# THE WINSTON CHURCHILL MEMORIAL TRUST OF AUSTRALIA

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**THE PETER MITCHELL CHURCHILL FELLOWSHIP** to explore methods of nutrition support at the worlds leading burns units particularly focusing on assessing and monitoring nutritional progress and the use of specialised nutrition products.

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Signed Dated:

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# 1. Introduction and Acknowledgements

This report discusses the findings from the 2004 fellowship to the United States of America to explore techniques of nutrition support in burn patients in the World's leading Burn hospitals and research centres.  The 6 main objectives of this fellowship are:

1. To better understand the hormonal and metabolic changes that occur when the human body when it is burnt and how nutrition can aid the healing process.
2. To explore different techniques of estimating a burn patients energy, protein, vitamin and mineral requirements.
3. Explore methods of assessing if a patient is receiving adequate nutrition throughout their hospital admission to ensure optimal healing and to prevent excessive weight loss.
4. Investigate methods of providing nutrition support
5. Investigate the use of specialised nutrition to boost the immune system and support the body as it recovers from the burn injury. This is called "immunonutrition"
6. Explore current research that is being completed at the leading Burns Institute and the methodology they are using.

This Fellowship has been an invaluable experience that has allowed growth as a Dietitian and as a person.  I could not have been completed without:

1. The financial support and encouragement of the Winston Churchill Memorial Trust and the Peter Mitchell Memorial Trust. In particular my mentor Jeff Paterson and my pseudo-mentor Kristen Campbell.

2. The financial and emotional support of Royal Perth Hospital, particularly:

    a. The Department of Dietetics and Nutrition, Ms Frances Phillips and staff for helping me grow as a dietitian and for providing unconditional support.

    b. All the Burns Unit Staff and Dr Fiona Wood for providing me with contacts and for inspiring me to extend myself.

3. The tremendous love and support of my family, my partner and my friends, for all your support and encouragement.

## 2. Executive summary

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**Fellowship Objective:** To explore methods of nutrition support at the worlds leading burns units particularly focusing on assessing and monitoring nutritional progress and the use of specialised nutrition products.

**Fellowship Highlights:**

**1. Brigham and Womens Hospital, Boston - Metabolic Cart.**
Discussions with Kris Mogensen about the positives and negatives of the metabolic cart. It was invaluable to find a dietitian with a broad knowledge and understanding of indirect calorimetry.

**2. Cincinnati Shriners - Research**
Michelle Gottschlich (a "guru" in the area of nutrition in burns) and her highly experienced team of dietitians. This centre highlighted the true meaning of "evidence based practise".

**3. Galveston Shriners, 7am Ward Rounds**
Dr David Herndon and the nutrition services team. These ward rounds gave me a new level of insight into the burn injury and its treatment. As a dietitian I rarely see burn patients without dressings. At these ward rounds patients' wounds were video taped that morning and displayed on a large plasma TV screen during word rounds.

**4. Galveston Shriners, Patients care**
Long-term follow-up is often not done with burn patients because of limited dietetic resources. At Galveston Shriners the dietitians were meticulous in their documentation and follow-up and ensured all patients were seen regularly and given a high level of care. This was inspirational.

**Conclusions:**

1. ***To better understand the hormonal and metabolic changes that occur when the human body when it is burnt and how nutrition can aid the healing process.***

- Nutrition support should not just provide energy and protein but must address hormonal and metabolic abnormalities!

2. ***To explore different techniques of estimating a burn patients energy, protein, vitamin and mineral requirements.***

- A metabolic cart is a useful piece of equipment but further investigation is required into it cost effectiveness
- Investigate cheaper and smaller hand-held machines for spontaneously breathing patients
- If mathematical formulas are going to be used effectively RPH must implement better methods of assessing adequate nutrition support are required (see objective 3).

***3. Explore methods of assessing if a patient is receiving adequate nutrition throughout their hospital admission to ensure optimal healing and to prevent excessive weight loss.***

- Use preablumin and CRP and nitrogen balance studies to monitor nutritional progress
- Conduct regular audits on daily kilojoule intake of patients and report as a kilojoule deficit

***4. Investigate methods of providing nutrition support***

- Trial feeding through theatre for patients with small bowel feeding tubes
- All patients with burn greater than 50% TBSA should have a small bowel feeding tube placed
- Nasogastric tubes can be used for patients with burns less than 50% TBSA burn
- Suggest the use of nasoduodenal feeding tubes rather than nasojejunal tubes to decrease incidence of diarrhoea.
- Use TPN when all other feeding methods have failed. Using TPN is better than not feeding at all

5. ***Investigate the use of specialised nutrition to boost the immune system and support the body as it recovers from the burn injury. This is called "immunonutrition"***

- Maintain protein intakes at 2-2.5g/kg of body weight and continue to add extra protein as required.
- Investigate the use and availability of whey protein containing products
- Increase carbohydrate intakes to 60-65% of total kilojoule intake
- Encourage the use of insulin rather than low carbohydrate feeds to control blood sugar levels.
- Reduce fat intake to provide only 20-25% of total kilojoule intake
- Arginine containing products should not be used in the critically ill
- Arginine and Glutamine may be useful for patients that are in the rehabilitation phase of recovery
- Fish oils may be beneficial but need further investigation
- Commence Vitamin C supplements or 500mg per day
- Consider Zn, Se, Cu, folate and B vitamin supplements but further investigate quantities required
- Use anabolic agents sparingly until further research is available

***6. Explore current research that is being completed at the leading Burns Institute and the methodology they are using.***

- Well-developed and implemented research protocols are the key to successful research.

**Methods of dispersing information:**

**Seminars:** The following seminars will be given on the above conclusions
Dietitians at Royal Perth Hospital

Burns unit medical, nursing and allied health staff
Public presentation for all West Australian dietitians and burns associated staff
Presentation to allied health staff at Australian and New Zealand association burns conference

**Publications**
Short articles on my experiences will be published in the Dietitians association of Australia newsletter.
A four-page review on my findings will be published in an Australian peer reviewed nutrition Journal.

**Research**
An evidence based trial will be implemented to highlight patient will retain more muscle mass and lose less weight when the combination of high carbohydrate enteral feeds and insulin is used instead of a high fat enteral feed.

# 3. Programme

**5th – 16th April Boston – Massachusetts**

5th – 9th April Brigham and Womens Hospital
Director: Katherine McManus
1. Burns Unit Dietitian: Anar Shah
Clinical Dietitians: Patricia Degroot, Marijane Staniec.
Metabolic and Research Dietitian Kris Mogensen (specialising in using metabolic carts)

12th – 16th April Shriners Hospital
Director: Kathy Prelack
Clinical Dietitian: Maggie Delweski
Pharmacy – regarding TPN
1 hour visit to Massachusetts General Hospital – adult burn unit

**20th – 29th April Cincinnati – Ohio**

20 –29th Shriners Hospital
Director: Michelle Gottschlich
Clinical Dietitians: Theresa Mayes and Carmen Brunner
½ day with Shriners respiratory technician
Physiotherapy and Occupational therapy visit

University Hospital – Cincinnati (adult burn unit)
½ day Visit

**3rd- 23rd May Galveston – Texas**
2.
3rd –23rd May Shriners Hospital
Medical Director: David Herndon
Director nutrition services: Randy Warnken
Clinical Dietitian: Amy
Diet Technician: Rachel Palmer

Research Dietitian: Cheryn Wall

12th May University of Texas Medical Branch (UTMB – Hospital**)**
Clinical Dietitian: Amy Hall

**28th – 31st May Chicago – Illinois**
International Congress of Dietetics

# 4. Main Body - Introduction

## 4.1 Why is good nutrition important for a burns patient?

The introduction of "nutrition support" in the early 1970's dramatically improve rate of survival in burns patients. A review in 1971-1975 of patients with burns to greater than ½ of their body showed an 80% drop in mortality from septicaemia (infections in the blood). This was attributed to aggressive nutrition[1]. It is also reported that the risk of death is markedly higher in patients that lose greater than ¼ of their body weight[2]. This amount of weight loss is not uncommon and despite our best effort still happens at Royal Perth Hospital.

Research has proven that good nutrition support will:

1. Improve and increase rate of wound healing
2. Prevent infection – Infection is a huge problem for burns patients and will significantly delay wound healing, prevent skin grafts from closing a burn wound and can lead to death in patients with large burns.
3. Prevent excessive weight loss particularly muscle mass therefore improving a patients strength and energy levels.
4. Reduce hypermetabolism
5. Improve the integrity of the gut and therefore prevent bacteria from entering the blood stream via the gut.
6. Reduce length of stay in hospital

The body required extra energy and protein to heal the burn wounds. Also when the body is burnt the body has an "acute inflammatory response" and alters the level of hormone levels and "metabolic" pathways to try and heal the body. These alterations will not only increase the patients' requirements further but it also alters the way the body uses carbohydrates and fats.

Hormonal changes, medications and severe pain will cause the patient to lose their appetite and may cause nausea and vomiting. This makes it extremely difficult for the patient to eat the large amount of kilojoules, protein, vitamin and mineral they require.

| |
|---|
| ↑ Nutrition needs + ↓ Appetite<br>=<br>Nutritional Problem |

# 5. Main Body - Findings

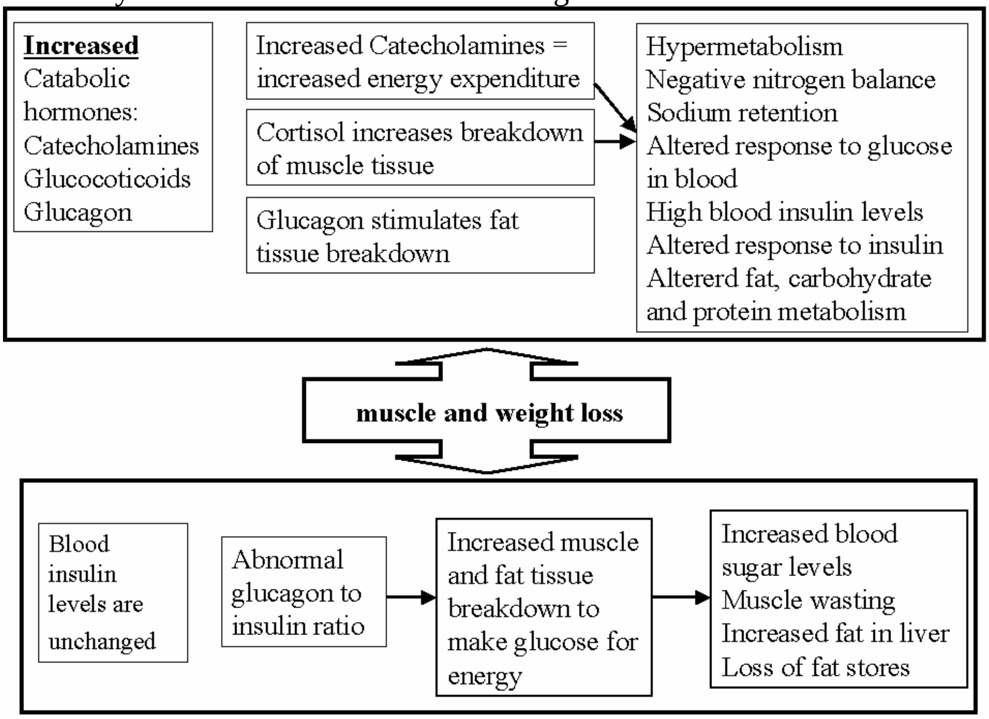
## 5.1 Objective 1: To better understand the hormonal and metabolic changes that occur when the human body when it is burnt and how nutrition can aid the healing process.

Current practise at RPH provides nutrition support by:

1. Providing large amounts of energy, protein, vitamins and minerals to all patients
2. Feeding tubes are inserted into all patients with burns covering 20% or more of their total bogy surface area (TBSA).
3. Nutrition support via these feeding tubes is commenced within 24hours of admission.
4. Weight, blood protein levels and rate of wound healing are monitored and support will be increased and decreased as required.

The findings from discussions with dietitians at the 6 hospital visited and review of literature are shown in figure 1

Figure 1 Summary of metabolic and hormonal changes




### 5.1.1 Conclusions

1. Nutrition support should not just provide energy and protein but must address hormonal and metabolic abnormalities!

## 5.2 Objective 2: To explore different techniques of estimating a burn patients energy, protein, vitamin and mineral requirements.

Precise methods are required determine burns patients energy and protein requirements. Both overfeeding and underfeeding have a negative effect on a burn patient's recovery and will result in an increased length of stay, delayed wound healing and potential death.

### 5.2.2 Metabolic carts:

RPH and does not own a metabolic cart. This is a machine that calculates how many kilojoules a patient requires while at rest. This is called a Resting Energy Expenditure or REE.

All 5 hospitals owned at least 1 metabolic cart. Generally the metabolic carts were used in a similar way at each of the hospitals.

1. All tube fed patients or in patients with burns greater than 40% TBSA
2. The 1st study was completed within 24hours of admission
3. Studies were then completed at least once per week during acute admission. One hospital completed studies twice a week.
4. The respiratory technician completed the studies. Except and one hospital where a research dietitian completed the studies.
5. An average was used when multiple REE's were available

1 hospital also owned a small hand held called "MedGem®". This is a less expensive piece of equipment that is able to calculate REE. The positive of this machine are:

- Less expensive than metabolic cart (approximately $3000US)
- Easy and quick to use
- Small and portable

It does have some negatives, these are:

- Less accurate than metabolic cart
- Can only be used on spontaneously breathing patients
- Does not measure RQ (explained below)

There is overwhelming evidence that when used correctly the metabolic cart will predict kilojoule requirements more accurately than all manual equations[3]. If done correctly the metabolic cart can also calculates the "Respiratory Quotient" which is a tool that can highlight if patient are being under or overfed. This is a useful tool because other tools for determining of over and underfeeding are usually masked by other medical problems.

2 hospitals could no longer use some of their metabolic carts because they were not compatible with the new mechanical ventilators purchased for the hospital. It also became evident that replacement parts were costly and difficult to find. This is a major limitation! A metabolic cart cost approximately $40,000 and RPH would be un-willing to purchase a piece of machinery that could be obsolete in 5 years.

### 5.2.3 Mathematical formulas

RPH relies on mathematical formulas to determine a patients' estimated energy requirements. All hospitals completed written calculations confirm patients' requirements determined by metabolic carts. Formulas used varied greatly. The graph below uses each hospitals mathematical formula to calculate the kJ requirements of an 18-year-old male with burns to 70% of his body. He weighs approximately 80kg and is 180cm tall.

Table 1: Estimated Energy Requirements:

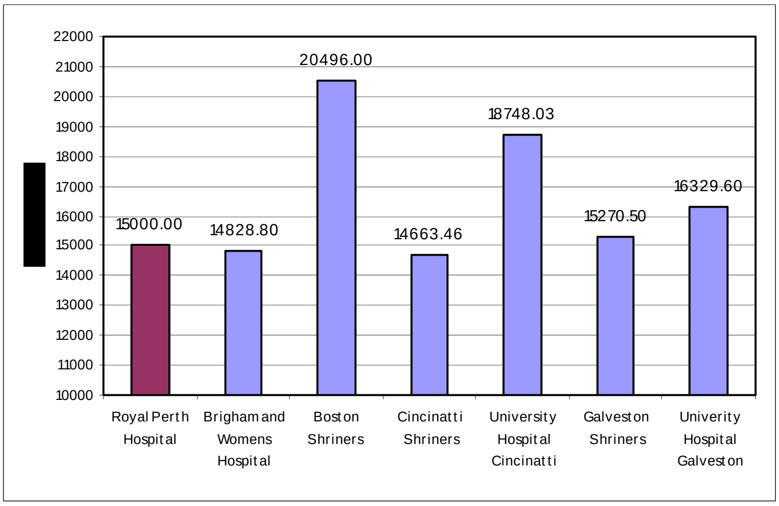



Table 1 highlights that the variation in mathematical calculations lead to a variation in the final estimate of energy requirements The range is from 14,600 kJ per day to as much as 20,500kJ per day. This is a significant difference.

There are more than 25 published mathematical formulas to determine a burn patients requirements. Clinical research has shown that on average the mathematical formulas may overestimate true requirements by 20-40%[4].

## 5.2.4 Protein requirements

A healthy person requires approximately 0.75g of protein per kilogram of body weight. Burns patient required a high protein diet to meet their increased metabolic demands and replace protein lost in the wound exudate. A high protein intake has been proven to will promote wound healing, boost the immune system and prevent excessive breakdown of muscle tissue to make energy[5]. The exact amount of protein required has been heavily researched using sophisticated techniques measure protein turnover and by-product excretion. It is known even when very high protein intakes are given the burn patients will still breakdown its own muscle as a source of protein. This is related to the derangement in hormone levels[6].

All hospitals provide 2-3 g protein per kilogram of body weight for patients with burns greater than 40% TBSA. This equates to approximately 20-25% of calories from protein. Studies report this level of protein improves survival rates, nutritional indices, nitrogen balance and reduces rates of infection. It also concluded that there was not benefit to providing protein at levels higher than this[5,7].

**5.2.5 Conclusions**

Calculating Energy Requirements:

1. A metabolic cart is a very useful piece of equipment but further investigation into its cost effectiveness.
2. Investigate smaller hand held machines like the Medgem® to assess requirements in spontaneously breathing patients. Particular for use in patients that are not responding as expected to nutrition support

Mathematical Formula's Conclusions:

1. If mathematical formulas are going to be used effectively RPH must implement better methods of assessing adequate nutrition support are required (see objective 3).

Protein requirements

1. RPH currently provides adequate protein to burn patients

## 5.3 Objective 3: Explore methods of assessing if a patient is receiving adequate nutrition throughout their hospital admission to ensure optimal healing and to prevent excessive weight loss.

It is very important to monitor a patients' progress and assess if they are receiving the type and amount of feed. Unfortunately other complications of a burn injury make this hard assess.

### 5.3.1 Weight

At RPH weight is checked weekly but fluid retention and bulky dressings add weight to the patient and can hide true weight loss. 5 of the 6 hospitals visited measured a patients weight on a daily to weekly basis. All hospitals identified the limitation with weight and cautiously interpreted weight. Galveston Shriners used day 5 post surgery and a day when patients was the least fluid overloaded. They called this the patient "dry weight". 1 hospital did not use weight as an indicator because they found to impossible to get accurate results.

**5.3.2 Albumin** (a blood protein) is checked regularly at RPH. If albumin is low or decreases it suggests that a patient is getting inadequate nutrition. There are 3 major limitations to using albumin to indicate nutritional status. These include:

1. Fluid shift between the blood and the tissue often cause albumin to be low regardless of nutrition.
2. Fluid retention will dilute the volume of albumin blood. Fluid retention is common in a burn patients because of over hydration and over resuscitation and poor functioning kidneys.
3. Albumin has a 23-day half-life. This means it take a long time to see a true nutrition related change in albumin levels.

3 hospitals monitored levels but all identified significant problems with albumin and did not place much emphasis on the levels.

### 5.3.3 Preablumin and CRP

Prealbumin and CRP was often used instead of albumin as a marker of nutritional status. Prealbumin is the transport protein for Vitamin A and thyroxine and circulates attached to Vitamin A and retinal binding protein. C-reactive protein levels were also monitored to give a more accurate interpretation of prealbumin. The advantages of using preablumin instead of highlighted are:

1. Prealbumin has a shorter half-life (1.9 days) than albumin (23 days) and therefore a true response from nutritional support is more likely to be seen.

2. It is less affected by hydration status, liver and kidney function

A trial conducted at Brigham and Womens hospital assessed the use of Pre Alb as part of a nutrition screening tool compared with their current protocol (using albumin) found that the use of Prealbumin did aid the screening process and was successful in identifying more malnourished patients than the old protocol. It also found a strong relationship between the % kilojoules recommended, % protein recommended, % change in weight over time with Prealbumin, Retinol Binding Protein and CRP. It did not find the same relationship with albumin (findings not published).

### 5.3.4 Nitrogen balance studies

4 of the 6 hospitals visited monitored nitrogen balance using 24 urine collections. Each of the hospitals recommended this study be completed at least once per week. One hospital completed studies daily. A negative nitrogen balance will indicate that the patient is breaking down body protein/muscle stores and is catabolic and a positive nitrogen balance indicates the patient is making protein and is anabolic.

Although this is a useful study, it is important to note the limitations of this measurement in burn patients. UUN only represents 80-90% of the nitrogen lost in the body, as extra 4g is added to cover the other losses. A burn patient however will also lose significant amounts of nitrogen from wounds, this loss may be as large as 30g/day. We are unable to measure this loss and therefore cannot factor it into the equation.

**Figure 4.4.2.4 –1 Calculating nitrogen balance:**

$$\text{Nitrogen Balance} = \text{Nitrogen intake} - \text{nitrogen output}$$
$$= \frac{\text{24hr protein intake (g)}}{6.25^{*}} - (\text{24hr Urine Urea Nitrogen}^{\lozenge} + 4g^{+})$$

[*] This converts protein intact into nitrogen intake -most protein is 16% Nitrogen
[+] 4g for faecal, dermal, wound and non urinary nitrogen loss)
[◊] Urine Urea Nitrogen (UUN) is determined from a 24-urine collection

A nitrogen balance of level of +3 - +5 was recommended (pers comm. Mayers and Brunner 2004).

### 5.3.5 Calories/Kilojoule counts

All hospitals completed daily intake charts on the patients and calculated total kilojoule intake daily. This included intake from enteral, oral and parenteral sources. Furthermore at 2 of the hospitals total kilojoule deficits were calculated. This was a calculation of the number of kilojoules the patients had not received over their entire admission. This was a very useful tool and highlighted the full extent of a patients intake

### 5.3.6 Conclusions:

- Use preablumin and CRP and nitrogen balance studies to monitor nutritional progress
- Conduct regular audits on daily kilojoule intake of patients and report as a kilojoule deficit

## 5.4 Objective 4: Investigate methods of providing nutrition support

### 5.4.1 Peri-operative feeding

A burn patient will be required to have several lengthy operations during an admission. It is estimated that a 50% burn admitted at RPH will require approximately 6-7 major operations during their admission. Each time a patient goes to theatre at RPH they are fasted for approximately 12 hours before their operation, plus feeds will remain of while they are in theatre. This often means a patient will receive no feeds for 24hours. This is a significant loss for a patient when nutrition support is very important.

In 4 of the hospital visited patients were not fasted before surgery and feeds remained running during surgery. At 1 hospital the feeds were stopped prior to theatre but parenteral nutrition (nutrition directly into the blood stream) was given during theatre. Only one other hospital continues to fast patients before and during surgery.

The benefits of peri-operative feeding are clear but it is important that this does not increase risk of complications.

### 5.4.2 Tube placement

At RPH it is standard practice for all patients who have a burn bigger than 20% of their total body surface area to have a tube put down their nose into their stomach and be given a liquid feed to meet their increased requirements. All hospitals visited considered a feeding tube in patients if they have a 20% TBSA burn or greater. This is supported by current research findings[8,9] .

Different types of feeding tubes that may be used. At RPH burns between 20-50% TBSA receive a nasogastric tube or NGT. This tube runs from the nose to the stomach. In patients with burns greater that 50% TBSA a tube is placed into the small intestine (jejunum), this is called a naso-jejunal tube or NJT. A tube could also be placed into the duodenum (high up in the small intestine) called a naso-duodenal tube (NDT) but this is not often done at RPH.

Of the 6 hospitals visited 4 fed directly into the small intestine in all patients regardless of burn size. One hospital surgically inserted a PEG (percutaneous endoscopic gastrostomy) tube in all patients requiring feeds at 4 weeks. This was seen at no other hospitals.

Figure 5.4.2.1 Position of small bowel feeding tube

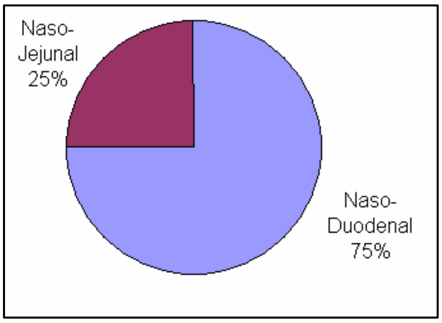



**Figure 1** shows 3 of the 4 hospitals using small bowel feeding tubes placed the feeding tube into the duodenum and rather than the jejunum. Discussions with dietitians at Cincinnati hospital (per comm. Mayers, 2004) suggests that this will improve the absorption of many nutrients and prevent diarrhoea.

Publications from Cincinnati and Boston Shriners support the use of small bowel feeding tube and report that a burn patient will suffer the loss of normal stomach and colon function. The small intestine however will continue to function as normal and therefore should be the route of feeding. It is also highlighted that stomach and colon function does improve over time and that withholding feeds until normal function returns is strongly discouraged[8,9] .

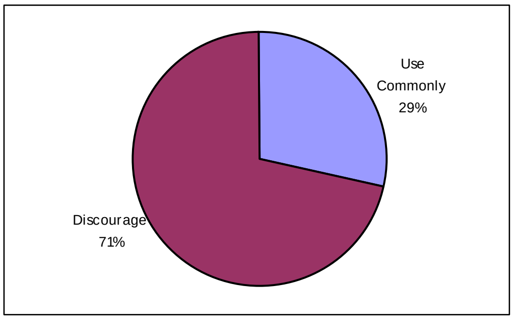
There is no comment in these articles or in other published research the suggest the loss in stomach function is dependant on burn size. It is therefore not clear if small intestine feeding tubes are required in all burn patients or only in larger burns (greater than 50% TBSA). This is an area requiring more research. From a practical point an NJT is more difficult to insert than a NGT and often takes longer to insert because nursing staff at the bedside cannot place it. This may lead to a loss of feeding time

These publications also suggest that feeding into the small bowel instead of the stomach is that will also reduce the risk of patients refluxing feeds from the stomach and inhaling it into their lungs[9].

## 5.4.3 Use of TPN

The use of total parenteral nutrition (TPN) is controversial in burns patients. Some units visited strongly discouraged its use and only used it as the last avenue of feeding. Others units used it regularly. This is highlighted in figure 4.5.1

Figure 4.5.1 Attitude toward TPN




One hospital used TPN instead of feeds when the patient was due to have surgery. TPN was commenced when enteral feeds were turned off 12hours before surgery and remained on during surgery. The TPN also remained on until NGT feeds reached full volume after surgery.

All the units visited that used TPN (regularly and occasionally) did not included lipid (fat) in the TPN formula. If patients were to remain on TPN long term then fat would be added in once or twice a week in small volumes. Alternatively 5-10ml/hr of NG feeds were trickled to provide the minimal fat requirements.

## 5.4.4 Conclusions

Feeding through theatre

- Trial feeding through theatre inpatients will naso-duodenal/nasojejunal feeding tubes

Tube placement

- All patients with burn greater than 50% TBSA should have a small bowel feeding tube placed
- Nasogastric tubes can be used for patients with burns less than 50% TBSA burn
- Suggest the use of nasoduodenal feeding tubes rather than nasojejunal tubes to decrease incidence of diarrhoea.

Use of TPN

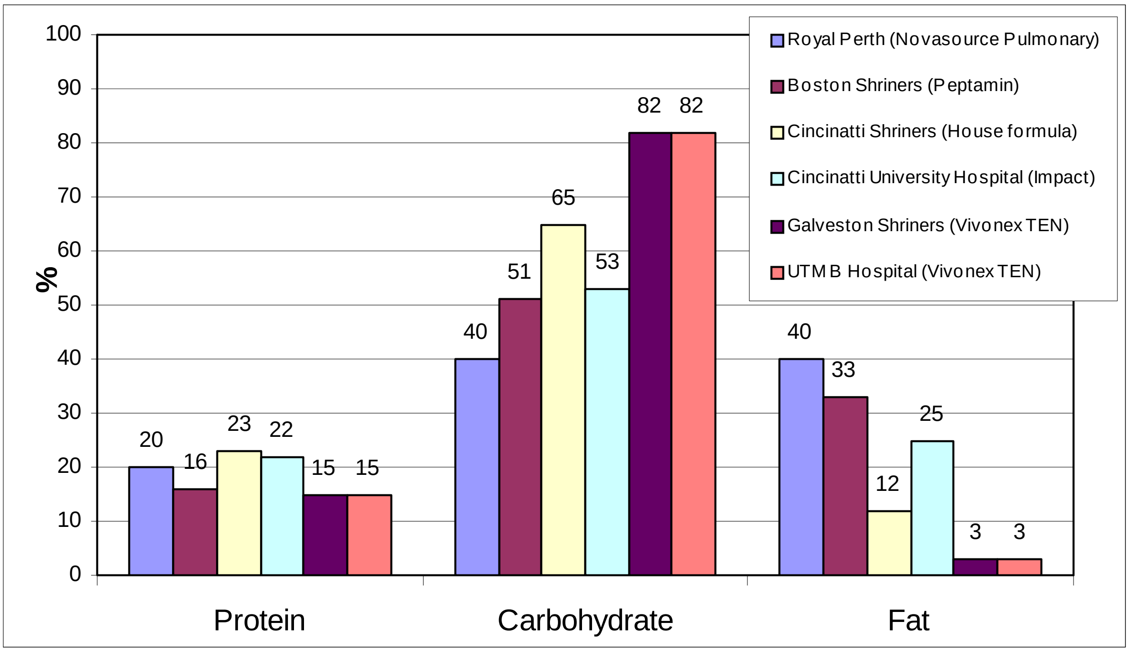
- Use TPN when other feeding methods have failed. Using TPN is better than not feeding at all.

## 5.5 Objective 5:Investigate the use of specialised nutrition to boost the immune system and support the body as it recovers from the burn injury. This is called "immunonutrition"

### 5.5.1 Macronutrients

Macronutrients are the components of food/enteral feed that provide energy (kJ). All burn units except Galveston and UTMB hospital used different standard enteral feed with different macronutrient compositions. Each hospital has strong evidence to support their choice of feed. Table 4.6.1 highlights the main composition of the enteral feed used by each hospital.

Figure 5.5.1.1 Macronutrient percentages




5.5.1.1 Protein

All hospitals including RPH choose a high protein formula that provides between 15-23% of calories as protein. RPH, Brigham and Womens and UTMB hospital in Galveston added extra protein to formulas when required (ie in large burns patients with a high healthy body weight). Diets providing 23% of energy from protein improve survival rates, decreased incidence of infection, increased serum protein, retinol binding protein, preablumin, transferrin, complement C3 and IgA[10].
The type of protein used did vary slightly.

The formula used in Galveston at Shriners and UTMB hospital was an "elemental feed" this means the all protein is in a broken down into amino acids.

5.5.1.2 Carbohydrate

As seen in table 4.6.1 the percentage of carbohydrate varies significantly at each hospital. RPH provides only 40% of the energy as carbohydrate, this is lowest of all the hospital. Galveston Shriners and the UTMB hospital provide 82% of the energy in the form of carbohydrate.

The literature recommends that carbohydrate is a very good source of energy for burn patient and that 60-65% of energy come from carbohydrates[7,5]. It also recommends that insulin should be supplemented if blood sugars become high. There are 3 main reasons for this:

1. Glucose is readily used by the cells of the burn wound as an energy source for healing.
2. It stimulates the body to make insulin. Insulin is anabolic and stimulates the production of new proteins and wound healing.
3. It will prevent the body from using it own protein stores (muscle) as a source of energy.

5.5.1.3 Fat

All hospitals except RPH used and encouraged the use of a low fat formula. Currently RPH fat provides 40% of energy provided. At Galveston and UTMB hospital fat provides only 3% of the total energy. This is very low fat and only provides enough to meet essential fatty acid requirements.

There is strong evidence[10] to support the use of a low fat formula. Research has shown that high fat formula's may be negative because:

- Enteral fats have been shown to depress the immune system
3. Increase risk of liver damage due to fat accumulation
- Fat does not stimulate insulin production which will promote the building of new proteins
- Fat does not have the protein sparing effect that carbohydrates
4. Negatively alter in prostaglandin metabolism and impairs blood clotting

## 5.5.2 Immunonutrition (micronutrients)

Immunonutrition are immune boosting micronutrients (oral or enteral) that are reported to limit the derangement in a burns patients' immune system (inflammatory/cytokine response). These micronutrients include arginine, glutamine, fish oils and some vitamins and minerals. These nutrients improve wound healing, prevent excessive fat and muscle loss and reduce the risk of infection. Despite extensive research into these immunonutrition a consensus on their use has not been reached. Finding from research show positive and negative effects from immunonutrition. For example Montejo et al 2003[11] concluded that considering the beneficial effects and the absence of detrimental ones, the use of diets enriched in phamaconutrients could be recommended in intensive care patients requiring enteral feeds. Immunonutrition however also been associated with an increased risk of mortality in critically ill patients[12]. Heyland et al[13] reports "Given the weakness of primary studies, their sample size and the suggestion that immunonutrition may be associated with increased mortality in critically ill patients, we cannot recommend immunonutrition to all critically ill patients".

Immununutrition products are not currently used at RPH.

5.5.2.1 Arginine and Glutamine

2 of the 6 hospitals visited used arginine routinely and only 3 of the 6 burn units used Glutamine. Interestingly both units using arginine and 2 of the 3 using glutamine were adult burn units, no children's burns units used arginine and only one used glutamine.

In healthy people glutamine and arginine are not essential nutrients because the body is able to make these nutrients itself. These nutrients become essential in a burn patients because:

1. Increased requirement by the body

2. Higher amounts are lost from burn wounds
3. The alteration in the body systems makes the bodies' production pathways less efficient.

The research on arginine in burns has predominately been done in animals and results cannot be extrapolated into the human population. Generally research suggested that supplementation with arginine has been linked with improved wound healing, the maintenance protein balance, lower rates of infection and requirement for antibiotics[14]. Heyland[13], suggests it is likely that it is the arginine component of immunonutrition that increases the risk of mortality.

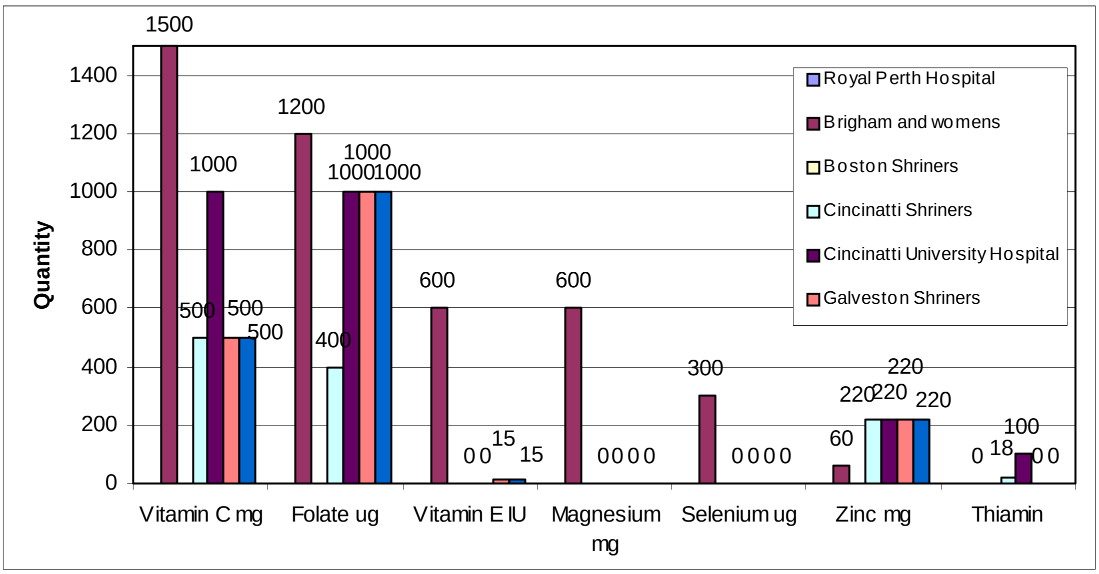
Glutamine has been shown to reduce rates of blood infection and a possible reduce mortality rates[15].

5.5.2.2 Fish Oils
2 of the 6 hospitals used fish oils. At Cincinnati Shriners fish oils provide 50% of the total fat in the enteral feed. Research conducted a Cincinnati Shriners linked fish oil supplementation to decreased rates of wound and general infection, reduced length of stay, reduced incidence of diarrhoea, decreased loss of muscle mass[10]. There is a limited amount of research conducted in this area.

5.5.2.3 Vitamin and Minerals
Vitamin and mineral supplementation was commonly seen. Many mineral and vitamins are "negative acute phase reactants". This means that blood levels of trace elements drop when the body enters the inflammatory response after a burn[16]. This makes it almost impossible to assess a burn patients true requirements. It is suggested however that burn patients develop an acute deficiency in 3 trace elements. These are selenium, copper and zinc. This deficiency is related to increased urinary, skin and wound losses[17].

The graph below shows the nutrients that are supplemented in all burn patients at the six hospitals visited. Vitamin C, Folate and Zinc were most commonly supplemented. It is reported that the increased need for several vitamins and minerals is due to the rapid turnover of these nutrients in the hypermetabolic state.

Figure 5.5.2.3.1 Supplemented Vitamins and minerals



Zinc, vitamin C and folate play an important role in wound healing because of their role in building new proteins and tissue regeneration[17]. Commonly 220mg of zinc sulphate is supplemented per day. This provided 46mg of elemental zinc. 500-1500mg of vitamin C are supplemented but no negative side affects are seen when up to 5g of vitamin C is given. When folate is supplemented 1000mg is given. It is recommended that zinc and Vitamin C supplements be given via feeding tube as high oral doses may cause nausea and vomiting[8]
5.
All commercial enteral feeds given to burn patients contain vitamins and mineral and patients will receive approximately twice the recommended daily intake many vitamin and minerals. RPH do not give additional supplements for this reason.

**4.5.3 Anabolic Agents**

Anabolic agents are medications that are given to promote lean tissue or muscle growth. They are similar to anabolic steroids used illegally by body builders.
The main anabolic agents are:

1. Human Growth Hormone
2. Oxandrolone
3. Insulin/Insulin like growth factor
4. Propranolol

Royal Perth Hospital does not use anabolic agents routinely. Anabolic agent were used at 4 of the six of the hospitals visited. Table 4.9.1 shows the agent used and the indications for use.

| **Hospital** | **Agent** | **Indications for use** |
|---|---|---|
| Brigham and Womens | Oxandrolone | Greater than 20% once met full nutritional requirements |
| Boston Shriners | No | May occasionally use if patient healing poorly |
| Cincinnati Shriners | > 3yrs = Oxandrolone<br>< 3 = Growth hormone | Yes – only in burns greater than 50%<br>Occasionally use in smaller burns if pt has poor healing or needs to increase wt |
| Cincinnati University | Oxandrolone | Commenced on admission in patients greater than 20% TBSA burns<br>Aim to continue for 1-2months but usually ceased when patient is moved to rehabilitation facility |
| Galveston Shriners | Growth hormone and oxandrolone (propranolol – test substance) | As part of research protocol |
| UTMB hospital | No | - |

Research reports that treatment with oxandrolone is associated with a reduction in weight loss, improved nitrogen balance and improved wound healing (donor sites) [18,19]. Research conducted at Galveston using 1 or a combinations of the agent listed above supported Demlings[19] findings and suggested that there is a significant clinical gain in using anabolic agents in burn patients.

These is a large amount of conflicting literature however and further research is required into this area to highlight the detrimental effects. For example some research shows increased survival rates other research reports and increased risk of mortality.

#### 5.5.4 Conclusions

**Macronutrients in enteral formula's**

1. Maintain protein intakes at 2-2.5g/kg of body weight and continue to add extra protein as required.
2. Investigate the use and availability of whey protein containing products
3. Increase carbohydrate intakes to 60-65% of total kilojoule intake
4. Encourage the use of insulin rather than low carbohydrate feeds to control blood sugar levels.
5. Reduce fat intake to provide only 20-25% of total kilojoule intake

**Micronutrients**

1. Arginine containing products should not be used in the critically ill
2. Arginine and Glutamine may be useful for patients that are in the rehabilitation phase of recovery
3. Fish oils may be beneficial but need further investigation
4. Commence Vitamin C supplements or 500mg per day
5. Consider Zn, Se, Cu, folate and B vitamin supplements but further investigate quantities required
6. Use anabolic agents sparingly until further research is available

### 5.6 Objective 6: Explore current research that is being completed at the leading Burns Institute and the methodology they are using.

6.

The Shriners hospitals have a strong research focus and many of the dietitians were involved in research as part of their daily routine. They are able to do this because they have strong financial support and good staffing levels.

The main areas currently being researched at these institutions include:

1. Vitamin D and bone status
2. Use of anabolic agents to maintain lean body mass
3. Long term assessments of a burn patients energy requirements ie 12months – 2 years
4. High carbohydrate diets and insulin regimes

#### 5.6.1 Conclusion:

1. Well-developed and implemented research protocols are the key to successful research

## 6. Summary

Currently the dietary focus is on preventing weight loss and ensuring patients receive enough kilojoules and protein. At Royal Perth Hospital we need to adopt a broader approach and focus on the complete nutritional picture.

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# 8. Appendix

## 1. Nutrition and the Immunomodulation in Burns

In a retrospective review of patients with burn injury greater than 50% TBSA there as an 80% drop in mortality from septicaemia in patients hospitalised between 1971 and 1975. This occurred concurrently with the introduction of aggressive nutrition support from continuous tube feeds. But immunologic problems (ie impaired immune function) were still seen and despite enteral feeding symptoms like protein calorie nutrition were seen. To some extent these were improved by the provision of high protein diets.

## 2.Glucose metabolism

- Hyperglycaemia or "diabetes of stress" is well documented in burns patients and is regularly seen in Burns patients at RPH. The cause of this is likely:
  - In shock phase (ebb phase) likely due to lack of insulin (Mayers Chpt 43)
  - In flow phase:
    - Reduced uptake of Glucose into the cells – ie reduced clearance and
    - Increased production from glycolysis (muscle and liver glucose stores will only last approx 2 hours) and GNG. Alanine and other amino acids are increasingly cycled into the GNG pathway in burns patients. This means these amino acids cannot be used in protein synthesis and therefore adds to the depletion of the body's protein stores.

(Wolfe, 1996, Mayers, Chpt 43 unsure of year)

- Kagan et al 1991 highlighted that a healthy person will make approx 200g of glucose from GNG and a burn pt (non septic) will make 300-400g per day.
- In a burn pt it is also seen that majority of glucose uptake is by insulin-independent tissues (liver) (Wolfe, 1996)

- The hypoglycaemic action of insulin in a burn patient reduced when insulin is within the physiologic range (ie if no CHO is given to a burn pt – despite being given insulin at physiologic level they will not get hypo's). But the maximal physiological effectiveness is not markedly reduced (Wolfe, 1996)

- Insulin resistance (lack of effect of insulin to cause glucose uptake by cells) has been shown when:

Comparisons between burn pt and healthy volunteers showed: that when glucose was infused at 4mg/kg/min (healthy level) it took almost 5 times as much insulin to maintain basal glucose in the burn patients (Original research: Wolfe, RR et al 1979, Glucose metabolism in severely burned patients, Metabolism 28:1031-1039). (Wolfe, 1996)

- Glucagon levels play a main role in increased glucose production:

It was seen in a study when insulin and glucagon production were inhibited by a somatostatin infusion and only insulin was infused to return insulin levels to normal. The accelerated production of glucose was almost decreased to the normal range. This was despite glucagon levels only being inhibited to 2x normal (table in article Wolfe, R, 1996)

- There must be something other than glucagon causing the increased glucose production because an elevation of glucagon in healthy volunteers only cause a temporary increase in glucose production that lasted for 1-2 hours (original research reference 7 in Wolfe, R 1996: Shawgraw RE et al, 1989, Differentiation between septic and post burn insulin resistance, Ann Surg, 196:420-435)

- Wolfe (1996) indicates that glucose is a good energy substrate to use for burned patients despite the alterations in normal glucoregulation. This is because:
  - The hyperglycaemia is not due to a lack of utilisation
  - It appears that burn wound metabolises large quantities of glucose (Mayers Chpt 43)
  - Glycolysis will result in pyruvate production; this is the peroxidised into lactate. Studies showed it was clear that there is no impairment of pyruvate peroxidation and in fact a high lactate production in burns patients derives from an extraordinarily high rate of appearance of pyruvate. This is caused by a rapid rate of glucose uptake from the plasma. This may seem that it contradicts the notion of "insulin resistance" but….
    - The rate of uptake is essentially dictated by the rate of appearance of glucose in the blood.
    - It is primarily the glucose clearance rate ie the plasma glucose concentration at which a given amount of glucose uptake occurs, that is affected by insulin resistance
    - Thus high rate of glucose production, both in basal state and during a glucose infusion, causes significantly higher than the normal rate of glucose uptake in burn injury regardless of cell insensitivity
  - Once inside the cell it is indicated that glucose is metabolised the same in burn patients and in normal subjects.
  - Glucose oxidation has been compared in burned and non-burned limbs. It showed that uptake in burned limb is up to 10 times greater than the uptake of the unburned limb (Reference 74 in Mayers Chpt 43, original research Wilmore, D., Aulick, L., et al 1977 Influence of the burn wound on local and systemic response to injury. Ann Surg, 186:444-458). The wound is able to satisfy its requirement by increasing circulation to the injured area. As noted above uptake is dictated by the rate of appearance of glucose in plasma. Ie more glucose is transported to the wound because of an increase in blood flow to the wound. Uptake is therefore increased to cope with the increased appearance (Mayers Chpt 43).
- Secondly the provision of glucose as an energy substrate causes insulin production and the anabolic effect of insulin on protein metabolism is well established (in normal circumstances). (Wolfe 1996, Mayers Chpt 43, Mayers 1997).
- It is seen that a constant dose of amino acids and glucose decreases nitrogen excretion but equal calories from fat does not have this affect (Mayers Chpt 43, Mayers 1997).
- The provision of excessive carbohydrates is discouraged and it sometimes results in hyperglycaemia, glucosuria, hyperosmolarity, osmotic diuresis and result in dehydration, hypovolemia, increased lipogenesis, fatty liver, $CO_2$ retention (increased dependence on ventilation). Mayer (Chpt 43) reports that the provision of 60%-65% of calories as carbohydrate is reasonable (for burns exceeding 25%). The amount should not exceed the 5mg/kg/min oxidation rate. Hyperglycaemia and Glucosuria should be routinely monitored.
- IV insulin can be administered to maximise the glucose uptake to this level (Mayers 2001).

- The provision of adequate carbohydrate perhaps also suppresses GNG and therefore reduces the use of amino acids as energy rather than as building block for new proteins (Mayers 2001Book).

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## 3. Fat Metabolism

- In highly stressed patients fat oxidation may be impaired with diminished ketone body formation. This places an increased reliance on glucose and protein for energy (Gottshclich et al 1990 Book).

- High fat formula's may be detrimental in this groups because
    - Enteral lipids have been shown to depress the immune system. It is not clearly known why this occurs but it is thought the negative impact may be due to:
        - Liver damage
        - Changes in prostaglandin metabolism
        - Reduced antibody formation
        - Inhibited neutrophil chemotaxis
        - Impaired phagocytosis and
        - Depressed function of he reticuloendothelial system.
- This is of particular importance because of high sepsis rates in this group
- Furthermore complications associated with excessive fat intake include:
    - Accumulation of fat in blood and liver
    - Impaired clotting
- Fat does not stimulate insulin
- Does not have the protein sparing effect

(Gottshslich et al 1990 Book).

- Studies in animals concluded that a diet containing 5-15% of non-protein calories as fat was optimal (Cited by Gottschlich 1990 book chapter – Ref 158 original research Alexander J, W, 1986, the importance of lipid content of enteral diets following thermal injury, Ann. Surg 204:1-8).

- Further studies in this series showed that the omega 6 fatty acid linoleate particularly has a negative effect on the immune system and pt survival. The substitution of oleic acid and treatment with indomethacin (?) were both associated with improved response to DNFB skin tests and concomitant increased in body weight and survival. (Cited Gottschlich 1990, ref 160 Saito, H et al 1985, Effect of dietary unsaturated fatty acids and indomethacin on metabolism and survival after burn, Proc. Am Burn Assoc 17)

- It is thought that the metabolites of arachidonic acid may be the reason for the negative affects associated with linoleic acid. Arachidonic acid is oxidised into prostaglandins, thromboxanes ($TXA_2$) and prostacyclins ($PGI_2$) and certain leukotrienes. $TXA_2$ cause platelet aggregation, and smooth muscle contractions, $PGI_2$ does the opposite. $PGE_2$ has also been shown to be an immunosuppressant and in associated with enhanced muscle protein breakdown.

- Omega 3 fatty acids may have a positive role to play. It produces similar compounds to the Omega 6 FA by with a different biological effect. It produces $TXA_3$, which has a weaker activity and will not aggregate platelets. $PGI_3$ is a potent vasodilator (similar to $PGI_2$) and $PGE_3$ does not have the same immunosuppressive effect as $PGE_2$ (Ref 170, 171 from Gottschlich 1990 book chapter)

- It is important to note that there is no interconversion between omega 3 and omega 6 FA and the metabolic ratios are largely related to dietary intake.

- Animal studies reference by Gottschlich et al (1990 book) indicate that when given EPA or oleic acid the animals had significantly less weight loss than those receiving linoleic acid.

- In studies into large amounts fish oils did not had the same level of immune dysfunction as those give linoleic rich diets. <u>But that fish oils had an adverse affect on weight</u>.

- A study assessing diarrhoea in burns patients also highlighted that using a <u>lower fat feed (less than 20% of caloric intake) reduced the frequency of diarrhoea in burns patients</u>. (Gottschlich et al 1988)

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