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Nutrition and wound care

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Abstract

The aim of this review is to synthesise literature on food, nutritional status and wound healing to help inform those working in wound care. A literature search was performed on PubMed, Scopus and EMBASE databases. Studies were critically appraised and the findings were analysed by narrative synthesis. Nutritional assessment is important in practice as nutritional status can impact on wound healing in several ways (including affecting both healing time and susceptibility to infection). There is widespread recognition of the importance of nutritional assessment tools, however completion can sometimes be overlooked in practice. Healthcare professionals also need to be aware that obesity may be accompanied by micronutrient deficiency causing low micronutrient levels, however nutritional assessment tools using body mass index BMI and weight loss may not identify this. Although there are intervention studies using nutritional formulations such as amino acids to support wound healing, the results of this review suggest that future research around using food as therapy and specific nutritional supplementation is needed.

## Introduction

Wound care currently represents a significant issue in healthcare in the UK. Over a decade ago, in 2008, Posnett and Franks estimated that the cost of caring for patients with chronic wounds in the UK from 2005–2006 was between £2.3–£3.1 billion a year. A few years later it was reported that dressings alone accounted for at least £120million in primary care costs (National Prescribing Centre, 2010). Scallon et al., also reported in 2013 that £400m was spent on venous leg ulcers in the UK. Moreover, wounds impact on the lives of hundreds of thousands of people. In 2004, Bennett et al., estimated 412,000 people in the UK develop a new pressure ulcer annually and estimate 150,000 people within the UK have active venous ulcers. Wound care is also an important issue due to ageing populations; this in itself places extra demands on healthcare resources whilst lessening the availability of revenue available to support healthcare through taxation (Phillips, 2005). This highlights the need for cost-effective strategies that both prevent complications and support recovery, reducing healing times where-ever possible.

## Aims

The aims of this review are to consider the relationship between wound healing and nutritional status in both acute and chronic wounds, including pressure ulcers and diabetic foot ulcers, in the hope of informing healthcare practice and increasing the awareness of the importance of consideration of nutrition in a multi-disciplinary approach. With economic austerity in the UK through much of the last decade, on-going healthcare funding issues and the increasing emphasis at a policy level on patient centred-care, prevention and minimisation of complications would undoubtedly be considered best practice. The author aims to demonstrate how assessment of nutritional status of patients combined with an awareness of

the prevalence of nutritional deficiencies and how they may impact on wound healing are worthy considerations to inform clinical approaches.

## Approach

A narrative approach has been used to synthesise findings from a literature search using search terms such as wound healing and nutritional status, nutritional supplements and wound healing, nutritional assessment and wound healing, nutrition and pressure ulcers, nutritional status and pressure ulcers, nutrition and diabetic foot ulcers.

The UK's current nutritional guidelines and requirements

Current nutritional recommendations are based on the Eat Well Guide (Figure 1). The National Diet and Nutrition Survey (NDNS) shows that not many adults currently meet nutritional guidelines and healthcare professionals would probably benefit from knowledge of this data (even at a population level) as it can help inform clinical approaches and highlight the importance of nutritional assessment.

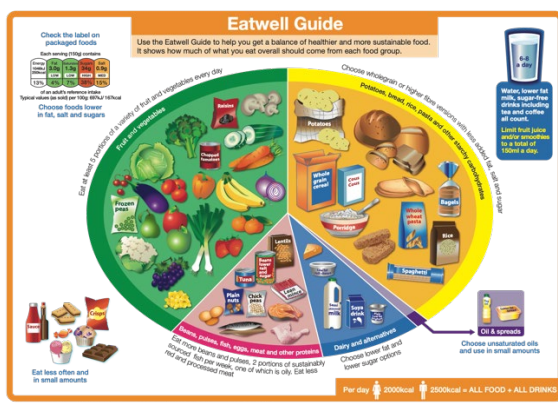


Figure 1. Eatwell Guide Source Public Health England in association with the Welsh Government, Food Standards Scotland and the Food Standards Agency in Northern Ireland © Crown copyright 2016 (AQ2: slight rewrite okay? JB OKAY by me)

## Malnutrition

It is also important to bear in mind that around three million people in the UK are at risk of malnutrition (Allied Health Professionals (AHP) 2012 and British Dietetic Association (BDA) no date). The BDA estimate 93% of these are living in their own home, whilst 5% are living in care homes and only 2% of these are in hospital. Malnutrition is an established risk factor for both delayed wound healing but also infection and reduced immunity (BDA, 2019) and in hospital stays it increases the chance of complications and re-admission (Frank et al., 2015). Malnutrition is associated with deprivation, but might be the result of problems with dentition (as commonly seen in the elderly) or the result of changes in taste that can also be associated with both ageing and some medication. Mobility issues can also cause difficulties with accessing and preparing food. Some academics and researchers now view obesity as a state of malnourishment; indeed the World Health Organization refer to this as the 'double burden of malnutrition'. Very simply, people may be malnourished through food and calorie deficit whilst others may be overfed in terms of energy (Kcal) but deficient in one or more micronutrients.

### MUST Nutritional Assessment

In the UK, the National Institute for Health and Clinical Excellence (NICE) has recommended for some time that nutritional screening tools such as MUST (Malnutrition Universal Screening Tool) be used on patients admitted to hospital (NICE 2006). MUST is a five-step tool developed by British Association for Parenteral and Enteral Nutrition (BAPEN). Information and materials are available at [www.bapen.org.uk](http://www.bapen.org.uk). MUST should be undertaken weekly after hospital admission but can also be used in a community setting. Healthcare professionals should be urged to remember the tool uses BMI and weight loss as

the primary determinants of risk; hence may not be able to identify obese or overweight individuals with micronutrient deficiencies.

Moreover, data on completion of nutritional assessment has been reported, a cross-sectional study in one hospital was reported in 2012 (Dingwal et al, 2012). This study reported sub-optimal completion of MUST assessments and nutritional care plans. In the study ten patients were randomly selected from ten wards across the hospital (100 patients in total). No wards had 100% completion of MUST assessments, whilst eight of ten of the wards had nutritional care plans, 45% of the 100 patients did not have a MUST score. Of the patients that did have a MUST score 52% were found to be at a medium or high risk of nutritional deficiency.

Another study in the UK on 80 medical patients also reported that MUST screening did not reach 100%. The authors report 'high' levels of completion (but below the target level of 100%) but also state rates of completion drops off over the period of 4 weeks after admission as the results were 87% completion in week one, 89% in week two, 85% in week three and 84% in week four (Middleton et al, 2012). Another study reports similarly that the MUST tool was under-utilised on vascular wards, but the authors did state that usage of the tool increased following an education session (Tewari et al, 2013). Another author raises the issue of accuracy of completion of MUST assessment and recommends that future audits of MUST completion should assess not just levels of completion but also accuracy of completion (Smith 2014).

## Hydration

The Eatwell Guide recommends 6–8 glasses of fluid a day such as water, low fat milk, tea or coffee. Ousey et al (2016) report on the importance of hydration in skin healing to maintain dermal water balance as dehydration can delay wound healing. Fluids should therefore also

be considered too in the context of wound healing and hydration charts are also important in terms of assessing patients in hospital settings.

### Fruits, Vegetables and Micronutrients

One of the main findings from the National Diet and Nutrition Survey (NNDS) over the last nine years is that in all age/sex groups mean intake of fruit and vegetables is below the 'Five A Day' recommendation. Only about 30% of adults and around 10% of 11-18 year olds meet the recommendation (BNF, 2019). Fruits and vegetables are a source of many nutrients including Vitamin C. It is important to consider that fruits and vegetables also contain many other phytonutrients such as carotenes. Among others, carotenes have demonstrated to be useful for supporting skin health as they are antioxidants and can help protect the skin from UV light (Meléndez-Martínez et al., 2019). Another type of phytonutrients are flavonoids found in fruits, berries, soy products, red wine and legumes. They have been associated with improved microcirculatory parameters, however trials on interventions with flavonoids have reported mixed results (Scallan et al., 2013) and further research is needed. Intervention studies using a randomised controlled model often assess the effect of a single nutrient or food component versus placebo or another component. It is difficult therefore to understand the combined synergistic effect of many foods such as fruits or vegetables in their natural state where they contain many nutrients and phytochemicals in combination. Consequently, it should be recognised that fruits and vegetables provide valuable sources of phytonutrients as well as vitamins and minerals.

### Vitamin C

Deficiency of Vitamin C causes scurvy, which affects the skin. Vitamin C is found in both the dermis and epidermis of the skin (Shindo et al, 1994), though ageing causes levels to

decline (Rhie et al, 2001). It is required for collagen synthesis and scurvy causes collagen production to decline which disrupts the connective tissue and makes blood vessels fragile. Recent case reports in the UK sadly indicate that this may be more prevalent than assumed (Mosdol et al, 2008). Mosdol et al., reported on their study which demonstrated that 25% of men and 16% of women in the low-income/materially deprived population had plasma Vitamin C concentrations indicative of deficiency of Vitamin C (<11 micromol l(-1)). Fresh fruits and vegetables are generally perceived as expensive so we know food choice may be affected in financial hardship as there is a tendency to buy starchy foods that are perceived as more filling, as these are generally cheaper. Vitamin C requirements may be increased in smokers as smokers demonstrate low levels (Schechtman et al., 1989). Health issues such as bleeding gums and easy bruising are associated with low levels of intake (BMJ, 2020). The Reference Nutrient Intake (RNI) for Vitamin C in the UK is 40mg/day for adults (set at a level to prevent deficiency in the majority 97.5% of the population). It is noteworthy that the EU Population Reference Intake is 110mg/day for adult males and 95mg/day for adult females because they have been derived from adequacy criteria (Gibney et al, 2009) as opposed to deficiency criteria as in the UK. Studies using interventions of Vitamin C supplements in wound healing have not yielded consistent results (Linus Pauling Institute, 2011), which probably highlights the importance of food sources of the nutrient.

### Vitamin D Deficiency

Vitamin D deficiency is common in people who are housebound as it is made through sunlight exposure to the skin. Skin pigmentation also affects levels of production and skin with more pigmentation will produce less, so deficiency is more common in people with darker skin (Richard et al., 2017). Both obesity and diabetes are also associated with high



rates of Vitamin D deficiency (Via, 2012). Patients with diabetes are at high risk of developing diabetic foot ulcers (Tatti and Barber, 2010). The aetiology of diabetes Type 2 is obviously very complex and involves many issues including genetic and behavioural/lifestyle factors,  $\beta$ -cell dysfunction in the pancreas, resistance to insulin and incretin hormone as well as injury from oxidative stress (via 2012). There is some indication that Vitamin D may play a role in insulin secretion and function as Vitamin D receptors are found in human pancreatic  $\beta$ -cells (Via, 2012). There have also been a few studies demonstrating positive results from intervention with Vitamin D supplementation, as it has been reported that Vitamin D supplements can improve both insulin signalling and glucose metabolism in patients with type 2 diabetes (Pittas et al, 2007). It is also worth noting in terms of infection risk in wound care that Vitamin D insufficiency may reduce immunity before other indicators of low levels are apparent (Miller et al, 2016). Moreover, it seems Vitamin D deficiency is relatively common in the UK as the recent NDNS analysis of the last 9 years reported that from January to March 19% of children aged 4 to 10 years, 37% of children aged 11 to 18 years and 29% of adults had low Vitamin D levels (25-OHD below 25nmol/L) which is defined as the threshold indicating risk of deficiency.

#### Other vitamins and minerals

The NDNS data also showed a downward trend in intakes of most vitamins and minerals for many age/sex groups, for example, all age/sex groups showed a reduction in vitamin A and folate intake that was significant (BNF, 2019). Other micronutrients including riboflavin (vitamin B2), iron, calcium, iodine, potassium and zinc also demonstrated reductions in intakes and an increase in the proportion of people with low intakes (below the lower reference nutrient intake) (BNF, 2019). Zinc has an important role in protein metabolism and

deficiency may be associated with poor sense of taste and smell and delayed wound healing (Pisano and Hilar, 2016).

Those with higher incomes are closer to meeting nutritional recommendations, yet the data demonstrates that diets don't meet guidelines across a range of incomes. In terms of wounds, nutritional inadequacy is an established risk factor in the development of pressure ulcers (Carter and Lecko, 2018).

Vitamin A (like Vitamin C) has many important functions, including in immunity, and Vitamin A (retinol) is important for skin and mucosal surfaces and involved in keratin production as retinoids help regulate keratin genes (Törmä 2011). Previous NDNS data indicated that Vitamin A was above or close to the RNI in all age/sex groups except in children aged 11 to 18 years. The latest report indicates declining intakes and demonstrates significant increase in the proportion with Vitamin A intake below the LRNI.

## Protein

In the UK, the recommended intake of protein is less than 15% energy (Kcal) or 0.75g protein per kg bodyweight per day (for adults). Committee on Medical Aspects of Food and Nutrition (COMA) recommended 46g/day for adults (COMA 1991). It is important to acknowledge there's some disagreement in the scientific community about protein requirements and no consensus on what is considered a safe upper limit. There's also some evidence that vegetarians and vegans should eat slightly more because of factors affecting digestibility (Ciuris et al.,2019). It is acknowledged that those with wounds have higher requirements and this is where there can be a challenge in the elderly particularly as more

elderly people, especially those with dental problems, might find protein foods such as meat or poultry too difficult to chew and this may affect intake. Moreover, deprived people may find it hard to afford protein based foods. The human diet should include ‘complete’ proteins which have a good level of all the essential amino acids (EAAs). Foods such as meat, fish, poultry, eggs, dairy and soy are complete proteins and the diet should contain some of these foods. This is because the EAAs have to be supplied by diet as they cannot be made in the body and they include, isoleucine, tryptophan, leucine, phenylalanine, valine, methionine, lysine and threonine. For those on a restricted income, eggs and milk can be more affordable sources of complete proteins. Other good sources of vegetarian protein include nuts/seeds, nut butters, beans and pulses and protein powders such as whey protein. Whey is the protein from the liquid part of milk, once it has been separated from the curd (casein). There are different types of whey protein, including whey protein isolate and hydrolysed whey protein.

Examples of approximate protein content of food (SELFNutritiondata, 2020)

- 1 glass of milk (8 gms)
- 1 egg (6.1 gms) 2 eggs (12.2g)
- Cooked chicken breast 54g
- 1 cup yoghurt (7.9 gms)
- 3 slices whole wheat bread (9 gms)
- 1/2 cup carrots (2 gms)

Proteins are made up of molecules called amino acids and they are the building blocks for the body and they are used to make most body structures and blood cells, neurotransmitters antibodies and hormones. They also help to regulate the fluid balance in the body and to transport other nutrients around the body (they help transport iron to where it is needed for

example) and are involved in other vital body processes such as clotting and regulating the pH of the body (Whitney et al, 2002). The amino acid arginine is a collagen precursor, it also stimulates insulin and growth hormone secretion and can enhance collagen accumulation. Bilsborough and Mann (2006) state the maximum protein intake based on bodily needs, weight control evidence, and avoiding protein toxicity would be approximately of 25% of energy requirements at approximately  $2\text{--}2.5\text{g} \times \text{kg}^{-1} \times \text{d}^{-1}$ , which is a lot higher than the current UK recommendation as it corresponds to 176g protein per day for an 80kg individual on a 12,000kJ/d diet. They define a maximum safe intake range for an 80kg person as 285 to 365g/d (Bilsborough and Mann, 2006).

There are some small-scale studies of amino acid based interventions. One study on twelve patients with recurrent diabetic foot ulcers was reported by Tatti and Barber in 2010. The study used a mixture of the amino acids glutamine and arginine and recommended a diet of around 20% of energy from protein (with overweight or obese patients having a 20% reduction in calories). All patients monitored blood glucose levels closely and the researchers monitored glycosylated haemoglobin and reported no difference before and after administration. Positive results were reported as ulcer duration was significantly decreased after supplementation (average 247 days before supplementation to 83 days after supplementation). Van Anholt (2010) also demonstrated an arginine enriched ready to drink formula was effective in treating pressure ulcers and positive findings were additionally reported from an arginine enriched oral supplement in a case report study on pressure ulcers, diabetic foot ulcers and leg ulcers (Neyens et al, 2017).

## Recommendations

The first step is to identify those at risk of malnutrition both in hospital and community settings and consider this maybe a possibility even if a patient is overweight or obese. A nutritional assessment such as a MUST should ideally be completed. If the patient is overweight or obese micronutrient deficiencies may still be present, so these should also be explored (especially in delayed wound healing). Dietetic advice will be required where patients can't eat, so specialist feeding such as tube feed or parental feeding can be started, if deemed necessary and appropriate for the patient. If a patient can eat it is important that health professionals, carers and family recognise that there is an increased calorie need and also try to provide a higher protein diet. Kcal at 30-35 kcal/kg CURRENT weight is recommended by the Health Services Executive of the Republic of Ireland in their wound management guidelines which were published in 2018 (Health Services Executive, 2018). A higher protein diet should be combined with with 5 x 80g portions of fruits and vegetables, healthy fats such as olive oil, and oily fish and some starchy carbohydrates. Small frequent meals can be considered if food intake is poor or even a milky drink made with a protein powder and 6-8 glasses of fluid should be consumed daily.

## Conclusions

Malnutrition is a factor that can negatively affect wounds and wound healing. Over 3 million people in UK are at risk and many of these live in their own homes. Whilst there is widespread recognition of the importance of nutritional assessment tools, completion can sometimes be overlooked in practice. Healthcare professionals need to be aware that obesity may be accompanied by malnutrition in the form of micronutrient deficiency, and also be aware that nutritional assessment tools using body mass index BMI and weight may not identify this. There are some intervention studies using nutritional formulations such as

amino acids to support wound healing, however the results of this review suggest that future research around using food as therapy and specific nutritional supplementation is needed.

What is the 5-a-day recommendation?

5 x 80g portions of fruits and vegetables excluding starchy vegetable such as potato. This can include one small glass of juice and 1 portion of beans or pulses.

Dietary Reference Values (DRVs)

Current nutritional guidelines include the DRVs; which are a set of values including the RNI and LRNI and Estimated Average Requirement (EAR) which can vary by age and gender. DRVs were set by the COMA in 1991 for the intake of nutrients, such as energy, carbohydrates including fibre and sugars as well as for micronutrients such as iron and Vitamin D. However, COMA has now been replaced by the Scientific Advisory Committee on Nutrition (SACN) and SACN has started to review and updated the DRVs (BNF, 2016). The DRVs are designed to be used at a population level to prevent deficiency diseases in the majority and do not take account of factors such as illness or individualised requirements, moreover they are not set to encourage optimum health.

RNIs are mostly used for micronutrients such as vitamins and minerals. The RNI is the amount of a nutrient that is enough to meet the needs for the 97.5% of the population and LRNI which is the amount of a nutrient that meets the needs for a 2.5% of people who are considered to have low requirements (BNF, 2016). The EAR tends to be used for energy and is set at being sufficient for 50% of the population.

## NDNS

Is a cross-sectional survey of around 1000 people per year in the UK, that has been a continuous rolling programme since fieldwork started in 2008 and it collects quantitative data about foods consumed, the nutrient intake and nutritional status of participants. The sample is designed to be representative of the general population in the UK aged 1.5 years and over living in private households. Participants are interviewed and complete a 4-day estimated diet diary, plus there are physical measurements and both blood and urine samples are taken. Low levels in the NDNS can be a cause for potential concern, however we must remember the survey only captures 4 days of participants' food intake so this does not necessarily mean low intakes are sustained over longer periods of time.

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