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Nutrition in Health Care Practice

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Effective clinical practice of any kind requires reliable diagnosis and risk-cost-benefit management for the short, medium and long-term, which is evidence-based. This is the case for clinical nutrition as well. Clinical nutrition rarely stands alone, but is integral to most of primary to tertiary health care in all of its disciplines (adult internal medicine, pediatrics, obstetrics and gynecology, surgery and psychiatry) and systems (e.g. gut, CNS, reproductive, hematologic, musculoskeletal). In the past, the role of food intake in disease expression has been under-recognized, leading to failure of nutritional diagnosis, without which there will be no nutritional management. Important examples are in disorders of immune function, those which are neurobehavioral, and of reproduction. Advances in nutritional epidemiology, food chemistry (especially the physical properties of food, and its phytochemistry) and in nutritional assessment (especially in body composition and in molecular nutrition) are providing more scope for nutritional approaches to the changing patterns of infections, and to the so called chronic diseases and mental health, which contribute the major burden of disease world-wide. All clinicians require a basic understanding of food health relationships and their relevance in the field in which they practice.

Key words: Clinical Nutrition, Nutritional Assessment, Nutrition Diagnosis, Nutrition Science, Nutritional Epidemiology, Nutritionally-Related Disease, Food Technology, Phytonutrients, Medical Education, Continuing Nutrition Education (CNE)

EFFECTIVE CLINICAL PRACTICE

Before formulating or judging the place of nutrition in health care practice, it is worth considering the elements of effective clinical practice in general (Table 1)[1].

The practiced inclusion of these elements into one's workaday encourages the compilation and review of critical information for care and the organization of appropriate resources for management.

For each of these elements, active attention to nutrition, either food intake or nutritional status perturbed by other factors, is warranted. Specifically, patient needs, problem definition, multi-factorial basis, health problem epidemiology, management plans and their risk-cost-effectiveness are likely to have a nutritional dimension. Even the ethics of practice need to reviewed from a nutritional point of view[2,3].

Table 1. Elements of Effective Clinical Practice

1. Ascertainment of *patient needs*, reasons for health-seeking behavior, and health beliefs.
2. Ability to establish a diagnosis or *define the problem*
3. Recognition of *multi-factorial basis* of health problems and of their recent, medium-term and remote determinants.
4. Awareness of the *epidemiology of the problem*--its geography, ethnicity, age and gender, relationships, frequency of occurrence, transmissibility or transferability, time course, consequences.
5. *Management plans* which take into account patient perceptions and biomedical realities, are communicated and supported by the patient and his/her carers, and are *risk-cost-effective* in the short and long-term.
6. An ethical framework

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CLINICAL NUTRITION

(1) What Is It?[4,5]

Clinical Nutrition is a discipline within Health Care Practice which acknowledges the significance of food and nutrients in the pathogenesis and management of disorders and disease. It is based on Nutrition Science which is defined as the study of the "assimilation of and function dependent on molecules derived from any organism's environment"[6,7].

That dimensions of Nutrition Science are biomedical, psycho-socio-cultural and environmental[8-11] is increasingly understood[12-14].

(2) Its Scope and Linkages

Clinical Nutrition is relevant to

(a) *All age groups*, especially those most vulnerable including pregnant and lactating women, the newborn, infants and toddlers under five, adolescents and the aged, each with their particular nutritional needs and risks

(b) *Socio-economically disadvantaged*

(c) *Displaced persons* (in conflict, refugees, migrants)

(d) *Institutionalized* (hospitals, nursing homes, school boarders) and people in work-places and work-place accommodation, shift-workers

(e) The *incapacitated and dependent*
- intellectual handicap
- physical handicap

(f) Persons whose *food supply* (*and water supply*) may be precarious, unsafe, highly climatically dependent, remote from the point of purchase or consumption, or unlabelled for place of origin, ingredients and nutritional value.

Unfortunately, only a minority of the world's population can be said to have a safe and secure food and water supply[15].

(g) Persons on *multiple medication*

(h) *Substance abuse* (tobacco, alcohol, illicit drugs)

(3) Nutritionally-Related Disorders and Disease (NRD)

Nutritionally-related Disorders and Diseases (NRD) are often classified in an over-simplified fashion--under and over-nutrition. To some extent this has been useful since the greatest burden of NRD has, numerically, been in poor countries and communities where food intake has been limited with associated hunger and famine. The problems have been growth retardation, PEM (protein energy malnutrition), micronutrient deficiencies (especially iodine, iron, zinc, vitamins A and D, thiamin and folic acid), and malnutrition-related infection.

Table 2. Classification of nutritional disorders

Disorders affecting food or nutrient intake
- Maternal malnutrition
- Eating disorders
- Physical handicap
- Low levels of physical activity
- Loss of appetite due to medication or micronutrient deficiency (e.g. thiamin and zinc deficiencies)

Growth and body compositional disorders
- Low birth weight
- Stunting
- Decreased lean mass
- Increased fatness or maldistribution of fat
- Osteopenia
- Fluid shifts

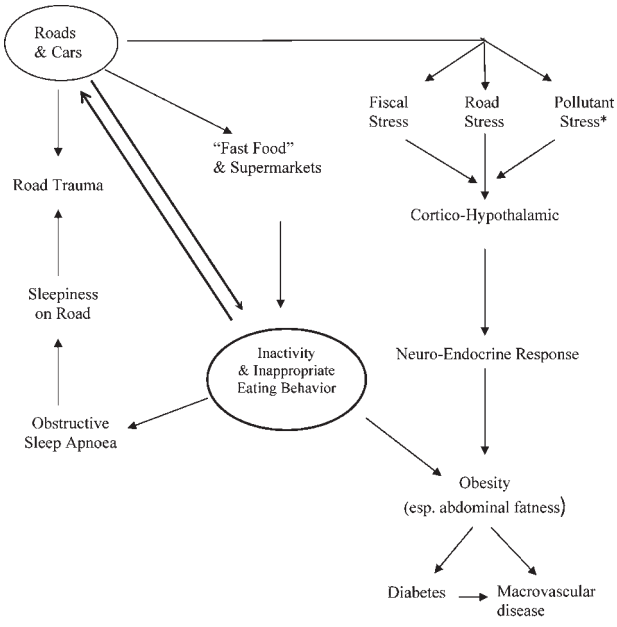
Nutritionally dependent disorders
- Metabolic, e.g. lipid disorders, diabetes
- Hematological, e.g. anemia, lymphopenia
- Immunological, e.g. with protein -energy malnutrition (PEM)

Nutritionally responsive disorders
- Inherited disorders of metabolism
- Disorders related to ageing
- Consequent on other disease processes, e.g. malabsorption, chronic renal failure, neoplastic disease
- Iatrogenic, e.g. due to medication use, institutionalization
- Low levels of physical activity with relative low energy and nutrient intakes, e.g. with physical handicap
- Self-inflicted, e.g. meganutrient dosage and toxicity
- Food sensitivities, which are more common than food allergies, and generally relate to salicylates, biogenic amines or occasionally monosodium glutamate (MSG)

This has been in great contrast with the so-called chronic diseases of affluence, such as obesity, diabetes, macrovascular disease (stroke, ischemic heart disease, peripheral vascular disease, and osteoporosis and certain cancers). However, in recent times the poor have also been exhibiting "chronic disease" and the more affluent experiencing a resurgence of micronutrient deficiency or, at least suboptimal intakes, of, for example, folic acid, vitamin D, iron and iodine. Some of this is contributing to "chronic disease". A combination of under- and over-nutrition may occur in the same individual, family or community, and lead to a complex spectrum of NRD.

Nevertheless, a classification of NRD, which will more often not stand alone, is shown in Table 2[1].

The links between *maternal nutrition*, fetal development, low birth weight, early life nutrition and *later life chronic disease* (obesity, diabetes, MVD) now apparent has underscored the life-long importance of optimal nutrition beginning at conception, or even in previous generations[16-20].



* Pollutant stress, e.g. xeno-estrogens (like pesticide residues)

Fig. 1 Fundamental and Intermediate Causes of Ecolgically and Nutritionally-related Disease (END): the example of eating, activity, cars and the road.

Beyond this reconceptualization of the spectrum of Nutritionally Related Disorders and Diseases, first as the "*Double Burden of Disease*"[21,22], there are *new emergent NRDs*. These have to do, in the main, with environmental and climate change, with urbanization, and with demographic change.

One example of emergent NRD would be the role of nutritional status, like selenium status, in viral pathogenecity[23-27]; and where this affects at least 2 species, avian and homo sapiens and the transmissibility between them[28,29].

Another would be the links between increasing dependent or non-renewable fuel, road transport, the food chain, body compositional disorders, road traffic accidents and death (Figure 1)[7].

FOOD INTAKE AND DISEASE EXPRESSION

Our understanding of food intake and disease expression is changing significantly.

1. The first way in which this is happening is that the physiology and disorders of all *body systems* are recognized as nutritionally-responsive (Table 3)[30,31]. Whereas NRD used to be thought about as principally metabolic, hormonal or gut-related, they are much more.

Table 3. Systems affected by nutritionally-related disorder or disease

System	Examples	Nutritional Factors
Factors	Cognitive impairment at all life's stages	Deficiencies of iodine, iron, folate, B-12, essential fatty acids; Dyslipoproteinemias dependent on apo E status
	Cerebrovascular disease	Macrovascular disease risk factors
	Movement disorders (e.g. Parkinsonism)	Oxidants - Antioxidants
Reproductive	Spermatogenesis	Food antioxidant capacity
	Menstrual cycle	Phytoestrogens
	Menopause	Phytoestrogens
Respiratory	Bronchoconstriction (asthma)	n-3 fatty acids
	Alveolar Function	Food antioxidants
	- macrophages	Vitamin D
Musculo-skeletal System	Inflammatory arthritides (e.g. Rheumatoid)	n-3 fatty acids Food antioxidants
	Bone health (osteoporosis)	Vitamin D Ca, P Na effects on calcium excretion Homocysteine (through folate, B-6 and B-12) Vitamin A (deficiency and toxicity) Fruits and vegetables (phytochemicals) Vitamin C
Gastrointestinal System	Microflora and gut function	Prebiotics Probiotics
	(Gastric - H. Pylori; Colonic - chronic inflammatory Bowel disease - Neoplasia)	Antibiotics
	Motility disorders	Caffeine Polyphenolics (culinary herbs) Ginger Alcohol
	Hepato-Biliary Pancreatic	Growth factors
Cardiovascular	Blood pressure	n-3 fatty acid sources (fish and plants)
	Lipids	Na/K/Mg/Ca
	Platelet function	Arginine, nuts
	Endothelial function	Low glycemic index food
	Glycemic status	Polyphenolics
	Cardiac rhythm	Alcohol
	Abdominal fatness	Wholegrains, fruits and vegetables (phytochemicals) including dietary fiber
Integument (skin)	Wrinkling (Ageing)	Fat and fatty acids Tocotrienol (Vitamin E) Phytonutrients (fruits, tea)
	Skin cancer (SCC)	As for wrinkling
Immuno-hematological	Hemopoiesis	Micronutrients
	Lymphoma and leukemia	EFA (essential fatty acid) Energy and protein deficiency Paternal nutrition Maternal nutrition
Endocrine	Thyroid	Iodine Anti-thyroid factors
	Insulin/Pancreas	Energy balance Food patterns Intactness of foods
Special Senses	Olfactory	Myriad of receptors - link to memory
	Taste	Preferences Polymorphisms Threshold with age and food components (Na, caffeine)
	Auditory	Sound of eating (e.g. crunch, grind)
	Vision	Vitamin A, carotenoids, zinc, alcohol
	- Retinal function (night blindness)	Lutein, zeaxanthin
	- macular function (maculopathy)	Antioxidant foods Minimizing UV damage
	- lens health (cataract)	
Mental Health	Mood	Nutritional adequacy Social role of food

The second way that this understanding is changing in relation to *mechanisms* of particular relevance are the:

- *Molecular*
  - gene and genomic expression which is dependent on nutrients, foods and food patterns, as early as fetal development, but which may not express itself fully until later life (e.g. during pregnancy in the offspring; lipoprotein disorders in the middle years) .

- *Inflammatory and immunological*
  - disease processes which were thought to be strictly metabolic or mechanical, like atherosclerotic vascular disease or microvascular disease in diabetes are now recognized as having inflammatory or immune pathways at work.

- *Infection*
  - diseases not previously regarded as attributable to infectious agents but which are (like H. pylori gastritis and duodenal ulceration) or may be (like coronary artery disease), since infection and nutritional status are tightly linked, will probably have previously unrecognized nutritional factors involved.

- *Degenerative*
  - which may be "ageing" or "age-related" or both, but where nutritional mechanisms might, in turn, damage or protect DNA (e.g. folic acid status and methylation; fruit and vegetable polyphenolics and protection against mutation; vitamin D and cell differentiation).

- *Socio-behavioral*

  The way we eat and how food affects our mood (and how this, in turn affects how we eat) are becoming of interest. An example is the likelihood that n-3 fatty acids help protect against depression, at least in a subpopulation.

  Yet another consideration is the way in which our genome and its interface with our behavior might operate. It is unlikely that this will be through the sum of mRNA -producing DNA; there is much more DNA than this which is likely to have a genome-integrating role. Although we are long way from having the bioinformatic tools which will allow us to evaluate these possibilities, it is almost certain that the way we eat will be a critical modulator of this genome-behavioural-environmental interface. However, it requires a level of integrative and multidisciplinary nutrition science not yet achieved. When it is, it will have a profound effect on nutrition in health care practice.

Table 4. Selected phytochemicals and their possible roles in health

Phytochemicals	Some important food sources	Possible roles in health
Carotenoids	Orange pigmented and green leafy vegetables, e.g. carrots, tomatoes, spinach	Antioxidants Antimutagen Anticarcinogen Immuno-enhancement
Flavonoids, isoflavonoids and saponins	Green and yellow leafy vegetables, e.g. parsley, celery, soy bean and soy products	Antioxidants Anticarcinogen Oestrogenic Immuno-modulating
Polyphenols	Cranberries, raspberries, blackberries Rosemary, oregano, thyme	Antioxidants Antibacterial Reduce urinary tract infection
Catechins	Green tea	Antimutagen Anticarcinogen Anticariogen
Allyl thiosulfinates	Garlic, onions, leeks	Anticarcinogen Antibacterial Cholesterol lowering
Isothiocyanates and indoles	Cruciferous vegetables, e.g. broccoli, cabbage	Antimutagen
Phytosterols, eg. β -sitosterol	Pumpkin seeds	Reduce symptoms of prostate enlargement

ADVANCES IN FOOD CHEMISTRY AND TECHNOLOGY: CLINICAL IMPLICATIONS

Food is extraordinarily clinically complex. Dozens of chemicals can account for a flavor or taste, color or texture[32]. It is remarkable that our homeostatic mechanisms act as well as they do in the face of this complexity. From the sight, smell or feel of food, which generates highly selective *food memory* in the amygdala[33], onwards with ingestion, digestion, assimilation, transport metabolism and excretion, these compounds are occupying receptors, regulating or affecting metabolic pathways, altering gene expression, being stored or catabolized. It is altogether too simplistic to take a single nutrient–single action approach to food components. Dalais and Wahlqvist[34] have developed this notion of multi-functionality in regard to the growing array of phyto-nutrients using isoflavones and lignans, with their estrogens and other properties as an example.

It is the field of phytonutrients (components of plant foods with putative physiological roles in animal species) that has excited much of the recent interest in this field[35].

Table 5. Occurrence of phytochemicals in human blood and tissues

Phytochemicals	Where can we find them in the body
Carotenoids	Serum (five major carotenoids)
Lutein/zeaxanthin	Skin
β-cryptoxanthin	Adipose tissues
Lycopene	Lens and macula (lutein/zeaxanthin)
α-carotene	Various tissues like prostate (lycopene)
β-carotene	
Flavonoids	Serum
Quercetin, kaempferol	Urine
Isoflavones	Serum
Genistein, daidzein	Urine
Catechins epigallo-catechin gallate	Serum
Allyl thiosulfinates	Blood, serum, red blood cells
Organosulfides	Adipose tissue
Vinyl dithiins	Liver
	Kidney
	Breath
Tocotrienols	Skin

As a consequence, the concept of "*Phytochemical Deficiency Disorders*" has developed[36,37] (Table 4).

The occurrence of some phytochemicals in human blood and tissues is tabulated in Table 5.

Such deficiencies are seen in patients with malabsorption syndromes and on long-term nutrition support, both total parenteral (TPN) and enteral. Their importance will grow as these nutrition support technologies extend further in clinical practice, with home TPN and PEGs (percutaneous endoscopic gastrotomies) being examples.

Some of the greatest changes in the foods we now eat are in their *physical structure*, using *extrusion technology*, and *re-formulation* of foods as analogues (e.g. "seafood" which may or may not be). This makes it increasingly difficult for consumers to meet their nutritional needs as they used to do with traditional foods and technologies, unless food labeling and education are adequate. Clinically, this has particular relevance where "intactness" of food is important for insulin and glycemic response (the glycemic index of foods) and *where the food matrix determines bioavailability and efficacy* (as with relatively intact soybean products like tofu or drinks, versus those made from soy protein isolates-the metabolic and hormonal effects are different)[38,39].

NUTRITIONAL EPIDEMIOLOGY: ITS CLINICAL RELEVANCE

Clinical activity is not often seen to have an epidemiologic connection. Diagnosis and patient care can be preoccupying, and the disease pattern context in which they occur inapparent. What we usually mean by the field of clinical nutrition is disease of "nutrient deficiency", such as wasting, or "nutrient excess", or combinations of these, for reasons primarily of intake, or, secondarily, due to increased need for nutrients or their loss. The nexus between malnutrition and communicable disease is the most appreciated *epidemiologic context*, while there is increasing interest in the links between the major non-communicable disease set (i.e. cardiovascular disease) and energy-dense diets. An epidemiologic approach could encompass a review of the potential importance of food intake patterns in a range of other clinical areas[31,40,41]. The epidemiology which allows a reappraisal of dietary factors in the pathogenesis of disease is that which documents food intake, namely "nutritional epidemiology".

A knowledge of the prevalence of NRD, within the community one serves as a health care professional, allows more correct probability analysis to apply to *nutritional diagnosis*[42] and also the avoidance of inappropriate nutritional diagnosis[43,44]. Clinical nutrition falls into disrepute if undue emphasis is placed on nutritional as opposed to other pathogenetic factors.

Again, *nutritional care* is assisted by a knowledge of the food cultures, systems and supply routes which are available in the community in which one practices. Where the food supply is deficient, alternatives should be sought in a cost-effective fashion. For example, the changing patterns of HIV (human immunodeficiency virus) positivity in communities requires safe formula feeds for the infants of nursing mothers who are HIV positive, and access to formula feeds for many who are symptomatic.

New opportunities for *preventive nutrition* arise when clinicians are aware of the nutritional basis for the medical problems they see and where their origins in the community are understood.

The *measurement of the outcomes of clinical nutritional practice* also requires an epidemiologic approach. It is increasingly required of clinical nutritionists that the level of nutritional disability that they address is quantified, in prevalence and severity. Such outcome measures include those related to wasting disorders, fracture arising from osteoporosis, obesity-related morbidity and the complications of diabetes, to mention a few. The changing patterns of NRD not only signal possible important changes in the food supply, but reflect the activities of those in health care practice.

The *planning and justification of health services* requires all of those in health care practice to adopt an epidemiologic view of their clinical activities. There are

sound humanistic reasons for the epidemiologic context, to say nothing of the growing health economic imperative.

NUTRITIONAL DIAGNOSIS

In a report by the Royal Australian College of Physician (RACP), Nutritional Diagnosis was identified as a critical clinical facility in medical practice, in the same way as any other diagnosis ought be regarded[45]. Its elements are to be able to make a nutritional assessment, relevant to the patient's current and future health needs; to compile and deduce what the nutritional basis is and what the prospects for nutritional management are, deriving and agreeing on a plan with the patient and carer[46]. Ordinarily a nutrition assessment requires food and nutrient intake information to be ascertained, anthropometry to be performed, a nutritionally relevant examination to be made, and where appropriate, nutritional investigations (hematological, biochemical, immunological imaging) to be made. This is over and above a general medical history and examination.

Whilst in an ideal world, one would work in a team with nurse, dietitian, pharmacist and others to derive and apply this information, there is a lot that can be done as a medical practitioner alone. For example, a *short*, *targeted enquiry can be made about what a person usually eats* over 24 hours, with a week as the denominator, and, mindful of the clinical condition in question, searching for key foods and beverages. This might be done, for example, where the patient has one or more cardiovascular risk factors like hypertension or hyperlipidemia. Recommendations for change are usually best made against background and preferences, if adherence is to be expected.

With *anthropometry*, the least one would ascertain would be height, weight and some body circumferences. With the upsurge in the prevalence of obesity and related insulin resistance syndromes, an abdominal circumference will probably be the most relevant, convenient and least intrusive circumference measurement to make.

HEALTH CARE PRACTICE CURRICULA AND CNE (CONTINUING NUTRITION EDUCATION)

Most are agreed that, in health care practice curricula, integration with other basic and clinical sciences is preferred, albeit underpinned by a specialized Human Nutrition and/or Clinical Nutrition Department or Unit[4,47]. Overall clinical performance must reflect the place of food and nutrients in health and care.

In turn, this needs to be career-long, as some form of CNE (Continuing Nutrition Education).

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