Reversing the Rising Tide of Type 2 Diabetes in Nova Scotia with Therapeutic Nutrition

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June 2019
DISCLAIMER

- Received grant money for implementing a low carbohydrate diet for type 2 DM from the Valley Regional Foundation.
- Member of Canadian Clinicians for Therapeutic Nutrition
- Advisor for Institute for Personalized Therapeutic Nutrition
- Medical Director of the Valley Metabolic Program
- I have no conflicts of interest with pharmaceutical industry.
Objectives

- Review evidence of therapeutic nutrition for remission of Type 2 DM: Hope or Hype?
- Review safety and efficacy of low carbohydrate diets for Type 2 DM.
- Consider innovative and scalable interventions to implement therapeutic nutrition.
“People are fed by the food industry which pays no attention to health and are treated by the health industry which pays no attention to food.”

~Wendell Berry
Weight Bias & Weight Stigma

Obesity and type 2 diabetes are **SOCIAL** diseases that manifest in those that have a **GENETIC** (and epigenetic) predisposition.
Clinical Trials
Diet and Health

- What population are we talking about and what is the aim of the dietary intervention?

- Is there a metabolic advantage of low carbohydrate diets over low fat diets in different clinical situations?

- Is low carb or low fat even the right way of thinking about nutrition in the first place?
Macronutrient Composition

Meta-Analysis of Weight Loss (LCHF vs Low Fat)

Meta-analysis of energy expenditure (LCHF vs Low Fat)

Common Ground: Limit Ultra-Processed Foods

- 20 inpatients received ultra-processed diets for 14 days each
- Diets were matched for presented calories, sugar, fat, fiber, and macronutrients
- Ad libitum intake was ~500 kcal/day more on the ultra-processed versus unprocessed diet
- Body weight changes were highly correlated with diet differences in energy intake.

Type 2 Diabetes

- Diabetes traditionally has been considered a progressive incurable condition that needs more and more medication over time.
- By three years after diagnosis, 50% of patients will need more than one agent.
- By 9 years, 75% will need multiple therapies to achieve glycemic targets and perhaps the majority will require insulin therapy.


Diabetes Remission: hope or hype?
# Diabetes Remission

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Partial</td>
<td>A1c &lt; 6.5, fasting glucose 5.6 to 6.9 for at least one year in absence of medication</td>
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<tr>
<td>Complete</td>
<td>A1c &lt; 5.7; fasting glucose &lt; 5.6 mmol/L for one year duration in absence of medications</td>
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<tr>
<td>Prolonged</td>
<td>Complete remission &gt; 5 yrs (cure)</td>
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<tr>
<th>Alternate</th>
<th>Definition</th>
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<tr>
<td>Reversal</td>
<td>A1c &lt; 6.5 without medication beside metformin (Virta)</td>
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<tr>
<td>Remission</td>
<td>A1c &lt; 6.5 off all medications for at least 2 months (DiRECT)</td>
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Look AHEAD

- Randomized 5145 patients with obesity & T2D to ILI or Control
- Intensive Lifestyle Intervention utilizing meal replacement systems and healthy low fat diet (<30% fat) aiming for modest weight decrease.
  - Weekly group and individual counseling for 6 months
  - Then 3 sessions per month for 6 months
  - Then twice monthly for 4 yrs
  - Control arm with 3 group sessions per year
- Primary outcome was reduction in MACE
- Post hoc analysis looked at partial or complete remission of T2D defined as an A1c <6.5 without diabetes medications


Look AHEAD: Major Adverse Cardiac Events

Look AHEAD: T2D remission

Figure 2. Prevalence of Any Remission (Partial or Complete) by Intervention Condition and Year

Figure 3. Duration of Any Remission (Partial or Complete) by Intervention Group and Duration of Sustained Remission

http://doi.org/10.1001/jama.2012.67929
Look AHEAD: Weight loss

![Graph showing weight loss over years with comparison between control and intervention groups. The graph indicates a significant main effect with a decrease in weight over time, especially notable in the intervention group.](image_url)
The 7 year cumulative incidence of achieving any remission was 1.6% among >100,000 patients.

Conclusion: Type 2 DM remission using dietary guidelines from the ADA with a calorie restricted <30% dietary fat can happen, but it is very rare.

Highlights the difference between clinical efficacy (ideal circumstances in Look AHEAD) vs effectiveness (real world).

Could we do better with a different dietary strategy?
Type 2 Diabetes Remission with therapeutic nutrition – any hope?
Natural History of Diabetes Mellitus Type 2

Figure adapted from American Association of Clinical Endocrinologists website; modified by MMINDRUM to include dietary trials.
Beta – Cell Function

FIGURE 1. Model showing the relative contributions of the reversible and irreversible components of beta-cell dysfunction over the course of type 2 diabetes. The contribution of the reversible component is greatest early in the course of diabetes and declines over time.

Type 2 Diabetes Remission: Bariatric Surgery

- 75% remission in gastric bypass and 95% in the biliopancreatic diversion group while there was no remission in the medical arm.

- Detailed review of bariatric surgery and T2D beyond scope of today’s talk. Accessibility to bariatric surgery in NS is poor.

Type 2 DM Remission with Therapeutic Nutrition

- Low Energy Diets (DiRECT)
- Mediterranean
- Low Carbohydrate Diets (Virta)
Direct Trial

- Open label, cluster randomized trial, 49 primary care practices in Scotland & England
- Those that collected & analyzed data were blinded
- 149 intervention participants age 20 to 65, T2D < 6 yrs
- Intervention with ~850 kcal/day formula for 3 to 5 months followed be stepped food reintroduction over 2 to 8 weeks & structured supports for weight loss maintenance (monthly visits) & “rescue plan” of 2 to 4 weeks partial meal replacement if weight regain occurs.
- Withdrawal of medications for blood sugar and blood pressure medications
- Those on insulin were excluded
- Primary outcome at one year
  - Weight loss >15 kg
  - A1c < 6.5 for 2 months off all anti-diabetes medications

DiRECT Trial T2D Remission

Year 1: odds ratio 19.71 (95% CI 7.79–49.83; p<0.0001)
Year 2: odds ratio 25.82 (95% CI 8.25–80.84; p<0.0001)
DiRECT Trial: T2D remission & weight loss
Link Between Obesity, MetS, Type 2 DM

Personal fat threshold

- Increased adiposity with metabolic health
- Metabolic syndrome, pre-diabetes
- Type 2 diabetes

Please also see twin cycle hypothesis referenced in “extra slides”
Low Carb Mediterranean vs Low Fat

- Assess long term effects of a dietary intervention on glycemic control, diabetes medications and remission of T2D in NEWLY diagnosed patients.

- Two arm design randomized to low carb mediterranean diet (108) or low fat diet (107)

- LCMD resulted in greater reduction in A1c, higher rate of diabetes remission, and delayed need for medication than a low fat diet.

Intervention

• Restriction of energy intake to 1500 kcal/day women and 1800 kcal/day men

• LCMD rich in vegetables, whole grains, low in red meat (replaced with poultry and fish), no more than 50% calories from CHOs, and no less than 30% from fat (30 to 50 g olive oil a day)

• Low fat diet rich in whole grains, restricted fats and sweets, no more than 30% dietary fat and <10% from saturated fat

(Very) Liberal Low Carb Mediterranean

Substitute fish for red meat, whole grains for the sweet potato, and olive oil for butter

Modified photo: courtesy www.dietdoctor.com
Prevalence of Remission

A1c and Weight

CSIRO Trial

- 115 adults with T2D
- Mean age of 58, Average A1c of 7.3
- Randomized to energy matched hypo-caloric diets for 2 yrs.
- LCHF: 14% CHO, 28% protein, 58% fat (<10% saturated fat)
- LFHC (low GI): 53% CHO, 17% protein, 30% fat (<10% saturated fat)
- Outcomes: HgbA1c, Glycemic variability, Anti-glycaemic medication effects score (MES), Weight, CVD and renal risk markers

CSIRO Trial Low Carbohydrate Arm

Less red meat & more olive oil instead of butter to keep saturated fat similar to low fat diet

Photo courtesy of: dietdoctor.com
Weight loss same between groups as expected (energy matched)

FIGURE 2   Estimated marginal mean change in body-weight after 2 years on a low-carbohydrate, high-unsaturated fat/low-saturated fat diet (LC) or a high-carbohydrate, low-fat diet (HC). Error bars represent 95% CIs. Differences between groups were not significant by linear mixed-effects model analysis (P = 0.26)
A1c Reduction

![Graph showing A1c reduction over months with LC and HC diets.](image)

- **HbA1c (%)**
  - 0 months: 8.0
  - 6 months: 7.5
  - 12 months: 7.0
  - 24 months: 6.5

- **Months**
  - 0
  - 6
  - 12
  - 24

- **LC Diet** (solid squares)
- **HC Diet** (open circles)

- **P = 0.52**
Medication Reduction

(B) MES (units)

- LC Diet
- HC Diet

P = 0.03

Months

0 6 12 24
Glycemic Variability
Conclusions

- After 2 yrs, an isocaloric LCHF achieved comparable reduction in A1c, body weight, and blood pressure.

- LCHF maintained greater improvements in lipid profile and glycemic variability

- LCHF led to greater reductions in medication burden.

- Support long term safety, clinical efficacy and potential therapeutic role of the LC in long term T2D management.
An ideal approach improves glycemic variability

<table>
<thead>
<tr>
<th>A1C %</th>
<th>CV %</th>
<th>% TI Hypo &lt;70</th>
<th>% TIR 70-180</th>
<th>Therapy</th>
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<tbody>
<tr>
<td>6.7</td>
<td>26</td>
<td>1 (14 min)</td>
<td>83</td>
<td></td>
</tr>
<tr>
<td>6.7</td>
<td>42</td>
<td>6 (86 min)</td>
<td>69</td>
<td></td>
</tr>
<tr>
<td>6.7</td>
<td>53</td>
<td>9 (130 min)</td>
<td>51</td>
<td></td>
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</table>

Courtesy of Dr. Richard Burgenstal’s lecture, Diabetes Canada Conference 2018
Virta Health Study

- Open label, non randomized, before and after 1 yr study of continuous care intervention versus usual care.

- Utilized a ketogenic diet for patients with Type 2 DM along with remote monitoring and virtual care

- Primary Outcomes: A1c, weight, and medication use

- 349 adults enrolled, n = 262 in the CCI group.

- Mean age  = 54 (52 in control),

- Mean Duration of T2D was 8 yrs

- Mean weight = 116.5 kg (105.6 in control)

- BMI = 40.4 (36.7 in control)

Virta Dietary Intervention

Ketogenic 0-20
Moderate 20-50
Liberal 50-100
Virta 1 yr Results:
A1c reduction from 7.6 to 6.3

Average Weight Loss of 12% (~14kg)

Figure 2. Body weight change over the course of one year in CCI completers.

(a) Mean (95% CI) change in body weight for completers over the course of one year. For each individual, weight on a given day was computed as the 3-day trailing mean (to reduce day-to-day variation). On dates where no weights were recorded during the 3-day time window for a given participant, the most recent 3-day mean preceding the date was used.

A1c Decreased by 1.3% while eliminating 60% of non-metformin medications

Usual Care: A1c unchanged & 7% increase in medications

Hallberg, S. et al. (2018). Effectiveness and Safety of a Novel Care Model for the Management of Type 2 Diabetes at 1 Year: An Open-Label, Non-Randomized, Controlled Study. *Diabetes Therapy: Research, Treatment and Education of Diabetes and Related Disorders, 9*(2), 583–612.
Cardiovascular disease risk factor responses to a type 2 diabetes care model including nutritional ketosis induced by sustained carbohydrate restriction at 1 year: an open label, non-randomized, controlled study. *Cardiovascular Diabetology*, 1–16.
Lower risk

Large LDL (Pattern A)

2.2 mmol/L

Higher risk

Small LDL (Pattern B)

2 mmol/L

LDL Cholesterol Balance

DISCORDANCE

adapted from
Virta Conclusions

- At 1 yr: 72% achieved A1c < 6.5 and 60% achieved T2D reversal (A1c < 6.5 off all meds except metformin)
- Marked improvement in cardiovascular risk markers
- Significant decrease in medication burden
- Scalable technology
- 2 yr preliminary pre-print results – reversal rate maintained at 53%
Virta Critique

- Authors of study are work for Virta, a for-profit company.
- Lack of randomization leading to selection bias & regression to the mean.
- Patients know they are being followed (performance bias).
- Statistical analysis sub-optimal with “before and after” within group T-tests. Why not measure difference between treatment arm and control?
- Tough to tease out factors that led to success: patient selection, virtual care technology, or diet?
- Hard to compare apples and oranges: what was the diabetes “reversal rate” in Look AHEAD (where metformin excluded for consideration of partial or complete remission)?
- Nevertheless, still remarkable results that challenges the paradigm that T2D is a chronic progressive disease that needs more medication over time.
- Will durability of remission stand up over 5 to 8 yrs? Will weight maintenance be achieved? What is the natural history of beta-cell function?
Therapeutic Nutrition and Type 2 Diabetes Remission

- Metabolic health
- Metabolic syndrome, pre-diabetes
- Type 2 diabetes

Liberal low carb (100 to 130 g)
Low fat/low calorie

Moderate Low carb (50 to 100g)
Low fat/lower calorie

Very Low carb/Ketogenic
Very low calorie
Digitally Delivered Liberal Low Carbohydrate Diet for T2D Self-Management

- 1000 study participants randomly selected from 100,000 clients over 1 yr.
- 67% completed 40% of the lessons
- 52% completed all lessons
- ~50% of patients lost 5% of body weight
- Participants starting with A1c >7.5% who engaged in 10 weekly modules reduced HgbA1c from 9.2 to 7.1%
- 26% achieved “reversal” of A1c < 6.5 +/- metformin

Guidelines with regards to Low Carbohydrate Diets

- 2018: ADA and EASD approved use of low carbohydrate diets as medical nutrition therapy for adults with type 2 diabetes.

- 2019: ADA states that “a low carbohydrate diet may result in lower glucose levels, reduce need for medications, and is effective for weight loss.”

- Guidelines in the UK and Australia are also inclusive of carbohydrate restriction.

- The UK and ADA recognize remission as an appropriate aim for type 2 DM management.

- Diabetes Canada
  - Macronutrient distribution is flexible within recommended ranges and will depend on individual treatment goals and preferences.
  - Unfortunately Diabetes Canada did not include LCHF it is summary statement to acknowledge it as a formally recognized pattern of eating for T2D.

†Dietary patterns include Mediterranean, vegetarian, DASH, Portfolio, and Nordic dietary patterns, as well as diets emphasizing specific foods (i.e., dietary pulses, fruit and vegetables, nuts, whole grains and dairy products) which have evidence of benefit for people with diabetes.

Key Points

- T2D remission is possible with low calorie diet (DiRECT) or low carbohydrate diets (very low carbohydrate diets may be more effective).
- LCHF is at least non-inferior and likely superior to other dietary strategies for the treatment of T2D.
- Utilizing therapeutic nutrition earlier in the disease may lead to higher rates of remission.
- Weight maintenance after diabetes remission achieved increases chance of durable remission.
- Scalable technologies are emerging to deliver broad scale interventions.
Valley Metabolic Pilot Project

- Aimed to create a medically supervised intervention with a ketogenic diet for patients with Type 2 DM

- Working group
  - Becca Green-LaPiere (MSc, PDt)
  - Ciara Stevens (RN)
  - Christa Mindrum (MD, CCFP)
  - Dr. Joelle Caplan, PhD, clinical psychology
  - Michael Mindrum, MD, FRCPC
  - Mardi Burton. M.Ed, BsC.OT Health Services Manager/Coordinator Chronic Disease Management

- Created a “Guide” and an outline of what to cover during group sessions.

- Supported by a grant from the Valley Regional Foundation

- Information session offered to ~12 family physicians about the intervention

- Referrals received over 3 weeks.
VMP Inclusion Criteria

- Type 2 DM
- Age > 18 and < 75
- BP < 150/90
- Overweight/Obese
- CrCl or eGFR >45
- No history of stroke or MI within the past 6 months
- Able to engage in group meetings and navigate online resources
VMP Participants

- 38 patients enrolled
- 1 excluded at onset due to lack of capacity to engage
- 1 excluded during intervention due to LADA (auto-immune T2D)
- 5 patients dropped out during intervention
  - GI intolerance
  - Psychosocial stressors too high
  - Other health issues
  - Left province
  - No reason offered (lost to follow up)
- 86% completion rate at 3 mos (dietary adherence was not formally assessed). 6 month completion rate data pending.
VMP Participants Baseline Data

- Age 60
- Duration of DM was 12 years
- Baseline weight 235 lbs
- 11 of 31 patients were on insulin (average duration 10 yrs)
- 22% with macrovascular disease, 29% with nephropathy, 12% neuropathy, 6% smokers
- A1c of 7.6
- BP 139/78
Valley Metabolic Program Pilot Cohort

- Medical Consultation and close medical supervision
- Participants taught a VLCHF diet over 12 weeks and then encouraged to continue LCHF afterward.
- 3 hr “Information Night” then enrollment
- Valley Metabolic Guide Book
- 4 Group sessions at 2, 4, 8, 12 weeks
- Grocery store tours
- Health professional monitored FB page
Information Night: Patient Education

[Diagram showing Blood Insulin levels over time, with peaks labeled Carbohydrate and Protein, and a lower level for Fat.]
T2D: model of carbohydrate intolerance

- Eat carbs over tolerance
- Need even more insulin
- Release more insulin
- Less sensitive to insulin

Insulin Resistance
Dr. Jason Fung; https://idmprogram.com/obesity-solving-the-two-compartment-problem/
Nutritional ketosis
Metabolic Guide with FOOD LISTS

Foods to Limit

Foods in Moderation

Foods Allowed
NET carbohydrates =
Total carbs (6g)
less fibre: (0g)
6g NET carbs in ¾ cup
Protein = 16g
Fat = 3.5g
Intake and Expenditure
Across Four Diet Phases

Daily caloric intakes and expenditure for a 5’6” woman going from 180 to 140 lbs with a well-formulated ketogenic diet. Assumes 30 kcal/kg before and 32 kcal/kg after weight loss.
Insulin de-prescribing
SAFETY FIRST

• Long acting insulins (NPH, Humulin N, Lantus, Basaglar, Toujeo)
  • Day -1
    • Blood glucose <11: reduce by 50%
    • Blood glucose <16: reduce by 25%
    • Blood glucose >16: same dose
  • EACH DAY for the first week (adjustments after first 1 to 2 weeks slow down)
    • Blood glucose < 10: decrease by 50%
    • Blood glucose <7: decrease by 75%
    • Blood glucose <5: hold or discontinue
• Short acting Insulin
  • Day -1
    • Stop all short acting insulin
    • Consider calculating an ISF (100/new TDD) to correct to glucose of 7 to 10.
  • Goal blood sugar 7 to 10 during insulin de-escalation. Increment of insulin reduction decreases over time.
Sulfonylureas

- Gliclazide, Glimeperide, Glyburide
- Day -1 changes
  - Discontinue if blood glucose <10 or A1c <8.
  - Reduce by 50% if BG is 10 to 16, or A1c of 8 to 10.
  - Continue same dose if BG > 16 or A1c >10
- After day 1
  - Reduce dose by 50% once glucose <10
  - Discontinue when glucose < 7
SGLT-2 Inhibitors

- Dapagliflozin (Forxiga), Canagliflozin (Invokana), Empagliflozin (Jardiance)
- Diabetes Canada recommends for patient w/ established CVD not at A1c goal on metformin.
- They cause glycosuria (urinate glucose)
- Shift balance of insulin/glucagon & in setting of LCHF there is a risk of euglycemic diabetic ketoacidosis.
- **Stop the drug 3 days prior to starting a ketogenic diet.**
GLP-1 agonists

- Liraglutide (Victoza), Dulaglutide (Trulicity), Semaglutide (Ozempic)
- Injectable therapies
- Diabetes Canada recommends for CVD when not at goal on metformin
- No risk of lows and very effective at weight loss
- Useful adjuncts to LCHF & sometimes added to assist insulin de-escalation
Valley Metabolic Program
6 month Results

Unpublished data analysis courtesy of
Dr. Jonathon Little (PhD), and Helena Neudorf PhD(c)
University of British Columbia
Weight Change at 6 mos
HgbA1c at 6 months
Medication Adjustments

- Metformin
- DPP-4
- GLP-1
- Long-Acting Insulin
- Short-Acting Insulin
- Insulin Sulfonylurea

Count

- New
- Increased
- No Change
- Decreased
- Eliminated
Long Acting Insulin Adjustment
Short Acting Insulin
Changes at 6 months

- Hemoglobin A1c
- Waist Circumference
- Body Mass Index
- Systolic Blood Pressure
- Diastolic Blood Pressure
- Total Cholesterol
- LDL-C
- HDL-C
- Triglycerides
- WBC

Percent Change (%)
A1c < 6.5 without medication (excluding metformin)
Key Points

• DiRECT trial and Virta Study challenge concept of diabetes as a chronic progressive disease

• Remission is possible and can be durable over two years. How about long term?

• Improved glycemic control with less medications is very feasible.

• Local clinical experience indicates similar rates of success can be obtained in the real world at low cost up to 6 months duration.
T2D management with therapeutic carbohydrate restriction: don’t forget the other guidelines

Vascular Protection

- Smoking Cessation
  - Often stop or decrease diuretics at start of diet
- Blood Pressure Control
  - Reduce dosing if SBP <120 & hold if SBP <110, *Increase salt intake
- ACE/ARBs
- Glycemic Control
  - Relax glycemic control for de-prescribing hypoglycemic agents
- Statins based on guideline targets
  - Optimize metformin, consider GLP-1 agonists
- Diet, Exercise, and Weight loss
Vision for a Brighter Future

- Political will needed to reduce exposure to processed foods. Prevention of chronic disease is the most effective treatment. We need to change our food environment and our food culture.

- Protect our children – OUR KIDS ARE NOT ALLRIGHT – see Heart & Stroke Foundation Campaign, check out the UpLift Program, support bill S-228.

- Increase structural supports for obesity and metabolic disease along with access to bariatric surgery. Be aware of weight bias and stigma. Let’s do something about it. Support Strides for Obesity.

- Funding needed for a multi-disciplinary team(s) to work with an integrated EMR that serves the patient longitudinally over not just months but years to assist patients achieve diabetes remission, diabetes reversal, or improve their metabolic disease with less drugs. Makes sense in a single payer system!

- Consider IT platforms and Virtual Clinics connecting resources across Nova Scotia to patients across Nova Scotia. Maximize use of wearable technology and interfaces to enhance remote monitoring, behavioral change, efficacy, and safety of therapeutic nutrition.

- Increase knowledge and competency in therapeutic nutrition.

- Eagerly await update from Diabetes Canada nutrition review.
How to contact me:

- **Email:** michael.mindrum@nshealth.ca
- **Twitter:** @MichaelMindrum

Acknowledgements:
- Patients and clinical experience are the best of teachers.
- Mentors from afar on twitter.
- CCTN & IPTN
- Local medical community (family physicians, dietitians, RNs, psychologist)
Extra Slides
“We believe it is implausible that each age, sex and ethnic group, with massive differences in life experience and attitudes, had a simultaneous decline in willpower related to healthy nutrition or exercise.”

Diabetes prevalence

Crude Diabetes Prevalence (%) for the Population Aged 20+ (Male and Female) in NS by Age Group and Sex, 2016/17

Graph showing diabetes prevalence by age group and sex.
Recommended Reading
Understanding Obesity & Bias

THE HUNGRY BRAIN
Outsmarting the Instincts that Make Us Overeat
Stephan J. Guyenet, Ph.D.
Illustrations by Shizuka N. Aoki

“One person stands out as completely altering my understanding of why we get fat. That person is Stephan Guyenet.”
—ROBB WOLF, New York Times bestselling author of THE PALEO SOLUTION

THINKING, FAST AND SLOW
Daniel Kahneman

Winner of the Nobel Prize in Economics

“(A) masterpiece... This is one of the greatest and most engaging collections of insights into the human mind I have read.”
—WILLIAM GUTHERIE, Financial Times
ACCESS TO SPECIALISTS AND INTERDISCIPLINARY TEAMS FOR BEHAVIOURAL INTERVENTION

**Facts:**

- Limited number of Canadian physicians are pursuing formal training in obesity management.
- Medical schools do not routinely include obesity in their curricula.
- There is a profound lack of interdisciplinary teams for obesity management.
- 40 Canadian physicians have completed certification through the American Board of Obesity Medicine.

**Conclusion:** There is a dire need for capacity building among health professionals.

Number of ABOM-Certified Physicians in Canada (2012–2016)
Bariatric surgery is available to only **one in 183** (or **0.54%**) of adult Canadians per year who may be eligible for it.
Physiologic Models


Figure 2: 12-month weight change for each participant
Perhaps a better quality RCT will show a metabolic advantage?

Ketogenic Diets lead to improved metabolism

Critical Appraisal of Ebbeling et al paper by Kevin Hall (BMJ 2018; 363:k4583)

No Significant Effect of Dietary Carbohydrate versus Fat on the Reduction in Total Energy Expenditure During Maintenance of Lost Weight

- To understand this study you probably need a Ph.D. in metabolism, statistics, and nuclear physics.
- Definitely need to understand how doubly labeled water works.
- Need to be as free as possible from cognitive bias.
- Dr. Kevin Hall does not believe that ketogenic diets lead to increased energy expenditure (and I believe him). Why?
  - Who has the knowledge and skills to assess the research?
  - Who is the most free of cognitive bias?
  - "Science is the belief in the ignorance of experts", Dr. Richard Feynman
Total Daily Energy Intake in Canadian Population 2 years and Over

The kids are not alright.

How the food and beverage industry is marketing our children and youth to death.


Heart&Stroke
http://doi.org/10.1016/j.tem.2018.03.018