2017 BAPEN Conference Report

A focus on estimating nutritional requirements, refeeding syndrome and the human microbiome

Pete Turner, Nutrition Support Dietitian, Ulster Hospital,
Chair of BAPEN Programmes Committee

The 2017 BAPEN Annual Conference, which took place in Birmingham, featured over 13 symposia, two keynote lectures, a breakfast symposium, chaired poster sessions incorporating top scoring abstracts, and the BAPEN Annual Dinner, celebrating BAPEN's 25th anniversary.

Although a huge variety of topics are included as part of the BAPEN Conference programme, this report for CN Magazine focuses on sessions that discussed estimating energy requirements, refeeding syndrome and the human microbiome in health and disease – detailing the important take home messages.

Estimating Nutritional Requirements – when is less more?

Chair of the symposium, Bruno Mafrici outlined the exciting changes and new sections that will be featured in the new 'PENG Pocket Guide to Clinical Nutrition' from the Parenteral and Enteral Nutrition Group (PENG) of the British Dietetic Association (BDA), which is due for launch in Spring 2018. Details on the adult requirements section were provided by Dr Elizabeth Weekes, who spoke about the huge amount of work done by five dietitians, undertaking five systematic reviews, to develop an evidence-based approach for estimating nutritional requirements. One interesting feature is that stress factors will no longer be included, due to inconsistencies in the literature and the confusion caused by attempting to apply them in clinical settings. Some of the points made by Liz were illustrated in the following debate between Critical Care Dietitian Ella Segaran and myself.

Debate: Complex predictive formulae are superior to kcal/kg in estimating energy requirements of critically ill adults

Ella Segaran argued in favour of using complex formulae. She started by quoting a paper by Arabi *et al.*[1] which states that measuring or estimating energy expenditure is a key part of the patient's treatment and asks the question: What is the optimum method? Ideally, a predictive formula would incorporate age, gender, muscle mass, disease, illness severity, surgery, paralysing agents, temperature, ventilator settings, physical activity and pain. Furthermore, it is necessary to identify safe, minimal and maximal amounts for the different nutrients and at the different stages of acute illness to avoid under and overfeeding.[2] These amounts might be specific for the different phases in the time course of a disease,[2] so the optimum formula would take this into account. Using the frequently quoted value of 25 kcal/kg usual weight for estimating, the intensive care unit (ICU) patient's requirements recommend by the American College of Chest Physicians (ACCP)[3] may not be ideal for the following reasons: It is a rule of thumb with unclear origins; the term usual weight is undefined and it does not encompass extremes in weight, age or patient type, which may lead to poor predictive value with the risk of over or underfeeding.

Several ICU specific formula have been developed, including Pen State (PSU), Faisy, Brandi, Swinamer, Ireton Jones and Toronto. The PSU(m) is a modified version of the Mifflin-St Joer equation which includes temperature and minute ventilation. It demonstrated good correlation with measured energy across all groups of ICU patients in a study by Frankenfield,[4] with 67% accuracy (≤10% measured energy expenditure) *versus* 35% accuracy for 25 kcal/kg. In 13 patients, Frankenfield demonstrated that daily repetition of PSU(m) correlated better with the daily fluctuations in measured energy expenditure than the static value of 25 kcal/kg. The conclusions were that all predictive equations have an element of inaccuracy compared to indirect calorimetry (IC) but, the PSU(m) equation appears to be more precise than 25 kcal/kg. PSU(m) is designed to be used in mixture of ICU patients, including obese and elderly, it makes you think of impact of clinical parameters and you can use it to help you track energy expenditure over the duration of critical illness.

It was then up to me to give the case for kcal/kg. I started by quoting the results and conclusions from the recent studies of predictive formulae in high impact peer reviewed journals. Tatucu-Babet[5] reviewed 18 studies comparing 13 equations, including PSU(m), with measured energy expenditure in mechanically ventilated adults and concluded that: *"Large discrepancies exist between predictive equation estimates and IC measurements in individuals and groups."* Rousing[6] compared several equations, including PSU(m), to IC in a group of critically ill adults and found that *"all predictive equations were accurate in less than 50% of patients with an root mean square error (RMSE) ≥15%"* leading to the conclusion *"this study confirms the inaccuracy of predictive equations"*. De Waele[7] compared several equations, including PSU(m), in a large group of critically adults and found that *"calculated values correlated very weakly with IC-derived measurements"*, going on to conclude: *"In critically ill adults, measured resting energy expenditure (REE) poorly correlated with measured values, regardless if what formula was used."* De Waele[7] looked at the equations in specific groups of patients (age and BMI). PSU(m) was one of the better equations but showed at best only modest correlation (R2 0.52) in the age group 18-64, poor correlation (R2 0.32) in the age group 65-79 and very poor correlation (R2 0.14) in patients over 80 years. For BMI, PSU(m) showed virtually no correlation whatsoever (R2 0.01) in the <18.5 kg/m^2 group, poor correlation (R2 0.37) in BMI 18.5-29.9 kg/m^2 and modest correlation (R2 = 0.52) in BMI >30 kg/m^2. This study suggests PSU(m) should not be used at all in low BMI patients – a group of special interest to dietitians. One key point that comes out of all the studies is that although some equations show modest correlation in groups, there can be a large variation in individuals.

The previously mentioned study by Frankenfield,[4] who developed the PSU(m), appears to be the only one that has shown a good correlation with measured energy expenditure. A key point about this study is that they had an accurate dry weight for each patient. How often do we have the luxury of an accurate dry weight in a UK ICU? Probably very rarely and, in practice, patients are often not referred to us until they have a significant degree of oedema from resuscitation, when weighing them or carrying out anthropometry is more or less pointless. Both weight and height are required for PSU(m) and studies have confirmed the inaccuracy of estimated weights and heights in ICU patients.[8] The surrogate methods of determining height are not precise, for example, ulna length has a standard error of 4.6 cm – enough to make a significant difference in a calculation. It is highly illogical to use estimated weights and heights in complex calculations and unwise to assume the answer you get has any degree of accuracy. In the absence of an accurate dry weight using kcal/kg estimated dry weight is probably the most sensible option, with the realisation that all it gives you is a starting point and monitoring and adjustment are the crucial factors. Looking for signs of over and underfeeding and adjusting the energy prescription according to the clinical judgement of a skilled ICU dietitian is far more important than any complex equation.

Another point to bear in mind is the fact that the PSU(m) is a modified version of the Mifflin-St Joer equation, which was developed in a group of 498 obese and non-obese Americans from mixed ethnic backgrounds. It may be applicable to the population in Frankenfield's USA studies, but it's potentially wrong to assume that it will accurately predict energy expenditure in a typical UK population.

Contrary to Ella's argument, kcal/kg does not always refer to the static value of 25 kcal/kg suggested by ACCP.[3] For example, the European Society for Clinical Nutrition and Metabolism (ESPEN) 2006 guidelines for enteral nutrition in the critically ill[9] were ahead of their time as they recognised the need to change energy prescription through the phases of ICU admission. They stated *"avoid excess of 20-25 kcal/kg in the initial phases of critical illness but provide 25-30 kcal/kg in the anabolic flow phase"*. They also gave specific kcal/kg recommendations for low BMI. Using clinical judgement to recognise the changing phases of critical illness by looking at factors, such as hyperglycaemia, insulin requirements, inflammatory markers, ventilation, and possibly prealbumin levels,[10] and adjusting energy levels, is a key role for the ICU dietitian. Anyone can plug figures into an equation and workout a feeding rate. The PSU(m) is already included in a feed company's app, which is just one step away from building it into an ICU computer system, such as IntelliVue Clinical Information Portfolio® (ICIP), and making the dietitian redundant.

Several large studies that indicate the safe levels of feeding in the different phases of critical illness have published their findings on kcal/kg. The EPANIC study[11] showed that giving 30-35 kcal from enteral nutrition (EN) and parenteral nutrition (PN) in the early phases of critical illness was harmful. The CALORIES[12] trial found that giving slightly less than 20 kcal/kg in the early stages did not lead to poor outcomes with PN compared to EN, indicating that it is the amount of nutrition not the route of delivery that is important. This was confirmed in a review by Elke,[13] who found that PN only led to poor outcomes when large amounts were given early. Heidegger[14] demonstrated that building up to around 28 kcal/kg later, from around in days 4-8, was favourable. Compher,[15] in a study of 5,672 ICU patients, found that there was no difference in morbidity or mortality when complex formulae, including Ireton-Jones, were used compared to kcal/kg but there were improved outcomes when more energy was given later during ICU stay. Broadly speaking, the trend is for less in the acute phase and more in recovery. Complex formulae are designed to estimate energy expenditure which may not equate to requirements. It has become clear that we may need to feed below energy expenditure in the very early stages of critical illness, and since equations like PSU(m) include factors like temperature and minute volume, using them risks giving more in the metabolically stressed phases and less in recovery.

Kcal/kg used with the monitoring and adjustment of an expert dietitian won the audience vote but, in the subsequent discussions involving the panel and audience, the following key points were agreed:

- All methods of estimating requirements in all patient groups, including the critically ill, are flawed. All they give is starting point, after which monitoring and adjustment are more important.
- Dietitians need to be aware of the limitations of all methods of estimating requirements and promote the importance of their clinical judgement.
- Kcal/kg cannot be considered the definitive way of estimating requirements on the ICU but may be the most sensible method of getting a starting point when only estimated weights and heights are available.
- The PSU(m) may be a good option on the ICU where an accurate height and weight are available but it still only gives a starting point. Consider a cross check with kcal/kg to see if your energy prescription is in the ranges suggested as being optimal in recent large trials.
- The purpose of the debate was not to decide the definitive way of estimating requirements but to make dietitians aware of the literature and limitations surrounding different methods.

Death by Chocolate – The refeeding syndrome revisited

It was a privilege to chair this session as it featured a truly expert panel, including: Mike Stroud (Consultant Gastroenterologist), Alison Culkin (Specialist Dietitian), Anna Hardman (Community Dietitian), Callum Livingstone (Consultant Chemical Pathologist) and Rebecca White (Pharmacist).

During hospital and community case-based presentations by Dr Alison Culkin and Anna Hardman respectively, questions were put to the panel as well as the audience. The following key points came out of the discussions:

- 98% of potassium is intracellular and levels are maintained by cell membrane pumps which account for around 37% of REE. For this reason, plasma levels do not reflect whole body status in starvation.
- Biochemical refeeding syndrome (RFS) with drops in potassium (K), magnesium (Mg) and phosphate (Po4) is common. Symptomatic RFS is less common but may manifest as oedema, respiratory/cardiac failure, Wernicke-Korsakoff syndrome and, very rarely, death.
- NICE CG32 recommendations are grade D evidence, based on expert opinion.
- Mike Stroud clarified the meaning of the NICE CG32 recommendation 'full dose IV B vitamin preparation, if necessary'. In most cases this means Pabrinex 1 pair of ampoules o.d. which can be stopped after 3 days providing the patient is established on nutrition support, is not an alcoholic or showing signs of Wernicke's encephalopathy. For patients with high alcohol intake see NICE CG100 recommendations for vitamins and treatment of Wernicke-Korsakoff syndrome.
- If feeds are started at 5-10 kcal/kg they should be built up quickly to establish full feed by day 4. It is not necessary to wait for normal blood levels of K, Mg or Po4 before increasing rates of feed providing large doses of electrolytes are given prophylactically, as per NICECG32, with regular monitoring. If feeds are built up quickly, following the NICE recommendations does not lead to a significant nutritional deficit or exacerbation of malnutrition.
- Some experts feel it is safe to start at higher energy levels based on the published evidence on anorexia nervosa.
- Dietitian prescribing will help to ensure that the right amounts of electrolytes and vitamins are given.
- In PN it is difficult to follow NICE CG32 if you do not have a compounding unit or the ability to add electrolytes to standard bags. It is not possible to give the NICE CG32 recommended amounts of electrolytes separately without overloading the patient with dangerous amounts of fluid, sodium or chloride. It would be helpful for industry to develop a refeeding PN bag.
- Be aware of the 'deadly triad' that is well recognised in malnourished children but which also occurs in very malnourished adults. The triad classically consists of hypoglycaemia, neutropenia and hypothermia and is triggered by infection which is often not clearly evident because the patient is effectively immunosuppressed by their malnutrition. There should, therefore, be a low threshold for cultures, etc. and treatment with broad spectrum IV antibiotics in a deteriorating malnourished patient with even one of the elements present.
- In the community it may be difficult to get prophylactic electrolytes prescribed so feeds may need to be built up slowly with as much monitoring as possible.
- Clinicians need to audit their practice and publish.

The Keynote Lecture: Human Microbiome in Health and Disease

This year's prestigious Keynote Lecture was delivered by Paul Wischmeyer from Duke University, North Carolina, USA. Paul gave a fascinating insight into the importance of microorganisms to human health and how disruptions to the microbiome can have a huge impact on wellbeing. This starts from birth when babies delivered by caesarean section are not exposed to the vaginal flora leading to a different microbiome and a much higher prevalence of allergies. Critical illness has the potential to decimate good gut bacterial leading to overgrowth of antibiotic resistant bugs, such as pseudomonas and clostridium difficile – a condition known as dysbiosis. This can, in turn, lead to colitis, changes in gut permeability, increased ICU infection, sepsis and possibly multiorgan dysfunction syndrome (MODS). There is growing evidence for the benefit of probiotics, prebiotics (soluble fibres that enhance existing good gut bacteria such bifido bacteria) and even faecal transplants in critical care in treating and preventing this. Care may need to be taken with faecal transplants, however, as there is a possibility the recipient may take on health traits of the donor. For example, sterile mice given faeces from obese humans change their eating behaviour and become obese. Even mental health could be influenced by gut organisms. During the discussion with the audience an interesting hypothesis evolved: it may be worth freezing some of your own faeces so that these can be transplanted back into you to enhance rehabilitation from an ICU admission!

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