From challenges of the past to opportunities of the future: Evolution of the field of nutrition

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Outline

» Early days of nutrition
» Contemporary challenges
» Scientific advancements
» Fatal flaws of the reductionist approach
» Transition to a holistic approach
» Closing thoughts
The early days of nutrition

» Public health challenges
  – Communicable disease, short life-span
  – Overt nutrient deficiency

» Scientific focus
  – Discovery of vitamins and essential minerals, hunger and malnutrition
Early nutrition science: The single nutrient model

Successful model was based on three main premises

1. Simple cause-effect relationship exists between a specific disease and a particular nutrient

2. Each nutrient deficiency disease can be explained physiologically in terms of the role played by the respective nutrient

3. Providing the nutrient in the diet can prevent, and in many cases reverse, the disease

Evolution to contemporary challenges

- Rapidly aging population
- Rapidly expanding population
- Physical inactivity
- Dietary imbalance
- Climate change and nutrition sustainability

Diet and lifestyle have become major contributors to death

Research trends

» Evolution of the scientific focus to diet and nutrition’s role in etiology of chronic disease

“Nutrition” OR “Diet” AND “Chronic disease” = 11572 citations
Number of bacterial cells in (oral, gut) or on (skin) the body exceed our own by 10-fold (100 trillion vs. 10 trillion)

The composition, nature and metabolism of these cells is influenced by diet and lifestyle and in turn influences health and well being
Beyond essential nutrients

Isoflavones

Carotenoids

Anthocyanins

Catechins
Evolution of dietary reference intakes

Options for basing Dietary Reference Intakes (DRIs) on chronic disease endpoints: report from a joint US-/Canadian-sponsored working group


"...substances that are essential or conditionally essential..."

"...Naturally occurring food substances, including nutrients..."
Genes → mRNA → Genomics → Transcriptomics
Yet chronic disease remains a leading cause of death.
Diets have become energy rich...

...But nutrient poor

- Large % of Brazilian population fail to achieve recommended intake levels
- Situation is mirrored in many other developed countries

Diets have become energy rich, yet nutrient poor; populations are overfed, yet undernourished

What went wrong?

“Greedy reductionism”:

“...in their eagerness for a bargain, in their zeal to explain too much too fast, scientists and philosophers . . . underestimate the complexities, trying to skip whole layers or levels of theory in their rush to fasten everything securely and neatly to the foundation”

Hierarchy of evidence

1. Randomized controlled trials
2. Prospective cohort studies
3. Case-control studies
4. Case series
5. Case reports
6. Expert opinion
7. Animal research
8. In vitro research
9. Systematic reviews & meta-analyses
Misapplication of evidence-based medicine

» Designed to assess safety and efficacy of drug therapy
» Considers the randomized-controlled trial (RCT) to be the “gold standard” (or only standard) of evidence
  – In many cases, not designed to address unique complexities and challenges presented by nutrients and other food components
» In absence of similar guidelines for nutrition, has been applied to nutrition and bioactive research for the purpose of informing policy decisions
“By analogy, when keys are missing, it is common to look for them under the lamppost where there is light rather than in the murky location where the keys were more likely dropped.”

JAMA. 2009;302(19):2152-2153
Looking for “the magic bullet”

- Studying nutrients as if they were drugs
- Can a nutrient reverse the effects of life-long smoking?

The Effect of Vitamin E and Beta Carotene on the Incidence of Lung Cancer and Other Cancers in Male Smokers

Beta Carotene Cancer Prevention Study Group The Alpha-Tocopherol
“...nonpharmacological dietary prevention of prostate cancer is probably more complex and may involve certain inconvenient truths... If it requires whole foods, extracts, or dietary patterns, *it may be necessary to give up the reductionist need to know which molecule is most responsible* and perhaps give up the notion of placebo controls as well. If it requires starting exposure early in life and sustaining it for decades, it *may mean having to give up the idea of phase 3 trials altogether*. This does not mean that whole food or complex mixture studies cannot be sound and biologically based...it may be time to critically examine the methods used to vet hypotheses for some phase 3 trials...”
Questioning the evidence-based paradigm

Nutrients, Endpoints, and the Problem of Proof

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J. Nutr. 2008;138 1591-1595

- Nutrients don’t function in isolation and have beneficial effects on multiple tissues and organ systems; a focus on a single or “primary” outcome measure, which is favored by RCTs, is not practical.
Nutrition contradiction

» As nutrition science has evolved, public’s perception of what is “good for you” vs. “bad for you” has “flip-flopped”

» Countless resources spent satisfying the demand for the nutrition “villain” and “hero”

» Perpetuated by reductionist approach on single macro & micronutrients
The nutrition “villain” and “hero”

- Antioxidants
- Fiber
- Protein
- Probiotics
- Organic
- All natural

- Saturated fat
- Refined carbs
- Trans fat
- Salt
- Sugar
- GMO?
The new science of nutrition

» Nutrition has rapidly evolved from a simple, nutrient and reductionist approach, to a complex systems approach.

» "Nutrition science is (now) defined as the study of food systems, foods and drinks, and their nutrients and other constituents; and of their interactions within and between all relevant biological, social and environmental systems". The Giessen Declaration
Moving beyond the molecule: The “ecology” of nutrition

Goals in Nutrition Science 2015–2020

“Nutrition is a field in which the need for interdisciplinarity is particularly pronounced, given the pervasive influence of nutrition on humans, from physiological to social, global, and planetary levels, and its extensive relationships with other domains including economics, politics, and environmental science”
Evolving research agenda


» Interagency Committee on Human Nutrition Research, 2016

**TABLE 2** The key research priorities for 2016–2021 put forth by the ICHNR in the National Nutrition Research Roadmap

1. How can we better understand and define eating patterns to improve and sustain health?
   - Topic 1: How do we enhance our understanding of the role of nutrition in health promotion and disease prevention and treatment?
   - Topic 2: How do we enhance our understanding of individual differences in nutritional status and variability in response to diet?
   - Topic 3: How do we enhance population-level food- and nutrition-related health monitoring systems and their integration with other data systems to increase our ability to evaluate change in nutritional and health status, as well as in the food supply, composition, and consumption?

2. What can be done to help people choose healthy eating patterns?
   - Topic 1: How can we more effectively characterize the interactions among the demographic, behavioral, lifestyle, social, cultural, economic, occupational, and environmental factors that influence eating choices?
   - Topic 2: How do we develop, enhance, and evaluate interventions at multiple levels to improve and sustain healthy eating patterns?
   - Topic 3: How can we enhance innovations in measuring dietary exposure, including use of biomarkers?
   - Topic 2: How can basic biobehavioral science be applied to better understand eating behaviors?
   - Topic 3: How can we use behavioral economics theories and other social science innovations to improve eating patterns?
   - Topic 4: How can we advance nutritional sciences through the use of research innovations involving Big Data?

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Fleischhacker et al. *J Nutr* 2017;147:1833–8
Reduces complexity through revealing key interactions that influence the outcomes of interest...a systems approach can help to identify common causal factors underlying the otherwise seemingly opposite problems of malnutrition and obesity.
"...the obesity epidemic is a systems problem, as opposed to a simple problem with a linear cause-and-effect relationship."
• Evolution from linking health benefits to specific nutrients at specific doses, to understanding the broader landscape that impacts health
Understanding the “dietary landscape”
Evolving public health challenges

- Communicable disease
- Overt nutrient deficiency
- Rise of noncommunicable disease and obesity
- Rising population, aging
- Food security, sustainability
Evolving nutrition research focus

- Discovery of vitamins & minerals, eradicating overt nutrient deficiency
- Diet & chronic disease
- Bioactive substances
- Personalized nutrition, microbiome
- Behavior modification

Nutrition focus: Curing/preventing deficiency & chronic disease
Nutrition focus: Health maintenance & promotion

Nutrition continuum
Key learnings

» Nutrition science has evolved significantly over time (and will continue)
  – Scientific focus has narrowed (reductionism) and expanded (holism)

» Nutrition research has followed the trend of public health challenges in order to provide solutions

» Nutrition recommendations and policy must continue to evolve in parallel with advances in science and technology and public health challenges
Thank You!