Ninewells Hospital & Medical School, Dundee DD1 9SY.*

The use of cyclical parenteral nutrition (PN) is common in clinical practice. Cyclical PN is the optimal treatment for all but acutely ill patients and careful aseptic techniques are required for catheter care to avoid catheter-related complications, especially infection.

The Interlink™ is a self-sealing injection site which can be used up to 200 times. A specially designed blunt cannula is connected to the injection site which is removed and discarded after each infusion. As this is a closed system there is a reduced requirement for sterile equipment.

The aim of the present study was to compare the cost and nursing time involved in standard catheter care procedures with that of a connection device, and to assess the safety of the device.

The cost of equipment required for each procedure was calculated using standard protocols for catheter care for the conventional method and the Interlink™. A comparison of the mean length of time for commencement and completion of the infusion was carried out. An experienced nurse was timed on three occasions commencing and completing infusions using each method.

The cost (£) is shown in the Table.

| | Conventional | Interlink™ (% savings) |
|---|---|---|
| Commencement | 2.12 | 0.63 (70) |
| Completion | 2.59 | 0.85 (68) |
| Totals | 4.71 | 1.48 (69) |

The mean nursing time involved in infusion commencement was reduced from 12 (range 11.5-12.5) to 4.5 (range 3.7-5) min (62.5% saving) while completion of the infusion was reduced from 12.5 (range 12-13.5) to 5 (range 3-5) min using Interlink™ (60% saving). The actual cost of nursing time is difficult to quantify because of the variation in the grading of nurses carrying out the procedure.

No episode of catheter-related infection has occurred during fifty-five courses of central parenteral nutrition following the introduction of the Interlink™. We have demonstrated that the use of the Interlink™ system is safe, it reduces nursing time and saves £3.23 per episode of cyclical PN. We conclude that this is a useful development for the management of patients receiving central parenteral nutrition via central catheters.

**Complications on home parenteral nutrition are significantly increased in opiate and sedative dependent patients.** By DAVID M. RICHARDS, NIGEL A. SCOTT, JON L. SHAFFER and SIR MILES IRVING, *The University of Manchester Intestinal Failure Unit, Hope Hospital, Stott Lane, Salford M6 8HD*

Home parenteral nutrition (HPN) is useful for the treatment of intestinal failure. We identified ten patients within this group who were dependent on oral and intramuscular opiates (*n* 9) or sedatives (*n* 6). All were commenced on drugs before the initiation of HPN. The outcomes of these patients were prospectively compared with ten well matched, non-dependent HPN patients for 12 months.

| | Drug dependent *n* 10 | Controls *n* 10 | Significance |
|---|---|---|---|
| Line sepsis episodes | 14 | 1 | P= 0.0007 |
| No of patients with line sepsis | 10 | 1 | |
| Total hospitalizations | 22 | 2 | P= 0.0002 |
| Total bed days | 630 | 16 | P= 0.0004 |
| Health Status Index* | 0.26 | 0.53 | P= 0.004 |

*(Scale; 0=death, 1= best possible quality of life)

Health status (measured by two validated questionnaires, SF 36 and EuroQol) was lower in the dependent group and controls reported less pain (P=0.04) and more energy (P=0.04). The drug dependent group were very difficult to manage during long periods of hospital care. The complications and the inevitable increased costs involved make opiate- and sedative-dependent patients a poor risk for HPN therapy.

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**The results of outcomes research on home parenteral nutrition.** By DAVID M. RICHARDS (1), JON J. DEEKS (3), TREVOR A. SHELDON (2), JON L. SHAFFER (1). 1 *Intestinal Failure Unit, Hope Hospital, Salford M6 8HD.* 2 *NHS Centre for Reviews, University of York York Y01 5DD.* 3 *Centre for Statistics in Medicine, University of Oxford, Oxford..*

The NHS Health Technology Assessment Programme prioritized home parenteral nutrition (HPN) as a therapy requiring systematic review. HPN involves complex aseptic procedures usually performed by the patient. Complications have an impact on the quality of life achieved and on the cost of treatment. Knowledge of outcomes on HPN creates opportunities for audit, formulation of guidelines and cost minimization. The aim of the present study was to determine the patient experience of HPN. From 1967 to 1996, a total of 256 relevant studies were identified by searching databases and English and European published literature. Of these fifty six satisfied minimum standards of scientific rigour. Data on side-effects and complications were extracted in a standardized fashion from each of the studies, (Table).

| Complication | Rate (Episodes per catheter year) | 95% Confidence Intervals |
|---|---|---|
| Catheter sepsis | 0.39 | (0.34, 0.44) |
| Catheter occlusion | 0.12 | (0.08, 0.2) |
| Central vein occlusion | 0.042 | (0.025, 0.071) |

Side-effects such as metabolic bone disease, gallstones and derangements of liver function were commonly reported in the literature. Quality of life was generally good for patients with benign disease, but some subgroups with intestinal failure due to malignant disease or AIDS, had not been assessed. One year survival rates for patients with Crohns disease were in excess of 90% compared with less than 30% for malignancy and 10% for AIDS. HPN related deaths were uncommon.

The results provide standards to which individual units can compare their results. HPN is a safe, effective treatment for benign intestinal failure. The use of HPN for those with malignant disease or AIDS requires further study.

**Nutritional adequacy of a standard parenteral nutrition formulation (SPNF) in preterm infants.**

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Adequate early nutrition is important for survival, favourable prognosis and development of small preterm infants (Lucas *et al.* 1989). Neonatal parenteral nutrition (PN) is commonly provided by individualized formulations, however, the long-term outcome and nutritional benefits compared with use of a SPNF are unclear.

It is known that SPNF can reduce prescribing errors, response time for requests, preparation time, wastage and cost (Hartwig & Gardner, 1989, Gow & Middlehurst, 1995). Aims of the present study were to determine the nutritional adequacy of a SPNF against intakes specified on the "in-house" guidelines for enteral nutrition and PN, and to assess benefits with respect to weight gain and biochemical assessment.

Fifty infants given SPNF for at least 5 d with or without milk feeds, were reviewed retrospectively. Amino acids were provided as Primene® 10% with Intralipid® 10% added when indicated. Fluid volumes were recorded daily from nursing charts and amounts of energy, protein, fat, Na and K from enteral nutrition and PN were compared with specified intakes. Ca and phosphate intakes were not evaluated as the SPNF provided only 50% of specified intakes. Weight gain was analysed in infants (*n* 19) after at least 10 d of PN and weights up to postnatal age 5 were excluded. Plasma Na (*n* 988) and K concentrations (*n* 932) were monitored during PN in fifty infants. At maximum TPN intake of 150 ml/kg per d, the SPNF provided 6.2 mmol Na and 1.5 mmol K.

Birth weights were 600-3480 g and gestation 23-37 weeks. Milk was started within 1-3 d of birth and SPNF plus milk was initiated at 1-32 postnatal days. Parenteral and enteral nutrition was provided for 602 d of which 338 d were by total parenteral nutrition (no milk). Mean intakes were: non-protein energy 299.2 (SD 48.7) kJ/kg per d, protein 2.3 (SD 0.5) g/kg per d, fat 1.1 (SD 0.7) g/kg per d, Na 5.6 (SD 1.6) mmol/kg per d and K 1.4 (SD 0.3) mmol/kg per d. Two infants received additional Na (1.5-6 mmol/150 ml SPNF) for six PN days and eleven infants received K (1.5-6 mmol/150 ml SPNF) for sixty-five PN days. Three infants each had three plasma Na concentrations >148 mmol/l and four infants each had three levels <134 mmol/l. Infants <1 kg were more likely to have hyponatraemia. Two infants who had hyponatraemia had received a mean Na intake of 5.8 (SD 1.8) and 10.6 (SD 5.6) mmol/kg per d. Eight infants had three or more episodes of hypokalaemia <3.2 mmol/l but none had three or more episodes of hyperkalaemia (>6.5 mmol/l). Mean weight gain was 12 (SD 5.5) g/kg per d.

The routine use of individualized PN solutions is questionable. This study has shown that a SPNF plus milk feed can result in weight gain similar to intrauterine growth rates with little electrolyte imbalance. The need for more K in the present SPNF has been highlighted and addressed. A higher energy SPNF may be needed for infants whose volume is restricted (<125 ml/kg per d) and are also on high volume intravenous medicines and fluids (>30% of total daily fluid).

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**Diversity of Bacterial Flora Involved in Gut Translocation in Man**

**BY C.J. O'BOYLE, M.D. PALMER, C.J. MITCHELL AND J. MACFIE**
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There is increasing evidence that bacterial translocation from the intestinal lumen may be implicated in the development of multiple organ failure. It has been suggested that changes in intestinal microflora may predispose to bacterial translocation. The aim of the present study was to investigate the diversity of translocating bacteria.

Bacterial translocation was determined by culture of mesenteric lymph nodes and serosal scrapings obtained at laparotomy.

A total of 448 patients were studied. Bacterial translocation was identified in sixty-nine patients (15%). The most common organism identified was E.coli (52%) and both aerobic and anaerobic types of indigenous intestinal flora were isolated. Anaerobes were particularly prevalent in the presence of intestinal obstruction. Bacterial translocation was identified in 30.4% of patients who developed septic complications compared with 8.5% who did not ($P<0.001$). The greater the diversity of bacteria within the nodes, the more likely septic complications were to develop.

We conclude that differences in intestinal microflora will influence bacterial translocation and subsequent septic morbidity.

**Percutaneous endoscopic gastrostomy (PEG) in Birmingham Heartlands Hospital (BHH): assessment of the effectiveness and outcome of one dose of prophylactic antibiotics prescribed before PEG placement; evaluation of nursing care of stoma site and monitoring of patient outcome.** By H. ARROWSMITH and M. TRACEY, *Birmingham Heartlands Hospital, B9 5SS*

There was concern over an apparent increase in infection at the stoma site following PEG insertion. The use of prophylactic antibiotics for reduction of infective complications has been recommended in a number of recent studies. (Fawcett, 1990: Payne-James *et al.* 1992; Sant *et al.* 1993; Panos *et al.* 1994).

The aim of this audit was to identify the reduction in infection rate at the PEG insertion site following implementation of local guidelines on the 1 November 1995. These guidelines recommended the use of 1 dose of Augmentin, 1.2 g in 1 dose, 30 min before PEG placement. Assessment of nursing care of the stoma site was also undertaken.

The audit was undertaken in two parts:

(1) A prospective audit evaluating all patients having a PEG inserted during the 6 months after the guidelines were implemented. Nursing care was evaluated by the Clinical Nurse Specialist (CNS) Nutrition who visited the patient at intervals (n46 patients)

(2) A retrospective audit monitoring the infection rate of patients who had a PEG inserted in the 6 months before the implementation of the guidelines (n35 patients).

NB. For statistical purposes, twelve patients who received prophylactic antibiotics in the retrospective audit were excluded as conditions were not the same as in the prospective group, ie. they received no visits from the CNS Nutrition.

A total of eighty-one patients had PEG inserted; forty six patients (prospective audit) received prophylactic antibiotics, twenty two (48%) developed a stoma site infection with none of these occurring in the first 3 d. Twenty three patients (retrospective audit) did not receive prophylactic antibiotics, fourteen (61%) developed a stoma site infection (*Staphylococcus aureus*) with three (21%) occurring in the first 3 d. On comparison of the two groups it would appear that one dose of prophylactic antibiotics is effective in prevention of stoma site infection up to 3 d post PEG insertion ($P<0.05$) but has no effect thereafter ($P>0.2$).

The nursing guidelines for swabbing the stoma site were adhered to in 52% of incidents, with the remaining 48% having being swabbed by the CNS Nutrition. With regard to dressing of the stoma site, guidelines were followed in the majority of cases (79%).

Of the total population, (eighty-one patients) 12% died within 7 d with an overall mortality rate of 43%; 51% were discharged feeding via the PEG; in 7%, oral feeding resumed.

The conclusion from this study was that one dose of prophylactic antibiotics appears to protect against stoma site infection for up to 3 d post PEG insertion. Further nurse education is required regarding identification of stoma site infection and care, with a view to amending the current stoma site dressing policy.

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**Cyclical Peripheral Parenteral Nutrition: An Audit By M.D. PALMER, C.J. MITCHELL and J. MACFIE** ***Combined Gastroenterology Service, Scarborough Hospital, Woodlands Drive, Scarborough, YO12 6QL***

Controversy persists as to the optimal method of peripheral parenteral nutrition (PPN) administration. Cyclical infusion of nutrients over a 12 h period with daily change of venous access sites has been our standard practice for 2 years. The present study was an audit of our experience.

A total of sixty patients received cyclical PPN in this period. The most frequent indications were: following major excisional surgery, the management of inflammatory bowel disease and treatment of enterocutaneous fistula.

The median duration of PPN was 7 (range 1-24)d. Nine patients (15%) were successfully fed for 10 d or longer. Fifty-six patients (93%) completed their TPN course using this technique. Only four (7%) patients required central parenteral nutrition because of inadequate peripheral veins.

No patient in this series developed catheter-related sepsis or other serious venous morbidity. Minimal phlebitis was recorded in only one patient. We encountered neither metabolic complications nor morbidity related to fluid overload.

Modified HAD questionnaire, confirmed that this method was acceptable to patients. Only 15% experienced a pain rating on cannula insertion of >2 (scale 0.5). 78% of patients, however, remained concerned about restricted mobility.

We conclude that PPN administration using cyclical infusion with rotation of venous access sites is the optimal method of delivery for PPN.

**Occluded long-term intravenous feeding lines: can they be salvaged?** By J.MORLEY, A.MYERS and J.L.SHAFFER, *Intestinal Failure Unit, Salford Royal Hospitals NHS Trust, Hope Hospital, Stott Lane, Salford M6 8HD*

Catheter occlusion is one of the major complications of Home Parenteral Nutrition (HPN) (Williams *et al.* 1993). The incidence of catheter occlusion and appropriate management of these lines is not well documented. We have performed a retrospective survey in ninety patients receiving HPN during the 30-month period between 1993 and 1996. The ninety patients consisted of fifty-three females (59%) and thirty-seven males (41%), median age 46 (range 18-71) years. The main underlying diseases were Crohn's disease (50%), mesenteric infarction (17%) and short bowel syndrome related to other conditions (10%). Eighty-six patients had a Broviac tunnelled line *in situ*, two had Viggo polyurethane cuffed lines and two had Port-a-Cath implantable ports.

There were forty-nine documented episodes of line blockage in thirty-two patients (0.22 episodes per patient per year), all of which were Broviac lines. In thirty-four incidences due to thrombus, thirty were treated with Urokinase locks, with a 63% success rate. Two were treated with Urokinase infusion without effect, two lines were flushed with saline, one successfully and one splitting the line. In one case the line was thought to be blocked with lipid deposits but an alcohol lock was unsuccessful. Of the blockages unsuccessfully treated with Urokinase locks, two were given Urokinase infusions and two had alcohol locks without response.

In the remaining fourteen episodes, two lines were removed due to superior vena cava thrombosis, and twelve lines were blocked due to mechanical problems, of which five were found to be kinked within the protective sheath. All five cases were successfully treated by unkinking. There were three episodes of positional difficulties and one of misplacement. Two of these were replaced, and two positional lines continued to be used. The three remaining incidencies were poorly documented but did not have to be replaced. In all, nineteen lines needed to be replaced.

It is unclear whether the type of feeding regimen, the heparin lock procedure or other factors are important in the incidence of line occlusion, and similarly whether improved patient education and therefore earlier treatment will improve the number of successful line salvages.

As Home Parenteral Nutrition continues to develop within the UK, the management of catheter occlusion remains a considerable challenge.

N.M.A.Williams, S.Wales, N.A.Scott & M.H.Irving,(1993). *Clinical Nutrition 12, 344-349*

**Hospitals with Nutrition Support Teams are more likely to have a Nutritional Assessement Policy and ward nurses who identify 'at-risk' patients than those that do not.** By ANNMARIE DANIELS[1] and JOHN WRIGHT[2], *Nutrition Support Team Office, Oldchurch Hospital, Romford, Essex RM7 0BE and [2]School of Biological Sciences, University of Surrey, Guildford, Surrey GU2 5XH*

Nutritional assessment is essential in identifying patients with potential or actual nutritional depletion. Nursing admission documentation should accomplish this. This study compares the nutritional assessments made by five hospitals with, and five hospitals without, a Nutrition Support Team (NST). The survey consisted of: (a) a questionnaire to all ward sisters asking about Nutrition Assessment Policy and education; (b) a site visit to four wards in each hospital (two medical, two surgical) to audit the recording of nutritional assessment data and the identification of 'at-risk' patients (using established nursing documentation unique to each establishment); (c) a questionnaire to providers of continuing education for ward nurses.

The results are shown in the Table.

| | NST | | No NST | | Chi squared |
|---|---|---|---|---|---|
| | n | % | n | % | |
| Hospitals | 5 | | 5 | | |
| Wards surveyed | 101 | 93 | 69 | 94 | |
| Questionnaire response | 76 | 75 | 58 | 84 | |
| Hospitals with Nutritional Assessment Policy | 3 | 60 | 0 | 0 | P < 0.0001 |
| Ward Staff aware of Nutritional Assessment Policy | 45 | 59 | 15 | 26 | P < 0.0001 |
| Wards using nutritional assessment tool | 28 | 37 | 14 | 24 | NS |
| Staff believed their assessments were reliable | 79 | 79 | 56 | 81 | NS |
| Staff believed that more education is required | 63 | 83 | 54 | 93 | P < 0.05 |
| Education events reported per year | 88 | | 36 | | |
| Patient records audited | 287 | | 289 | | |
| Nutrition data noted by ward nurses | 276 | 96 | 222 | 77 | P < 0.01 |
| Patients identified as having nutritional problems | 132 | 46 | 79 | 27 | P < 0.001 |

The results showed that hospitals with Nutrition Support Teams had ward nurses who were more likely to work to a policy, use a nutritional assessment tool, record nutritional data and detect 'at-risk' patients. Non-NST hospital nurses believed their assessments were equally effective, but were more likely to feel a need for further education; a high percentage in both groups identified this as a need.

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**Nursing support offered to stroke patients at mealtimes: a direct, non-participant observation study.**

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Acute stroke can result in a complex array of eating disabilities which if severe, can significantly impair food intake (McLaren *et al.* 1995). Skilled nursing support at mealtimes is necessary to assist in compensating disability and to ensure an adequate intake of food of an appropriate texture. The aim of the present study was to observe eating disability related activities engaged in or omitted by forty nine randomly selected nurses, each feeding a single patient over the entire period of one main meal.

A check list was used to record information concerning: grades of staff engaged in feeding; responsibilities for meal selection and direct, non-participant observations of nursing activities engaged or omitted in relation to impairments of lip closure, chewing, swallowing, attention to mealtime events, arm movement, posture, vision, perception, communication. Pilot studies established satisfactory levels of inter-observer reliability (>80% agreement within categories). Patients' eating disabilities were independently assessed by the researcher before and during the observation period using an ordinal scaled instrument (McLaren *et al.* 1995). A period of dummy data collection was undertaken to minimise the Hawthorn effect.

Although moderate to severe levels of eating disability were sustained by 67% of patients, responsibilities for feeding were principally devolved on unqualified nursing students and assistants, who constituted 73% of the sample; only 27% were RGN. Ward receptionists and nurses selected 54% of the meals, involving dietitians on five occasions. Only 38% of patients selected their own meal, yet 76% were capable of doing so alone or with help. On the basis of dietary textures proposed by Martin (1991) 4% of meals provided to dysphagic patients were unsuitable and only 10% were entirely suitable.

Engagement in assessment of patients eating disabilities was observed in 42% of the sample; RGN and senior students undertook significantly more assessments ($P<0.05$; Fisher's exact probability). High levels of nursing engagement occurred in selected activities relating to impaired trunk posture (>90% provided effective support); arm movement (>80% help with cutting food and/or manipulating cutlery); communication (>70% used verbal and non-verbal approaches) and attention deficits (80% nurses cued patients successfully). In contrast, high levels of omission were observed in nursing activities related to impaired lip closure, chewing, swallowing, vision and perception, i.e. omitting to use effective food insertion techniques (74%); to remove hoarded impacted food (82%); to give complete instructions on supra-glottic swallowing (80%) or use of visual field scanning techniques to localize the entire meal tray (93%).

These findings indicate that unqualified nursing staff may not possess the knowledge and skill necessary to assist patients with complex chewing and swallowing problems; this is a matter for concern where risks of aspiration exist (Martin 1991). Similarly, the involvement of unqualified personnel in meal selection, with sub-maximal involvement of dieticians and patients suggests continuing confusion over professional responsibilities in providing optimal feeding support.

Martin, A.W. (1991). *Dysphagia* **6**: 129-134.

McLaren, S., Dickerson J.W.T. & Wright, J. (1995). *Proceedings of the Nutrition Society.* **56**, 192A.

**Implementation of a training programme for the insertion of Percutaneous Endoscopic Gastrostomy tubes through the anterior abdominal wall.** By C.C. HEPWORTH, S.P. BURNHAM, S. BARTON, M. NEWTON, S. MIDDLETON and W.R. BURNHAM, *Department of Gastroenterology and Nutrition Support Team, Havering Hospitals NHS Trust, Oldchurch Hospital, Romford RM7 0BE*

The Nutrition Support Team is identifying more patients who require enteral nutrition. Our experience is that Percutaneous Endoscopic Gastrostomy is the best way to provide this long term in the community. Thus, the need for endoscopically placed gastrostomy tubes is increasing. In most units placement involves the combined skills of two doctors; one to perform the endoscopy, the other to insert the gastrostomy tube. However, the organization of tube feeding and maintenance of the tube are normally performed by trained nurses, preferably Nutrition Sisters. Specialist nursing staff usually stay in post for some years, offering good continuity of care and can develop considerable expertise in practical procedures. We have piloted a training programme for nurses to place gastrostomies through the anterior abdominal wall. The aim was to reduce the workload on junior and senior medical staff so that only one doctor (the endoscopist) would be required for each procedure. This doctor would supervise the whole procedure, but the preparation of the abdomen, skin incision and placement of the trocar was to be performed by a nurse.

In order to achieve this, a strict training plan was devised and approved by the Trust. Use of the videoendoscope enabled both operators to view all aspects of the insertion simultaneously. The training programme required the nurse to observe fifty insertions and to follow-up the patients subsequently. Then ten more patients, who had given consent, had their gastrostomy tube inserted by the nurse under the supervision of a trained surgeon or gastroenterologist. No complications have so far occurred from the abdominal insertion of the gastrostomy tube. One nurse has completed the training and now operates alone with a gastroenterologist and it is planned to offer this training to others. As a result of this training, our Nutrition Support Team has streamlined and developed a more efficient service of gastrostomy placement. Guidelines for the selection of patients suitable for gastrostomy were circulated to all Consultant Staff and preparatory screening details are given to ward staff with every request for gastrostomy. These include (1) signed informed consent, (2) a current chest X-ray, (3) clotting screen, and (4) arterial blood gases. Intravenous sedation before the procedure is not without its risks and prior knowledge of these results helps facilitate a safe and successful outcome. The waiting time for gastrostomy insertion has also been reduced.

It is concluded that specialist nurses can be trained to insert gastrostomy tubes through the anterior abdominal wall and that this will facilitate the process and quality of care in the future.

**The adsorption of micronutrients in Total Parenteral Nutrition (TPN) mixtures to end-line filters.** By MICHAEL C. ALLWOOD, HELEN MARTIN, GIL HARDY and BRUCE McELROY, *Medicines Research Unit, University of Derby, Derby DE3 5GX; Oxford Nutrition Ltd., Oxon OX8 7FJ and Pharmacy Department, Royal Shrewsbury Hospital, Shrewsbury SY3 8XF*

The inclusion of end-line filters to remove particulates and precipitates has been strongly advocated (Food and Drug Administration, 1994). The ability of such filters to remove fungal spores has also been confirmed (Barnett *et al.*, 1995). However, in-line filters have been shown to adsorb certain compounds, although the mechanisms are not clearly identified. The possibility exists therefore that micronutrients in TPN mixtures could be removed by this mechanism. A number of vitamins with widely differing chemical structures and physical properties are included in most TPN mixtures in small amounts. Adsorption mechanisms relate to molecular charge. It was the purpose of the present study to investigate the possible binding of vitamins to end-line filters. The vitamins chosen represented compounds carrying either a positive (thiamin) or negative (pteroylglutamic (folic) acid) a charge, due to partial or complete ionization in TPN mixtures, and also including an example of an uncharged lipophilic compound (retinol).

A 2.5 litre all-in-one TPN mixture containing Aminoplex 12 as amino acid source, was used. Multibionta was added as the retinol and thiamine source, and folic acid injection (15 mg) as folate source. After compounding, each mixture was infused *in vitro* at a flow rate of 20 ml/h by electronic control, with the Mirafilter IV (Baxter Miranda, Italy) as end-line filter (pore size 1.2 μm). TPN mixtures were protected from exposure to daylight during preparation and administration. Samples were taken at hourly intervals. Vitamins were determined by HPLC. Controls consisted of samples taken from TPN mixture directly from the bag. Data presented in the Table summarize the results.

| Vitamin | % remaining in infusate after infusion for (h)*: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 6 | |
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| Retinol palmitate | 99.8 | 2.66 | 99.6 | 4.20 | 102.1 | 1.54 | 100.0 | 5.92 | 105.0 | 5.78 |
| Thiamin | 101.2 | 0.73 | 100.8 | 1.21 | 101.3 | 1.08 | 101.2 | 1.71 | 101.2 | 2.20 |
| Folic acid | 99.2 | 1.97 | 98.4 | 2.76 | 100.6 | 0.71 | 99.8 | 1.87 | 98.7 | 0.55 |

* Mean of two tests, duplicate assays

All concentrations of vitamins tested remained within acceptable limits throughout the test period, indicating that retinol, thiamin and folic acid in all-in-one TPN mixtures showed no evidence of binding to the end-line filter tested. The all-in-one mixtures were tested for emulsion stability, which was retained during the filtration process. It is concluded therefore that micronutrients added to all-in-one TPN mixtures are compatible with the Mirafilter IV end-line filter. Losses due to adsorption to the filter surface do not occur *in vitro*. It should however be noted that only one source of multivitamins was tested. The source and formulation of the multi-vitamin additive could influence binding to end-line filters.

Barnett, M.I.B., Cosslett, A.& Cohen, D.A. (1995).*Clinical Nutrition* **14** suppl.,49.

Food and Drug Administration Alert.(1994). *American Journal of Hospital Pharmacy* **51**,1427-1428.

**Influence of the amino acid source on ascorbic acid stability in Total Parenteral Nutrition (TPN) mixtures.** By MELANIE L. KEARNEY, MICHAEL C. ALLWOOD, TREVOR NEAL and GIL HARDY, *Medicines Research Unit, University of Derby, Derby DE3 5GX and Oxford Nutrition Ltd, Oxon OX8 7FJ*

Ascorbic acid (AA) is the least stable vitamin in TPN mixtures (Nordfjeld *et al.* 1984), reacting with $O_2$ present in the ingredients, the air space in the bag and entering the mixture by transmission through the Ethyl Vinyl Acetatate (EVA) bag wall. AA degrades by a reversible reaction to dehydroascorbic acid (DHAA), which retains biological activity (Proot *et al.* 1994). Therefore, loss of biological activity must be measured as the sum of AA + DHAA (TAA). DHAA degradation is influenced by $O_2$ concentration and pH (Davis *et al.* 1991). Since the amino acid source influences both $O_2$ levels in TPN mixtures (due to the reducing activity of certain amino acids, excipients) and pH. Both factors will influence the quantity and rate of ascorbate degradation in any TPN mixture. It was the purpose of the present study to examine the influence of amino acid source on ascorbate stability during extended storage of TPN mixtures in multi-layered bags.

A standard 2-in1 TPN mixture was prepared in multi-layered bags (Ultrastab, Miramed). Each mixture contained amino acid influsion 200 ml, glucose (200g/l) 300 ml, electrolytes, trace elements and ascorbic acid, 50 mg/bag. Bags were stored at 5°C and each bag sampled at intervals for analysis of AA and DHAA by HPLC (Allwood *et al* 1992).

| | Concentration remaining (μg/ml)* | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Storage Time (d) | 1 | | 2 | | 12 | | 28 | |
| Amino acid source | AA | TAA | AA | TAA | AA | TAA | AA | TAA |
| Vamin 14 | 74.6 | 89.9 | 57.9 | 98.6 | 71.5 | 91.4 | 57.9 | 83.3 |
| Freamine III | 77.1 | 88.5 | 56.4 | 94.9 | 74.5 | 93.4 | 84.5 | 84.5 |
| Synthamin 14 | 47.4 | 68.8 | 11.2 | 75.8 | 30.6 | 68.3 | 48.6 | 53.5 |
| Aminoplex 12 | 49.4 | 62.7 | 28.4 | 77.4 | 45.5 | 62.1 | 55.4 | 55.4 |

*Mean of two bags, two samples/bag, initial conc=100μg/ml.

The results in the Table indicate that the rate and extent of AA loss in any TPN mixture is strongly influenced by the amino acid source. Results also indicate the importance of measuring TAA content at any time ,including DHAA, in order to measure total vitamin activity. In a number of the tests, AA content was substantially lower than TAA, due to DHAA content. The findings indicate the importance of the amino acid source in determining TAA stability, and the need to determine DHAA content in order to assess total vitamin activity in any stored bag.

Allwood, M.C., Brown, P.W., Ghedini, C. & Hardy, G. (1992). *Clinical Nutrition* **11**, 284 - 288.

Davis, M.B., Austin, J.& Partridge, D.A.(1991). *Vitamin C: Its Chemistry and Biochemistry*, Letchworth: R.S.C.

Nordfjeld, K., Pederson, J. L., Rasmussen, M.& Jensen, V. G. (1984).*Journal of Clinical and Hospital Pharmacy* **9**, 293-301.

Proot, P.,De Pourco, L.& Raymakers, A. (1994). *Clinical Nutrition* **13**, 273-279.

**Could standard parenteral nutrition solutions be used for the newborn instead of computer generated individual prescriptions?** By CHRISTINA BEECROFT, HELEN MARTIN and JOHN W. L. PUNTIS. *Division of Paediatrics and Child Health, University of Leeds and the Children's Centre, The General Infirmary at Leeds, LS2 9NS*

Parenteral nutrition (PN) is widely used on the neonatal intensive care unit for infants with gastrointestinal immaturity. PN prescribing is often performed with the aid of a computer using "KabiPN" programme or similar software. Although this has a number of theoretical advantages over use of standard solutions (less wastage, better biochemical control), there are also disadvantages. For example, we hypothesized that the programme effectively encourages the prescriber to make frequent minor adjustments to the standard regimen, generating pharmacy workload with little if any clinical advantage.

In an attempt to define the importance of the flexibility afforded by computer- assisted prescribing we examined prospectively the frequency with which PN prescriptions using the KabiPN programme actually deviated from the standard regimen. In addition we investigated how routine daily biochemical monitoring results influenced the prescriber. The setting for this study was a regional neonatal intensive care unit. A prescription was considered to have "deviated" only if the content of specific nutrients fell outside the following ranges around the recommended intake/kg given in the standard regimen: carbohydrate +/- 2 g; fat +/- 1 g; amino acid +/- 0.3 g; $Na^+$ +/- 1 mmol; $K^+$ +/- 1mmol; $PO_4^{2-}$ +/- 0.3 mmol; $Ca^{2+}$ +/- 0.4 mmol. PN prescriptions ($^n$ 148) for fifteen infants were evaluated over a 1 month period. The median gestational age of the patients was 29 (range 24-34) weeks, and median birthweight 1080 (range 560-2470)g. Overall, 121 (82%) prescriptions deviated with respect to one or more nutrients. The number of prescriptions that deviated in relation to specific nutrients were as follows: carbohydrate 91 (61%); fat 0 (0%); amino acid 11 (7%); $Na^+$ 77 (52%); $K^+$ 14 (9%); $PO_4^{2-}$ 78 (53%); $Ca^{2+}$ 36 (24%).

We conclude from this study that prescribers chose to override both the computer-recommended prescription and the standard feeding regimen for the majority of PN prescriptions, usually involving an increase in intake of carbohydrate, $PO_4^{2-}$ or $Na^{2+}$. However, on reviewing monitoring investigations these decisions often did not appear to be dictated by biochemical instability in the patients. Our findings could be interpreted as confirmation that the ability to individualize PN feeds is perceived as an important advantage of computer-assisted prescribing, and is an argument against the use of standard bag feeds. Alternatively, a new "standard regimen" is required including increases in carbohydrate, $PO_4^{2-}$ and $Na^{2+}$ intake. However, at least one fifth of feeds adhered closely to the recommended regimen suggesting that there is scope for demands on pharmacy by making available a range of "off the shelf" PN solution for use on the neonatal unit. The flexibility of computer- assisted prescribing is likely to be of most value in unstable patients and those with non-standard fluid and nutrient requirements.

**Filterability of parenteral nutrition admixtures and emulsions.** By C.A. GRANGER[1], K.M. WILKINS[1], M. LATTER[1], A.J. HUNTER[1] and J. COHEN[2], [1]*Pall Europe, Portsmouth PO1 3PD,* [2]*Welsh School of Pharmacy, Cardiff CF1 3XF.*

The use of filters in the infusion of parenteral nutrition (PN) admixtures has been suggested, to remove unwanted particulate matter, oversized lipid droplets and microbial contamination (Lewis, 1993). Filters of 1.2 μm pore size are now available for use with lipid-containing admixtures, as recommended by the Food and Drug Administration (1994). The aim of the present study was to confirm the filterability of a range of lipid emulsions and PN admixtures through a commercially available 1.2 μm modified nylon filter.

Formulations were passed through the filter at clinical flow rates with continuous measurement of pressures upstream and downstream of the filter. Similarly lipid droplet size distributions were determined using laser diffraction. All regimens tested were successfully filtered with no significant increase in upstream pressure (see Table) and no adverse effect on normal lipid droplet size distribution.

| Lipid emulsion/PN regimen | Flow rate (ml/h) | Volume infused (ml) | Final pressure (bar) |
|---|---|---|---|
| Soyacal® 20% | 3 | 60 | 0.102 |
| Lipofundin® S 20% | 3 | 60 | 0.303 |
| Lipofundin® MCT/LCT 20% | 3 | 60 | 0.579 |
| Intralipid® 10% | 6 | 120 | 0.488 |
| Intralipid® 20% | 3 | 60 | 0.069 |
| Ivelip® 20% | 3 | 60 | 0.151 |
| Lipovenös® 20% | 3 | 60 | 0.085 |
| Lipofundin® S 20% and Nutriflex 48 | 100 | 2500 | 0.748 |
| Pharmacia Regimen P1 and Intralipid 10% | 125 | 3040 | 0.164 |
| Pharmacia Regimen P3 and Intralipid 20% | 125 | 2540 | 0.275 |
| Pharmacia Regimen C5 and Intralipid 20% | 125 | 2535 | 0.097 |
| Pharmacia Intrafusion 22 Regimen B and Intralipid 20% | 125 | 2030 | 0.117 |
| Pharmacia Glamin Regimen and Intralipid 20% | 125 | 3035 | 0.679 |
| Kabimix® 9 | 125 | 2580 | 0.855 |
| Kabimix® 14 | 125 | 2580 | 0.124 |
| Pharmacia Regimen P2 and Lipovenos 10% | 125 | 3040 | 0.420 |
| Pharmacia Regimen C5 and Lipovenos 20% | 125 | 2535 | 0.224 |
| Pharmacia Regimen P3 and Lipovenos 20% | 125 | 2540 | 0.097 |

These data support the exercise in clinical use. Filters reported to have occluded in clinical use were found to have been used with non-standard regimens or practices, such as the addition of medications to the infusion.

Lewis, J.S. (1993). *Hospital Pharmacy* **28**, 656-658, 697.
Food and Drug Administration Safety Alert (1994). *American Journal of Hospital Pharmacy* S1, 1427-1428.

**Plasma trace element concentrations during paediatric parenteral nutrition.** By GEORGE H. PRIEST, JULIE COORE, HELEN MARTIN and JOHN W. L. PUNTIS, *Division of Paediatrics and Child Health, The University of Leeds, and the Children's Centre, The General Infirmary at Leeds, Leeds LS2 9NS.*

Although there are standard guidelines for trace elements during parenteral nutrition (PN) in young children, precise requirements remain uncertain (Greene *et al.* 1988). Whilst deficiences have important clinical consequencies, there are few data regarding plasma concentrations commonly achieved in practice. We have retrospectively reviewed measurements of plasma Cu, Zn and Se made in fourteen infants during > 16 d of PN. The indications for PN were post-surgical gastrointenstinal failure (*n* 5), protracted diarrhoea (*n* 3), biliary atresia (*n* 1), and immaturity of the gastrointestinal tract associated with premature birth (*n* 5). PN prescribing was performed using the KabiPharmicia PN programme; trace elements were given as Peditrace (KabiPharmicia), supplying 20 μg Cu / kg per d, 2 μg Se / kg per d, and 250 μg Zn / kg per d. Median duration of PN was 35 (range 16 - 175) d. Plasma concentrations were determined by atomic absorption spectroscopy (Burtis & Ashwood, 1994). There were twenty-nine measurements of Cu: median 16 (range 5 - 50) μmol/l; twenty-nine of Se: median 0.65 (range 0.2 - 1.18) μmol/l, and thirty-three of Zn: median 13 (range 9 - 44) μmol/l. Twenty-two Cu results were within the reference range, whilst seven were above normal (all from one patient with liver disease). Twenty-three Se results fell within the reference range whilst six were below normal; all abnormal results occured during the first 4 weeks of PN and increased to normal in the four patients who subsequently had repeat measurements. Of thirty-three Zn results, twenty-three fell within the low-normal range, nine were subnormal, and one high. Although this study shows that when using standard feeding regimens (including Peditrace) plasma Cu, Se, and Zn concentrations usually fall within the reference range, there are some causes for concern. High concentrations of Cu in the patient with biliary atresia highlight potential hazards of accumulation in patients with cholestasis. The low plasma Se concentrations seen early in PN suggest that an intake of 2 μg/kg per d may be inadequate. Zn concentrations tended to be low-normal and to fall with time, indicating that Peditrace may not meet Zn requirements in some young infants. As it is nearly 10 years since Greene and colleagues formulated their recommendations for trace element requirements in children, an updated review of the literature may now be warranted.

Greene, H. L., Hambidge, K. M., Schanler, R., & Tsang, R. C, (1988). *American Journal of Clinical Nutrition* **48**, 1324-1342.

Burtis, C. A., & Ashwood, E. R., eds. (1994) *Tietz Textbook of Clinical Chemistry.* W. B. Saunders Company, Philadelphia.

**Effectiveness of alcohol swabbing and use of disposable gloves in reducing microbial contamination during the assembly of enteral feeding systems.** By L. McROBBIE[1], A. ANDERTON[2], J. McKINLAY[1] and A. ROBERTSON[1]. [1]*Aberdeen Royal Infirmary, Foresterhill, Aberdeen AB9 2ZB and* [2]*Environmental Health Division, University of Strathclyde, Glasgow G4 0NG*

Handling and manipulation of enteral feeding systems is an important route for microbial contamination and assembly procedures have been shown to affect the levels of contamination in enteral feeds (Anderton & Aidoo, 1988). The purpose of the present study was to investigate whether the use of disposable gloves and alcohol swabbing of feeding systems was effective in reducing microbial contamination in the feed.

Patients receiving 1000-2000 ml sterile, undiluted, whole protein feed over 24 h from 500 ml prefilled glass bottles (Nutrison, Cow & Gate Nutricia Ltd) were included in the study. One giving set was used over 24 h for each patient. On day 1 nurses were asked to assemble a new enteral feeding system using a new giving set. No instructions regarding procedure were given. On day 2 nurses were again asked to set up a new system, this time they were instructed to wash hands thoroughly, put on disposable gloves (non-sterile) and wipe the neck of the opened nutrient container with an alcohol impregnated wipe (Alcowipe, Seton Prebbles Ltd; isopropyl alcohol, 700 ml/l). This procedure was to be carried out each time a new bottle of feed was used. Samples of feed from the nutrient containers and the distal end of the giving set were sent for microbiological analysis immediately after removal from the patient. Control experiments showed that there were no micro-organisms in the unopened feed and none were introduced during the sampling procedure.

| | No. of days on which contamination was detected* | |
|---|---|---|
| | Nutrient containers | Giving set only |
| Non-disinfected systems ($n = 21$) | 7 (33%) | 8 (38%) |
| Disinfected systems ($n = 21$) | 3 (14%) | 8 (38%) |

* Most counts were $\geq 10^{-3}$ colony forming units/ml

Organisms isolated included *Enterococcus faecalis, Enterobacter cloacae, Acinetobacter anitratus.*

This Table shows that improved hygienic practices (i.e. the use of disposable gloves and alcohol swabbing) reduced the incidence of contamination in nutrient containers from 7/21 patient d (33%) to 3/21 patient d (14%) but had no effect on the frequency of contamination of the feed samples collected from the distal ends of the giving sets. The results demonstrate the effectiveness of good hygienic practice in reducing the incidence of contamination introduced into the feed in the nutrient containers when assembling enteral feeding systems. They also provide further evidence that contamination of feed in the giving set may be caused by retrograde growth of the patients own flora.

Anderton, A. & Aidoo, K. E. (1988). *Journal of Hospital Infection* **11**, 364-372.

**Knowledge of nutrition and its application within a children's hospital.** By SARA McDOWELL and MICHAEL R. GREEN, *Children's Hospital, Leicester Royal Infirmary, Leicester LE1 5WW.*

The main aim of a nutrition team or working group is to optimize the detection, prevention and treatment of malnutrition by educating all disciplines of hospital staff. In order to assess the baseline knowledge of nutritional screening and nutritional support, a multiple-choice questionnaire was completed by dietitians, doctors, nursing staff, a pharmacist and medical students at the Children's Hospital.

The forty-eight questions were devised by all disciplines of the Nutrition Working Group: nine questions were about nutritional assessment, six on nutritional requirements and nutritional support, thirteen about enteral nutrition, seventeen on parenteral nutrition and three were pharmaceutical questions. One answer out of five was considered to be correct, or the correction indication of true or false, based on hospital guidelines and procedures.

The results are shown in the Table below:

| Profession | *n* | Mean score | % | Range |
|---|---|---|---|---|
| Children's dietitians | 5 | 38 | 79 | 35-41 |
| Children's pharmacist | 1 | 32 | 67 | 32 |
| Doctors | 32 | 30 | 62.5 | 25.35 |
| Medical students | 2 | 30 | 62.5 | 27-33 |
| Student nurses | 3 | 25 | 52 | 21-29 |
| Nurses | 32 | 23.5 | 49 | 19-35 |

Overall the marks were good, with all disciplines, except qualified nursing staff, scoring more than 50%: dietitians 79%, pharmacist 67%, doctors and medical students 62.5%, student nurses 52%, nursing staff 49%. As expected there was a significant difference in the knowledge of a junior grade doctor and consultant (mean scores 26 and 32 respectively) but this was not reflected in the nursing staff score (grade D mean score 23, grade G mean score 24).

All respondents answered the nutrition assessment questions well but knowledge of energy and protein requirements, infant feeding, nasogastric or nasojejunal feeding and parenteral nutrition were poor. Only 8% knew that liver function abnormalities in children receiving long-term parenteral nutrition commonly relate to a high-carbohydrate feed; 30% of respondents correctly indicated that the hub connection is the most common source of an infection to the parenteral line.

Children's dietitians scored the most correct answers with 60% achieving full marks for the fifteen nutrition nutritional assessment, nutritional requirements and nutritional support questions.

Teaching sessions to all six groups are now taking place with emphasis on demonstrated weak areas, for instance, specific medical and nurse training has been set up on handling of central/long lines and medical/nurse nutrition education is being handled at regular update sessions.

A further survey is planned to audit the educational role of our nutrition team/working group in view of these teaching sessions being carried out.

**Starvation in the midst of plenty: the development of a nutrition screening tool to identify patients at risk of malnutrition.** By ANN ASHWORTH[1] and CHRIS WRIGHT[2], [1]*Department of Nutrition and Dietetics, Radcliffe Infirmary, Woodstock Road, Oxford OX2 6HE and* [2]*School of Mathematical and Information Science, Coventry University, Priory Street, Coventry CV1 5FB*

It is now well accepted that malnutrition exists in hospital patients. The major challenge to health professionals who wish to tackle the problem of malnutrition is now to effectively identify patients who are at risk of malnutrition. This screening process must be repeated both on admission and during a prolonged hospital stay. Many screening tools have been designed by both dietitians and nurses, but very few have been evaluated for reliability and validity.

The present study aimed to develop and evaluate a nutrition screening tool for use by nursing staff on two oncology wards in a large hospital in the West Midlands. The screening tool was designed to be easy and quick to use by nursing staff to assess patients on admission to hospital. The study was accepted by the Ethics Committee and thirty-eight patients consented to take part. The tool was evaluated by assessing different aspects of reliability and validity as follows;

(1) reliability; test-retest reliability, inter-rater reliability and internal consistency

(2) validity; content validity and criterion-related validity.

Test-retest reliability was assessed by two different nurses administering the tool on two separate occasions. Inter-rater reliability was determined by assessing whether the degree of agreement between the two assessments was due to chance alone. Internal consistency is the extent to which the different questions within the tool measure the same characteristic, i.e. malnutrition. This was determined by using the statistical software programme, SPSS, as recommended by Spector (1992).

Content validity was determined by circulating the tool to trained nursing and medical staff. Criterion-related validity compares the performance of a new tool to an existing criterion. This method therefore depends on the existence of a reasonably reliable and valid criterion. In the field of assessment of nutritional status, many different variables have been measured, but no single variable is of use on its own. Criterion-related validity was tested by using anthropometric measurements (mid-upper arm circumference, triceps skinfold thickness and mid-arm muscle circumference) and a dietary assessment (24 h dietary recall).

| Test | Result (expressed as a correlation coefficient) |
|---|---|
| Test-retest reliability | 0.92 (Pearsons coefficient) |
| Inter-rater reliability | 0.73 (Kappas coefficient of agreement) |
| Internal consistency | 0.68 (Cronbachs alpha) |
| Criterion-related validity | 0.51 (Kappas coefficient of agreement) |

The results of this study demonstrated that the tool appeared to be reliable when administered by trained nursing staff on the wards in this particular hospital. The coefficient obtained for criterion-related validity indicated a moderate strength of agreement.

The above findings indicate that it is possible for dietitians and nurses to test screening tools for aspects of validity and reliability. It is unlikely that any tool can be said to be fully 'validated', only that evidence has been collected to support its validity.

Spector, P.E. (1992). *Summated Rating Scale Construction.* London: Sage Publications.

**Nutritional status of patients admitted for elective surgery.** By LISA HARRISON, *Department of Nutrition and Dietetics, North Staffordshire NHS Trust, Stoke-on-Trent ST4 7LN*

Many patients develop malnutrition in hospital, others are admitted to hospital with established malnutrition having not been identified in the community (Dickerson, 1986). Signs of malnutrition often go unrecognized by staff who are not trained to look for them. The aim of the present study was to obtain (1) baseline information on the nutritional status of patients admitted for elective surgery and (2) review the medical notes for any reference to nutrition.

A total of 808 patients (60% male, 40% female) provided data which included height, weight, mid-arm muscle circumference (MAMC), triceps skinfold thickness (TST), questions about appetite and a review of medical notes for any reference to nutrition. (Age range 18-91 yrs median age 61 yrs). The degree of malnutrition was calculated using BMI and skinfold thickness or MAMC using the following criteria:

| | | |
|---|---|---|
| Mild malnutrition | BMI | < 20 + (TSF or MAMC < 15th centile). |
| Moderate malnutrition | BMI | < 18 + (TSF or MAMC < 5th centile). |
| Severe malnutrition | BMI | < 16 + (TSF or MAMC < 5th centile). |

BMI results for all patients aged < 65 yrs (range 18-64 median 49) were compared with the national average for the population under 65 years old.
The Table shows the results found.

| | | Study Population | | UK Population |
|---|---|---|---|---|
| | | Number | % | % |
| BMI ($kg/m^2$) | 20-24.9 | 193 | 41 | 46 |
| | ≥ 25 | 260 | 55 | 46 |
| Malnutrition | Mild | 31 | 4 | |
| | Moderate | 6 | 1 | |
| | Severe | 2 | 1 | |
| Reference in medical notes to | Appetite | 45 | 6 | |
| | Weight | 98 | 12 | |
| | Weight recorded | 27 | 3 | |
| | Height recorded | 2 | 0.2 | |

It can be seen that the number of patients who were overweight (BMI ≥ 25) was higher than the national average. Only 6% were classified as malnourished, which is lower than that previously documented (McWhirter & Pennington, 1994) although the present sample were all elective admissions. The documentation in medical notes of height and weight was very poor as were any comments on nutritional intake. This information reflects that found by McWhirter & Pennington (1994) and Lennard Jones *et al.* (1995).

British Association of Parenteral and Enteral Nutrition (BAPEN) have since made recommendations that all patients on admission to hospital are asked four questions relating to their height, weight, appetite and any weight loss which should all then be documented. Therefore documentation in North Staffordshire is poor and needs improvement to meet the recommendations set out by BAPEN.

Dickerson, J.W.T. (1986). *The Professional Nurse* August, 293-296.
Lennard Jones, J.E., Arrowsmith, C., Denham, A.F. & Micklewright, A. (1995). *Clinical Nutrition* **14,** 336-340.
McWhirter, J.P. & Pennington, C.R. (1994). *British Medical Journal* **308,** 945-948.

**Changes in nutritional status and pulmonary function in adults with cystic fibrosis.** By HELEN G. MUSSON, JANICE ABBOTT, MARY E. DODD and A. KEVIN WEBB, *Adult Cystic Fibrosis Unit, Wythenshawe Hospital, Wythenshawe, Manchester M23 9LT*

Maintaining an optimal nutritional status in an adult cystic fibrosis population with declining pulmonary function can be difficult due to recurrent chest infections, associated anorexia and an increased energy expenditure (Vaisman *et al.*1987), combined with malabsorption losses. The present study looked retrospectively over an 8 year period at patients attending the Manchester Adult Cystic Fibrosis Unit to identify trends in nutritional status and pulmonary function. Data were collected for patients present in two or more of the cohort years: 1986, 1990 and 1994. BMI was used as a means of measuring nutritional status, and forced expiratory volume in 1 s expressed as a percentage of predicted (FEV1%predicted) for pulmonary function.

| Year | *n* | BMI | | FEV1% predicted | | Correlation | |
|---|---|---|---|---|---|---|---|
| 1986- 1990 | 48 | 18.57-19.14 | ($P$<0.02) | 61.7-58.4 | (NS) | $r$ 0.63 | ($P$ <0.001) |
| 1986- 1994 | 41 | 18.59-20.70 | ($P$<0.000) | 63.0-54.0 | ($P$<0.01) | $r$ 0.54 | ($P$ <0.001) |
| 1990- 1994 | 98 | 19.57-20.93 | ($P$<0.000) | 68.6-59.9 | ($P$<0.000) | $r$ 0.29 | ($P$ <0.01) |

Significant positive correlations between nutritional status and pulmonary function were observed in all three cohorts. The Table also shows that despite significant declining pulmonary function over two of the time periods the nutritional status of the adult Cystic Fibrosis patients can be significantly improved. The current use of enteric coated enzymes combined with an energy-dense diet will have contributed to the improvement (Beverley *et al.*1987). Additionally the increasingly aggressive nutritional support within the unit, either as long-term nasogastric or gastrostomy feeding will have promoted a positive nutritional status. For the first cohort group 4.3% of the population was enterally fed compared with 10.2% for the most recent group.

The weakening correlations as shown in the second table between the three time periods suggest that presently in our adult cystic fibrosis population declining pulmonary function is not necessarily linked with a compromised nutritional status.

The findings indicate that despite declining pulmonary function with appropriate nutritional advice and nutritional support our adult cystic fibrosis population are able to improve their nutritional status.

Beverley, D.W., Kelleher, J., MacDonald, A., Littlewood, J.M., Robinson, T. & Walters, M.P. (1987). *Archives of Disease in Childhood* **62**, 564-568.

Vaisman, N., Pencharz, P.B., Corey, M., Canny, G.J. & Hahn, E. (1987). *Journal of Pediatrics* **111**, 496-500.

**Patients at risk of malnutrition.** By JACKIE EDINGTON. *Abbott Laboratories, Abbott House, Norden Road, Maidenhead, Berkshire SL6 4XE*

Twenty years ago in the United States (Butterworth, 1974), 251 hospitalized patients were surveyed to determine their nutritional status; of these 44% had protein energy malnutrition and 34% had suppressed immune function. One year later in the United Kingdom (Hill *et al*, 1977), 105 surgical patients were surveyed 1 week after surgery, and 55% had two or more abnormal indices of nutritional status. Despite significant advances in medical knowledge and diagnostic techniques over the last 20 years, and the consequent benefits to medical science, malnutrition still remains undiagnosed and consequently untreated in hospitals today. McWhirter & Pennington (1994) found that 40% of patients admitted to hospital were malnourished on admission, and the nutritional status of 78% of these deteriorated during their hospital stay.

Until recently there have not been any data on the prevalence of malnutrition in patients in the community. We have conducted a study in 704 patients under the care of their general practitioner: 213 patients with cancer of the gastrointestinal tract, lung or prostate, 228 patients with chronic disorders of the gastrointestinal tract, lung or nervous system, 123 patients who had had major surgery within 6 weeks before being surveyed and 140 patients with chronic leg ulcers. The first three groups were chosen because they would be expected to be at risk of malnutrition by virtue of their disease conditions, the last group because they would be expected to lose protein from their wounds. We used the same criteria as McWhirter & Pennington (1994) to determine the prevalence of malnutrition, that is BMI < 20 kg/m$^2$ and TST or MAMC < 15th centile. In addition we looked at correlates of malnutrition: for example numbers of malnourished *v* non-malnourished patients who were receiving district nurse care, social class in these two groups; numbers of patients experiencing chronic or severe pain; and history of involuntary weight loss. Of the 704 patients surveyed, fifty-eight were classified as malnourished by our criteria. We found that 10% of patients with cancer, 8% of those with chronic disorders, 4% of those with leg ulcers and 11% of post surgical patients were malnourished: thirty-seven (5.3%) mildly, twelve (1.7%) moderately, and nine (1.3%) severely. Malnutrition was more common in social classes 3.2, 4 and 5 than in social classes 1, 2 and 3.1 ($P$=0.046) (Office of Population Censuses & Surveys, 1990), in patients receiving district nurse care ($P$<0.001) and in patients suffering chronic and/or severe pain ($P$=0.046). General practitioners need to be aware of the kinds of patients who are potentially at nutritional risk and of the associated factors which could compound the problem. The ability to recognize malnutrition by simply weighing and measuring patients, and referring to a dietitian when in doubt, may help in preventing malnutrition in the most vulnerable patients.

Butterworth, C.E. (1974). *Nutrition Today* **March/ April**, 4-8.

Office of Population Censuses & Surveys (1990). Standard Occupational Classification **1-3** London: HMSO.

Hill, G.L. Pickford, L., Young, G.A. *et al* (1977) *Lancet* **1**, 689-692.

McWhirter, J.P. & Pennington, C.R. (1994); *British Medical Journal* **308**, 945-948.

**Audit tools for identifying the 'at-risk' patient in hospital.** By JEREMY M. D. NIGHTINGALE, *Department of Gastroenterology, Leicester Royal Infirmary, Leicester LE1 5WW*

Three types of hospital patient are at risk of the complications of undernutrition, those who are undernourished, those who are at risk of becoming undernourished and those receiving inadequate nutritional therapy. An audit aims to evaluate and improve the care of these patients, using audit tools that must be simple, measurable, reproducible and inexpensive.

Three audit tools were used to determine the prevalence of undernutrition in medical in-patients. On a single day, all patients (*n* 84) were asked their usual weight in health and their weight, height, mid-arm circumference and triceps skinfold thickness were measured. Not all patients could be weighed. A percentage weight loss (%WL) of more than 10% occurred in 17/65, a body mass index (BMI) of less than 19 $kg/m^2$ in 13/69, and a mid-arm muscle circumference (MAMC) of less than the $5^{th}$ percentile in 16/83, giving an overall prevalence of undernutrition of 35%; of these only eight (28%) had been seen by a dietitian (Nightingale *et al.* 1996). Ideally, %WL and BMI are recorded on all patients; thus their significance needs to be understood by doctors and nurses. A multiple-choice questionnaire about nutritional assessment was given to twenty-nine doctors and forty-five nurses. While 60% of doctors and 31% of nurses knew a %WL of 10% to be indicative of malnutrition, only 55% of doctors and 31% of nurses could calculate it. Only 90 % of doctors and 56% of dietitians knew the correct units of BMI, and 34 and 44% respectively knew the normal range. Both %WL or BMI depends upon a patient being weighed, so accurate working weighing scales need to be present on all wards. A dietitian was weighed on thirty-four scales in twenty-three wards and three out-patient clinics. Her median weight was 48.7 (range 45.5 - 50.8) kg; on ten (29%) scales her weight was 1 kg more or less than the median.

A patient may be at risk of undernutrition due to reduced energy intake, malabsorption or increased requirements. These are rarely assessed alone but as part of a nutritional assessment tool that includes measures of undernutrition.

Inadequate treatment may occur due to a delay in starting to feed a patient or the patient not receiving the feed. In 1 month all referrals (*n* 139) for nutritional support were audited; the mean time from admission to receiving nutritional support was 3 d; 40% of those given oral supplements took less than half their feed.

Audit tools to detect undernutrition include %WL and BMI. MAMC is used if a patient cannot be weighed or if there is excess fluid. Patients at risk of undernutrition may be detected by looking for a reduced oral intake, malabsorption or increased requirements. To determine if nutritional support is adequate, the amount entering the patient and the time taken to start treatment can be measured. These tools will only be effective if medical and nursing staff are taught about the importance of detecting, preventing and treating undernutrition.

Nightingale, J.M.D., Walsh, N., Bullock, M.E. & Wicks, A.C. (1996). *Journal of the Royal Society of Medicine* **89**, 144-148.

**British Association for Parenteral and Enteral Nutrition guidelines and standards of practice in home enteral tube feeding: are they being met?** By SARAH J. WHITTINGHAM, *Department of Dietetics, Stafford District General Hospital, Weston Road, Stafford ST16 3SA*

Within the UK, the number of patients receiving home enteral tube feeding (HETF) is increasing by 20% per year (BAPEN, 1994). With such a significant rise it is essential that existing 'uncoordinated and erratic' discharge practices are improved (Wilcock *et al.* 1991) to ensure a minimum and acceptable standard of practice. Consequently BAPEN developed procedural guidelines and standards of care (BAPEN, 1994), and the present study compares these recommended standards with current practice. Seventeen out of a total of twenty-two hospitals within the West Midlands agreed to participate in the study. Nine hospitals were randomly selected, and face to face interviews were conducted with the person responsible for discharging HETF patients. Questions were designed:

(1) to establish current practice and awareness of the BAPEN recommendations;

(2) to identify the extent to which the BAPEN standards were met, and whether they could be achieved within current resources (human and monetary).

| Hospital | No. beds | No. HETF discharged last year | Awareness of standards | % BAPEN standards met |
|---|---|---|---|---|
| A | 1100 | 37 | Yes | 25% |
| B | 1100 | 27 | Yes | 31% |
| C | 1320 | 17 | No | 25% |
| D | 650 | 39 | Yes | 44% |
| E | 570 | 12 | Yes | 38% |
| F | 820 | 12 | Yes | 13% |
| G | 320 | 30 | Yes | 31% |
| H | 340 | 11 | No | 31% |
| I | 500 | 6 | No | 31% |

The Table would suggest no relationship between either the size of the hospital, the number of HETF patients discharged or the degree to which hospitals were meeting BAPEN standards. Of the hospitals surveyed, 33% had a nutritional advisory committee and 11% an active nutrition team, none of which were involved in discharging patients on HETF. Of the sixteen standards recommended by BAPEN, two were achieved by all nine hospitals, eight standards were unachievable, and the remaining six standards were partially achieved. The results of this study would suggest that seven BAPEN standards are achievable, but the other nine should be amended. For example:

(a) **BAPEN standard**: there will be written patient/carer learning goals for HETF;

Amended standard: there will be a checklist for staff to ensure the patient is competent in HETF.

(b) **BAPEN standard**: there will be a model of care for patients needing home enteral nutrition;

Amended standard: a manual will be available to those healthcare professionals involved in the discharge of HETF patients providing a step by step guide to the procedure.

Setting standards for patient care is an integral and fundamental part of improving quality of health care provision. However, these standards will only be successfully implemented if they are applicable to current practice, and regularly validated.

BAPEN (1994). *Enteral and Parenteral Nutrition in the Community*.. Maidenhead: BAPEN.

Wilcock, H, Armstrong, J, Cottee, S, Neale, G, Elia, M. (1991). Artificial nutritional support for patients in the Cambridge Health District. *Health Trends*, **23**, 93-100.

**Influencing the policy makers: a guide to decision makers in health and nutrition in the UK.** By PATRICK PARKER, *Corporate Relations Limited, Orpington, BR6 9LG*

It is assumed that government policies concerning health needs are based on recommendations that have received the full sanction and backing of the professional groups who have to implement the policies. This does not appear to be the practice that has emerged over the last five to six years. The Department of Health (DoH) continues to make policy statements about which interest groups, such as doctors, nurses pharmacists and now patients themselves have had little knowledge and certainly little input. Two examples indicate how difficult it is to apply the correct kind of influence and to define just who has made the decision about the policy.

On Monday 25 November 1996, the Advisory Committee on NHS Drugs (Department of Health, 1996) recommended that 60 products in 7 therapeutic categories of medicine should no longer be prescribed under the NHS. These products fall in the same area that were originally covered in the Selected List Scheme of November 1992 that has received so much attention that they had been sidelined in the interim period. The Skin Care Campaign has been active in attacking the previous proposals, yet had not been party to the latest recommendations. The Skin Care Campaign, led by the National Eczema Society and other patient groups has over the past four years been one of the foremost sources for patient advocacy, melding together some 10 patient groups, 12 industry companies, dermatologists, nurses, general practitioners, pharmacists, health strategists and planners. Evidence has been presented on the needs of skin care patients to the Health Select Committee, the NHS Executive Committee and via an All Party Parliamentary Group of 130 members. Yet still recommendations are made without prior discussion.

At the same time the DoH's Advisory Committee on Borderline Substances recommends withdrawing over 200 unlicensed products due to lack of therapeutic value. Most were food supplements and the justification is that the products are intended by the manufacturers for over-the-counter purchase, thus ignoring the fact that GPs have found it necessary to make the substances available on prescription. Their decision was possibly made on pure cost economics.

The second example involves the announcement by the UK Committee on Safety of Medicines (CSM) that several commonly used oral contraceptive pills were associated with an increased risk of venous thromboembolism (Department of Health, 1995). Known as 'third generation' contraceptive pills, the advice was based on three unpublished studies that indicated a two fold increase in the chance of a thrombosis in a vein with this type of pill. Simultaneously, as a letter was sent to general practitioners, pharmacists and directors of public health, a short press release containing no quantifiable *numerical* evidence of the increased risk was sent to the press and broadcast media. Panic among 1¼ million women using the third generation pills resulted, with most information being obtained by women from TV and newspapers, often with lurid front page headlines. This situation has been the subject of a detailed paper (Furedi, 1996) showing both the national and international impact, which is reflected in the rising abortion rates. The damage done has been recognised and will hopefully not be repeated in the future.

Patient power has become all important. The more radical groups have evolved from traditional self-help and support associations into true advocacy groups incorporating both industry and professional needs. Such groups can and do influence policy by direct involvement with the Department of Health but also the Treasury on fiscal matters. Aside from the Skin Care Campaign two other groups are also important players. The Long-Term Medical Conditions Alliance (LMCA) comprises some 62 patient groups and is involved with six Health Authorities on purchase-provider systems and the Department of Health on PRODIGY, the computer generated diagnosis/treatment system for general practitioners. The Genetic Interest Group (GIG) is working directly with the Association of the British Pharmaceutical Industry (ABPI) on biotechnology developments in gene therapy.

BAPEN, the British Association for Parenteral and Enteral Nutrition, as an association, can benefit from such links. It is in a position to help in influencing the policy makers. The October White Paper *'Primary Care - The Future'* makes clear the agenda on the way forward is open for discussion by such a professional alliance.

Department of Health press release. *'Consultations on Selected List Scheme Announced"*, 95\363, 25 November 1996

Furedi, A. and S., *'The International Impact of a Pill Panic in the UK'.*, Birth Control Trust, November 1996

Department of Health press release. *'New Advice on Oral Contraceptives'*, 95\489, 19 October 1995

**Malnutrition: Can we screen for it.** By JANET K. CURWELL[1], MOIRA J. DIXON[1] and IAN RAWLINS [2], *Department of Nutrition and Dietetics, Bradford Hospitals Trust, BD5 0NA and School of Computing & Mathematics, University of Huddersfield, Queensgate, HD1 3DH*

To identify patients at risk of malnutrition a quick and simple method of nutritional assessment is needed. Many hospitals have developed their own nutritional screening forms but few of these have been validated. The aim of the present research probject was to develop and validate a simple nutritional assessment tool (NAT) which could replicate (with a similar degree of accuracy and reproducibility) the results of nutritional assessment carried out by other more invasive or complicated means.

A total of 158 patients underwent a full nutritional assessment using subjective global assessment (SGA) (Detsky et al 1987), nutritional assessment chart, biochemical variables and anthropometrical measurements BMI, mid-upper-arm circumference (MUAC) and mid-upper-arm muscle area (MUAMA). The table shows the results of screening comparing the SGA scores with simple anthropometrical and biochemical measurements obtained.

| SGA score (n 158) | % (Number) showing malnutrition by: | | | | |
|---|---|---|---|---|---|
| | BMI<20 | MUAC <15° | MUAMA <15° | Albumin <33 g/l | Transferrin <2.5 g/l |
| **A Well nourished** | | | | | |
| **52%(82)** | 17% (14) | 18% (15) | 30% (25) | 15% (12) | 29% (24) |
| **B Moderately malnourished** | | | | | |
| **39%(62)** | 41% (25) | 69% (43) | 76% (47) | 31% (26) | 44% (27) |
| **C Severely malnourished** | | | | | |
| **9%(14)** | 79% (11) | 93% (13) | 79% (11) | 79% (11) | 79% (11) |

The data obtained were compared using Spearman's rank correlation coefficient (SRCC), and principal component analysis (PCA). PCA indicated that BMI and MUAC had the highest factor loading in principal component 1 (0.896 and 0.960 respectively). Principal component 1 also correlated well with SGA score (0.73 at 1% level).

The sample was then randomized into two sections (A and B). Section A was used to calculate a multiple regression equation to predict principal component 1. The predicted values were then transformed into a malnutrition quotient (MQ)

$$MA = (3.28 \times MUAC) + (2.48 \times BMI) - 40$$

The "MQ" was tested against section B data producing a correlation coefficient of -0.64, thus indicating the MQ equation was comparable with the SGA scores

A "MQ" score >100 indicates that the patient is well nourished, 80 ⇨100 may be a risk of malnutrition and <80 is severely malnourished. This MQ when used in conjunction with a nutrition care action plan forms a simple nutritional assessment tool which can be used to identify and treat malnourished patients.

Detsky, A.S., McLaughlin, J.R., Baker, J.P., Johnson, N., Whittaker, S., Mendelson, R.A. & Jeejeebhoy, K.N. (1987). Journal of Parenteral and Enteral Nutrition, **11**, 8-13

**The nutritional assessment of renal patients.** By G. H. HARTLEY[1], I. R. LAWRENCE[1], A. L. BROWN[2], J. S. TAPSON[2] and R. WILKINSON,[2] *Departments of [1]Dietetics and [2]Nephrology, Freeman Hospital, Newcastle upon Tyne NE7 7DN*

The high incidence of malnutrition amongst general medical, general surgical, orthopaedic and elderly hospital inpatients has been well documented. In renal patients treated with dialysis therapy, similarly high rates of malnutrition of over 50% have been reported (Marckmann, 1988). However, little information regarding the nutritional status of renal inpatients is available.

The present pilot study aimed to determine the incidence of malnutrition amongst patients being admitted to our nephrology ward, and to compare subjective and objective methods of nutritional assessment.

The nutritional status of twenty consecutive patients (eleven male, nine female) of mean age 64 (range 40-84) years was determined on admission to hospital by subjective global assessment (SGA) (Detsky *et al.* 1987), as well as by the objective measures of height, weight, serum albumin concentration (ALB), and serum transferrin concentration (TRANS). Skinfold thickness was also recorded at four sites: biceps, triceps, subscapular and suprailiac crest. BMI, body fat content (BFC) (Durnin & Womersley, 1974) and a composite nutritional score (CNS) were then calculated from these results. Reasons for admission were varied and included haemodialysis-related (n 10), chronic renal failure (n 4 ), acute renal failure (n 1), hypertension (n 2), loin pain (n 1), nephrotic syndrome (n 1) and planned renal biopsy (n 1).

As the Table shows, SGA found that 50% patients were well-nourished and 50% mildly/moderately malnourished. No subjects were found to be severely malnourished. Average results of the objective measurements BMI, ALB, TRANS and BFC were highest in the well nourished group and lowest in the mildly/moderately malnourished group. The relationship between SGA and objective measurements in the two patient groupings was evaluated by the Spearman rank correlation test.

| | SGA Rating | | Spearman rank correlation | |
|---|---|---|---|---|
| | Good (n 10) | Mild/moderate malnutrition (n 10) | r | P |
| BMI (kg/m$^2$) | 24.3 | 20.8 | 0.47 | 0.035 |
| ALB (g/l) | 40.3 | 36.5 | 0.44 | 0.081 |
| TRANS (g/l) | 2.7 | 2.08 | 0.49 | 0.048 |
| BFC (%) | 30.2 | 21.2 | 0.57 | 0.008 |
| CNS | 1.6 | 4.1 | -0.69 | <0.001 |

Excepting ALB, all objective markers of nutritional status independently showed a significant degree of correlation with SGA. Combining several of the objective measures into the CNS improved the degree of correlation with SGA. This indicates that objective nutritional assessment is best undertaken using several markers, rather than one alone.

In conclusion, our data indicate that high levels of malnutrition appear to be present amongst individuals admitted to a hospital renal inpatient ward. Further investigation of this problem is therefore warranted. SGA was found to correlate with overall objective markers of nutritional status, and being inexpensive and straightforward to apply may prove a useful assessment tool with renal patients.

Detsky, A.S., McLaughlin, J.R., Baker, J.P., Johnston, N., Whittaker, S. Mendelson, R.A. & Jeejeebhoy, K.N. (1987). *Journal of Parenteral and Enteral Nutrition* **11**, 8-13.

Durnin, J.V.G.A. & Womersley, J. (1974). *British Journal of Nutrition* **32**, 77-97.

Marckmann, P. (1988). *Clinical Nephrology*, **29**, 75-78.

**Audit of nutritional supplements within three general practices.** By LISA COOPER *Department of Community Dietetics, St Catherines Hospital, Church Road, Birkenhead, Wirral, L42 OLQ*

The use of nutritional supplements (NS) has been raised as an area of concern by dietitians both nationally and locally. There is a general feeling that the use of NS has increased, inappropriate prescribing occurs and that their clinical effectiveness is rarely evaluated. General practitioners appear to assume that dietitians alone are responsible for the increase in the prescribing of NS. However, dietitians themselves believe that they would be able to reduce the inappropriate use of NS.

The aim of the present study was to audit the prescribing practices for NS in three general practices within Wirral. The main objectives were to determine which NS were prescribed, why they were prescribed, and what influenced the prescribing practices for NS.

The practices were visited and data collected on all patients prescribed NS for the audit period 1st April 1994 to 31st March 1995. Additional information regarding total spent on NS was obtained from the pharmaceutical advisor at Wirral Health Authority .

The main results showed that a total of fifty-one patients were prescribed NS during the audit period within the general practices. Of these fifty-one patients, sixteen patients did not have any medical condition noted in their medical notes/computer records which indicated the prescribing of NS. Thus, 30% of patients were prescribed NS inappropriately. Half of prescriptions were initiated by the General practitioner (51%) although the influence of district nurses within this category is noted. Data from the pharmaceutical advisor at Wirral Family Health Service Authority showed an approximate total of £334, 000 was spent on the prescribing of NS for the period 1st April 1994 to 31st March 1995. Thus it is estimated that within this year approximately £100,200 was spent on the inappropriate prescribing of NS.

The following conclusions and recommendations were sent to each of the general practices involved in the audit and any general practice that requested information regarding NS. All patients discharged from hospital should be referred to a community dietitian for follow-up. Patients receiving NS should be regularly reviewed by a community dietitian, with regard to their actual supplement intake and nutritional status. The influence of private nursing homes and district nurses should be investigated further. Training for General practitioners and district nurses regarding this aspect of nutritional support should be initiated and regularly reviewed. The clinical effectiveness of NS should be regularly monitored.

Following the production of these conclusions and recommendations the community dietetic department is now investigating the prescribing of NS throughout the Wirral with the aim of containing costs and reducing inappropriate prescribing. Training has been initiated with district nurses and community pharmacists. All patients discharged from Wirral Hospitals NHS Trust are referred to the community dietetic department for follow-up and nutritional monitoring.

**Effect of a new mixed-fibre-supplemented enteral formula on healthy volunteers' bowel function.**

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The important role of fibre in normal nutrition is well established but its relevance in enteral feeding remains unclear. Most early fibre-supplemented formulas contained a single source of fibre. There is little evidence to support a clinically significant benefit of these diets on stool characteristics and bowel function. Supplementing these diets with a mixed fibre source more closely reflecting dietary fibre may be required to provide this. Recently a new fibre-supplemented polymeric diet has been developed (Nutrison Fibre New Formula, Nutricia) containing a mixed fibre source (15g/litre).

The aim of the present study was to establish the effect of the new fibre formula on bowel function in normal human subjects. Subjects over 18 years old with no history suggestive of gastrointestinal disease were recruited. They were randomized to receive a self-selected diet (SSD), fibre-free polymeric enteral diet (Nutrison Standard (NS)) or the new fibre formula (Nutrison Fibre New Formula (NF)). On day three of each study two capsules containing forty radio-opaque pellets were taken to assess gut transit time (Cummings, 1976). Stool samples were collected and the study ended on finding forty pellets on x-ray screening. Wilcoxon's paired signed rank test was performed for each subject. Objective measurements of bowel function included mean faecal wet weight, bowel frequency per day and whole-gut transit time.

Eleven subjects (four male, seven female) entered the study; one female subject was withdrawn due to non-compliance. There was no significant difference between energy intakes during the enteral, mean 8610kJ (2050kcals) and self-selected diets, mean 9101kJ (2167kcals). Fibre intake differed significantly between SSD and NF ($p<0.01$). The mean daily non-starch polysaccharide during SSD was 14.8±1.923 g, higher than the average consumption of 12g in the U.K.

Subjects mean daily bowel frequency during the SSD was 1.2 and daily stool weight 166g. These are comparable with the accepted norm for Western populations of a daily bowel movement and 100-160g/d stool weight.

| | Self-selected diet (n10) | | Nutrison standard (n10) | | Nutrison fibre new formula (n10) | |
|---|---|---|---|---|---|---|
| | Mean | SE | Mean | SE | Mean | SE |
| **Gut transit time (h)** | 46.08 | 6.98 | 75.66† | 12.63 | 50.37† | 6.78 |
| **Bowel frequency/d** | 1.2 | 0.12 | 0.99 | 0.18 | 0.97 | 0.09 |
| **Stool weight (g)** | 166.0 ‡§ | 23.84 | 97.0‡ | 22.49 | 95.0§ | 10.69 |

† $P$=0.037. ‡ $P$=0.013. § $P$=0.032.

The mixed fibre source in NF did not significantly increase stool weight from that seen in NS. An explanation could relate to the fibre supplement particle size which has been reduced to maintain the correct viscosity of the formula to allow it to pass easily down a fine bore naso-gastric tube. This reduced fibre particle size increases total surface area allowing greater bacterial fermentation, thus influencing the effect on bowel function. It may therefore be unreasonable to expect any fibre-supplemented enteral formula to have a significant effect on stool weight. The small fibre particle size may even be beneficial, since colonic bacterial fermentation produces short-chain fatty acids which may have a role in reducing enteral-feeding-related diarrhoea.

The most clinically important result is gut transit time (GTT). NS increased mean GTT to nearly double that observed during SSD. However, GTT seen during the NF diet was very similar to that observed during the SSD. From these results the mixed fibre source used in NF appears to have a role to play in normalizing bowel function, particularly GTT. The clinical benefits may include prevention of enteral-feeding-related diarrhoea and also constipation.

Cummings, J.H., Jenkins, D.J.A., Wiggens, H.S. (1976) *Gut* 17,210-218.

**Dietary treatment of hepatic encephalopathy: a survey of current practice.** By CLARE T. SOULSBY, *Department of Nutrition and Dietetics, Royal Free (Hampstead) NHS Trust, Pond Street, London NW3 2QG.*

Restriction of dietary protein is an accepted method of treatment for patients with hepatic encephalopathy, but the level of restriction remains controversial and varies between hospitals (Wicks & Madden, 1994). Patients with liver cirrhosis have a higher requirement for energy (Schneeweiss 1990) and protein (Swart 1988) than healthy individuals. Protein catabolism is accentuated in liver disease and may be perpetuated by inappropriate protein restriction (Wicks & Madden, 1994). A postal survey was carried out to identify current practice.

Following a pilot study, self-administered questionnaires containing open and closed questions were sent to 110 dietetic departments in the UK responsible for training student dietitians, which was considered to be a representative sample. The questionnaires were anonymous and designed to be completed by an individual dietitian or the department as a whole. The closed questions were analysed using descriptive statistics, the open questions were analysed using content analysis.

Seventy one questionnaires were returned (65% response rate). Seven uncompleted questionnaires were excluded from the analysis as no patients with hepatic encephalopathy had been seen by the respondents in the previous 12 months. The majority of requests for dietary treatment to patients with hepatic encephalopathy came from general medical wards (54%), followed by gastroenterology wards (26%) and liver units or wards with a special interest in liver disease (15%).

Dietitians were asked (1) what they considered to be the most appropriate dietary treatment for hepatic encephalopathy, and (2) which dietary therapy was used in clinical practice (see table). The results found dietary protein restrictions used in clinical practice to be more restrictive than the dietitians considered to be appropriate.

| Level of protein restriction | (1) Dietitian's opinion | (2) Clinical practice |
|---|---|---|
| No restriction: >60 g/d | 23 (36%) | 14 (22%) |
| Moderate: 40-50 g/d | 20 (31%) | 25 (39%) |
| Severe: 0-20 g/d | 8 (13%) | 14 (22%) |
| Other/ unclassifiable | 13 (20%) | 11 (17%) |

Dietitians reported a number of problems in providing dietary therapy to these patients. 66% of dietitians reported that patients had poor appetites, 63% considered that doctors requested over restrictive diets. Patients finding diets unpalatable and being too drowsy or confused to eat were also identified as problems. Only 21% of patients were given artificial nutritional support (19% naso-gastric feeds, 2% parenteral feeds).

This study has identified that protein restriction remains the standard dietary treatment in hepatic encephalopathy, but there has been a movement away from strict low protein diets (<40 g or less per day). Further work is needed in this area.

Schneeweiss, B. (1990). *Hepatology* 11:387-393.

Swart G. R. (1988). *Clinical Science* 75:101-107.

Wicks C. & Madden A (1994). *A Practical Guide to Nutrition in Liver Disease* 2nd Ed. London British Dietetic Association.