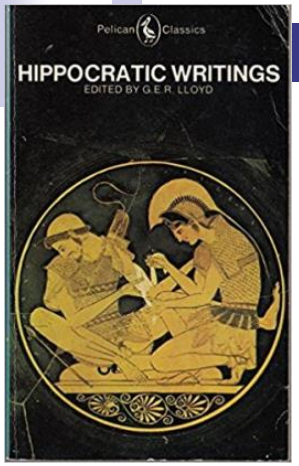
Pitfalls in nutritional assessment in sick or critically ill paediatric patients

Konstantinos Gerasimidis (PhD)

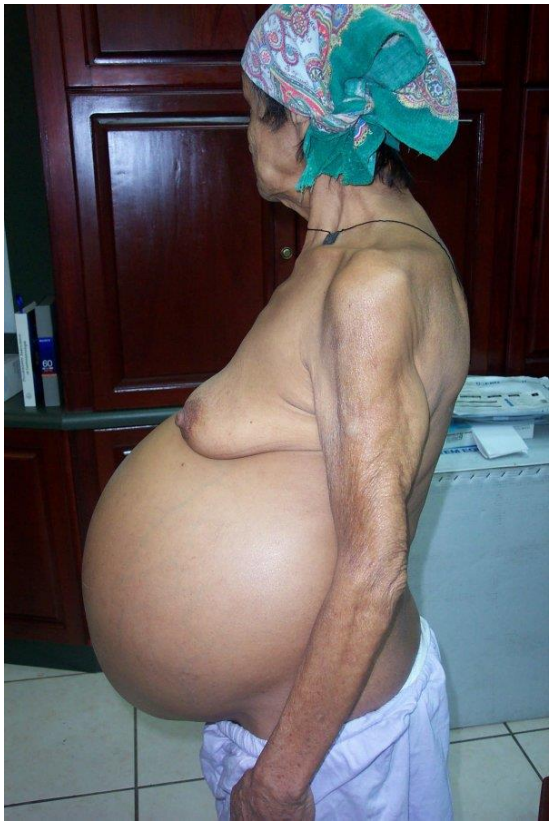
Senior Lecturer in Clinical Nutrition-Dietitian

CoI: Speaker fees, consultancy, travel & research grants, from Nestle and Nutricia



Malnutrition is not new!

"The flesh is consumed, the abdomen fills with water. The shoulders, clavicles, chest, and thighs, melt away. This illness is fatal."



Hippocrates (460 BC)

Malnutrition Matters

Meeting Quality Standards in Nutritional Care

Ailsa Brotherton, Nicola Simmonds
and Mike Stroud
on behalf of the BAPEN Quality Group

2,500 years later….

BAPEN
Advancing Clinical Nutrition

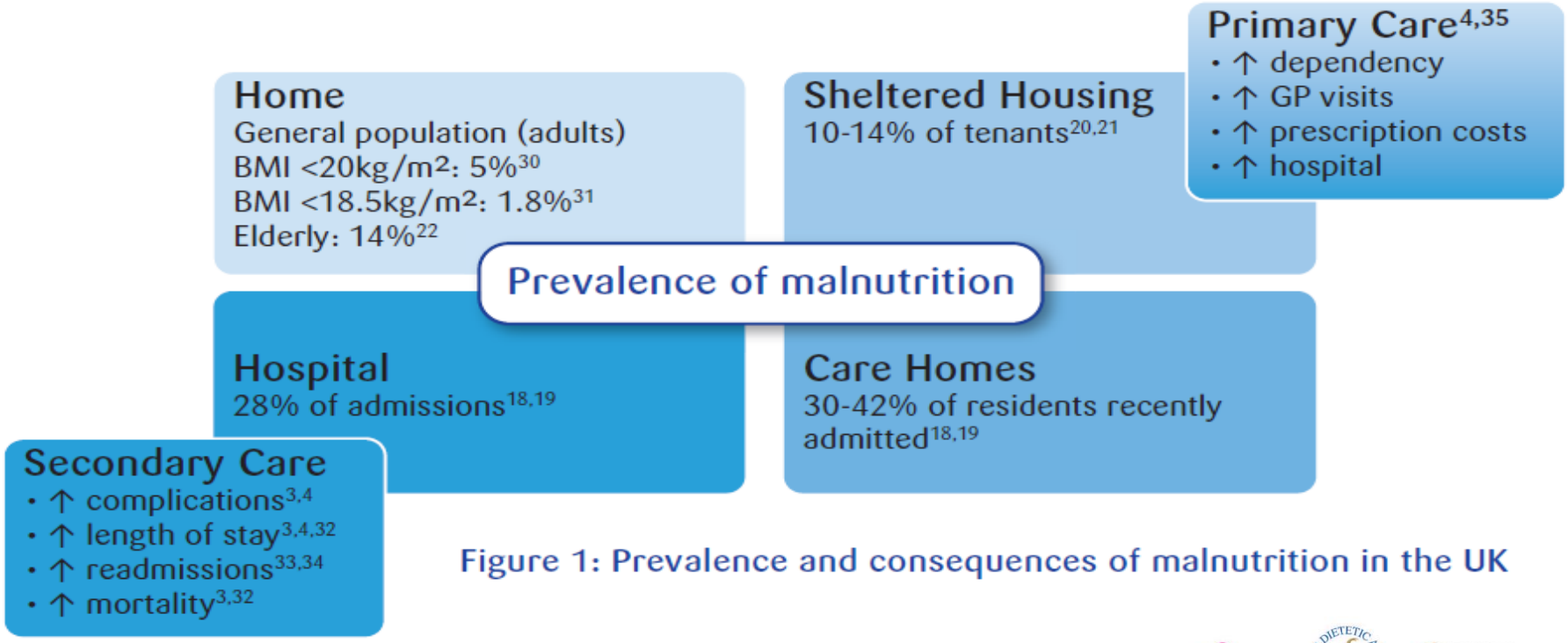


Figure 1: Prevalence and consequences of malnutrition in the UK

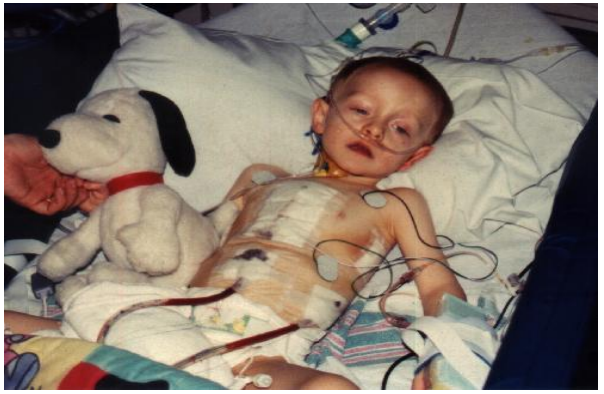
https://www.bapen.org.uk/pdfs/toolkit-for-commissioners.pdf

Which type of malnutrition?

Starvation-Associated Malnutrition

- Food security is **the** major cause
  - Low food availability & access
  - Unequal food provision
  - Poor hygiene
  - Inflammation secondary effect

Disease-Associated Malnutrition



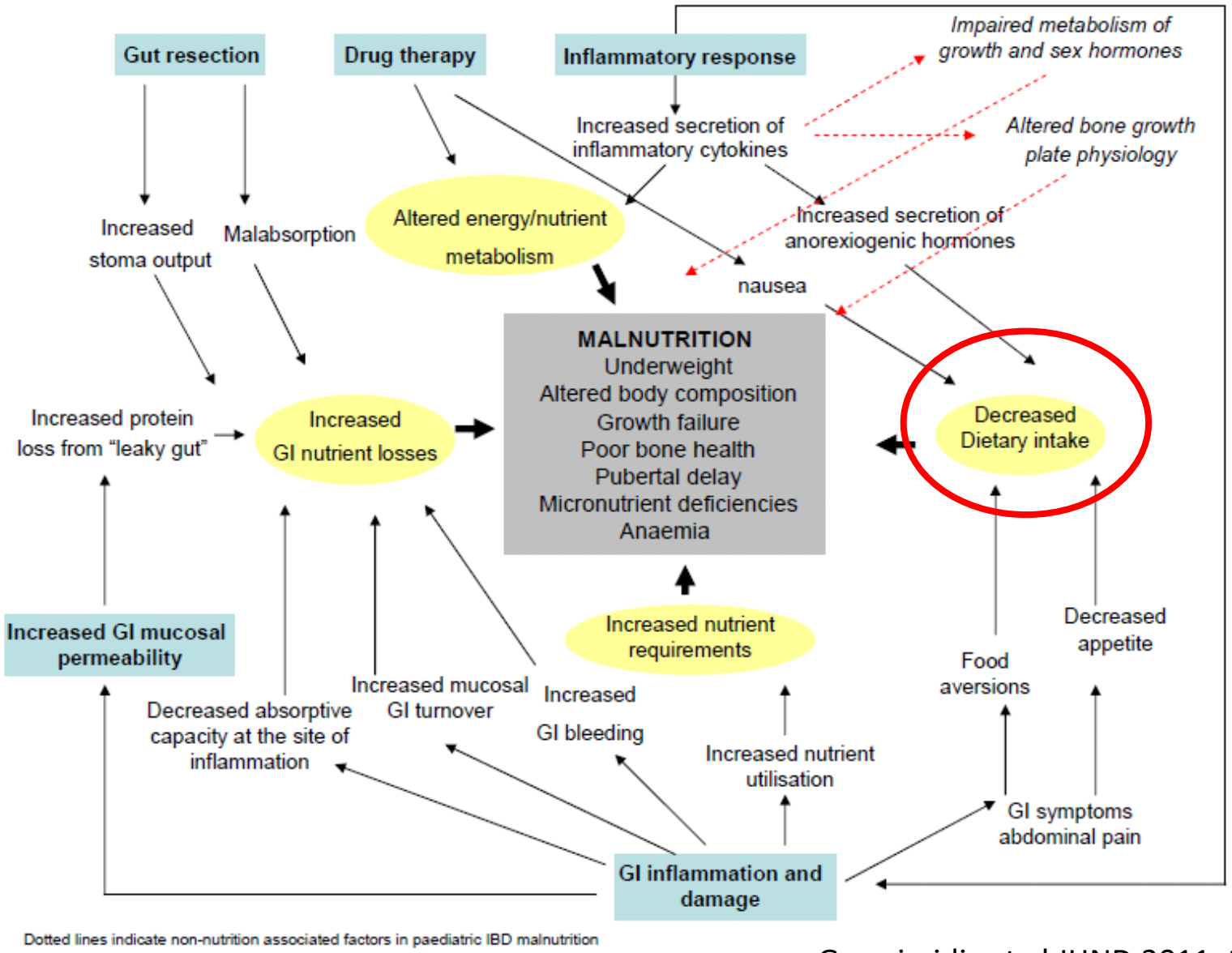
•Food security **not** a major issue

The impact of disease on:

- Appetite & food intake
- Energy/nutrient requirements
- Absorption/losses
- Inflammation primary effect

Jensen et al, JPEN 2010 156-159

Malnutrition in Inflammatory Bowel Disease

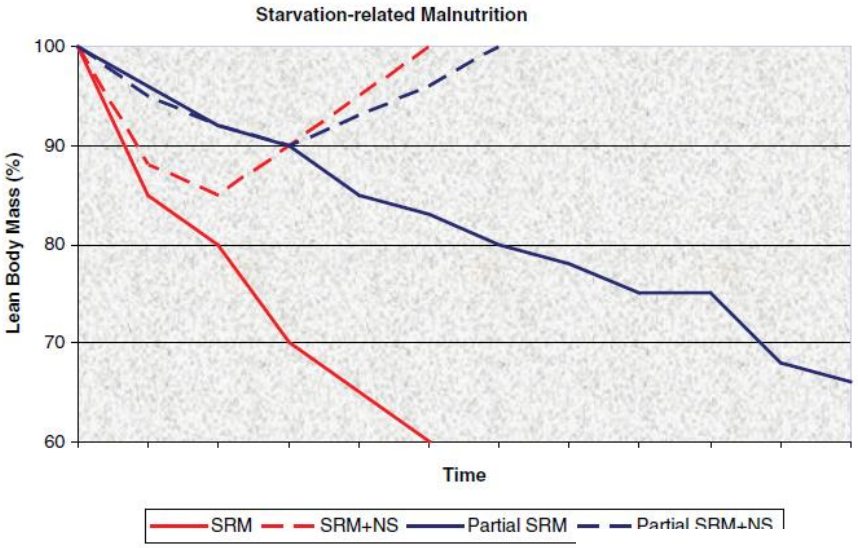


Gerasimidis et al JHND 2011; 24: 313-26

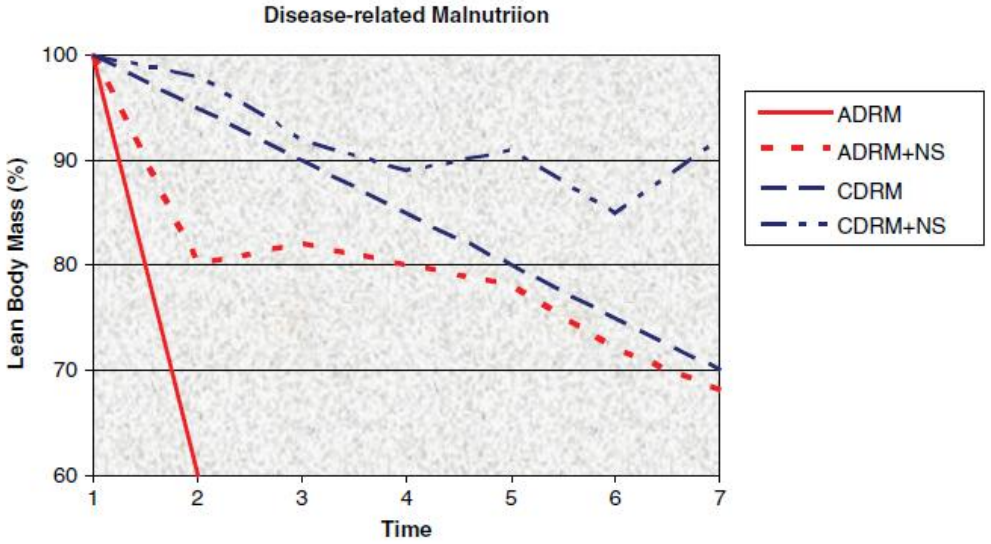
Adult Starvation and Disease-Related Malnutrition : A Proposal for Etiology-Based Diagnosis in the Clinical Practice Setting From the International Consensus Guideline Committee

Gordon L. Jensen, Jay Mirtallo, Charlene Compher, Rupinder Dhaliwal, Alastair Forbes, Rafael Figueredo Grijalba, Gil Hardy, Jens Kondrup, Demetre Labadarios, Ibolya Nyulasi, Juan Carlos Castillo Pineda and Dan Waitzberg

JPEN J Parenter Enteral Nutr 2010 34: 156
DOI: 10.1177/0148607110361910



Which one to prevent and treat does matter



Suboptimal anthropometry at hospital admission

Prevalence of malnutrition and demographic aspects ($n = 2410$).

	Underweight[a] n (%)	p[b]	Stunting[c] n (%)	Sum n (%)
Total group	167 (7%)		193 (7.9%)	322 (13.4%)
Moderate (−2 to −3 SDS)	120 (5%)		133 (5.5%)	241 (10.0%)
Severe (<−3 SDS)	47 (2%)		60 (2.5%)	97 (4.4%)
Age groups				
31 days–0.9 years	49 (10.8%)	<0.001	44 (9.7%)	79 (17.4%)
1–1.9 years	24 (8.3%)		31 (10.7%)	49 (17.0%)
2–5.9 years	24 (4.1%)		52 (8.8%)	73 (12.4%)
6–12.9 years	45 (6.9%)		42 (6.4%)	81 (12.4%)
13–17.9 years	25 (5.8%)		24 (5.6%)	40 (9.3%)
Sex				
Female	67 (6.1%)	0.188	81 (7.4%)	136 (12.5%)
Male	100 (7.6%)		112 (8.5%)	186 (14.1%)
Ethnic background				
Caucasian	142 (6.5%)	0.005	164 (7.4%)	280 (12.7%)
Non-caucasian	25 (11.8%)		29 (13.7%)	42 (19.9%)
Admission				
Acute	100 (7.9%)	0.038	103 (7.6%)	184 (13.7%)
Elective	67 (5.7%)		90 (8.3%)	138 (12.9%)
Chronic disease				
Yes	99 (9.2%)	<0.001	123 (11.4%)	195 (18.1%)
No	68 (5.1%)		70 (5.3%)	127 (9.6%)
Ward				
Surgical	33 (7.1%)	0.897	33 (7.1%)	59 (12.7%)
General	134 (6.9%)		160 (8.9%)	263 (13.5%)

[a] Defined as body mass index <−2 standard deviation scores (SDS).
[b] Chi^2-test; comparison between the malnourished and not malnourished patients.
[c] Defined as height/length for age <−2 SDS.

Hecht et al Clin Nutr 2015; 34: 53-9

How to assess nutrition in routine clinical practice and which are the pitfalls?

Malnutrition is not simply a measurement of anthropometry

*"**Undernutrition is a condition resulting from imbalanced nutrition** which causes clinically meaningful adverse effects on tissue function, body size/composition with subsequent impact on health outcomes"*

Hulst *et al* (ESPGHAN Clin Malnutrition SIG)

Condition resulting from imbalanced nutrition

MALNUTRITION

↑Requirements

↑ Losses

↑↓Metabolism

↓Intake

Causes

Prolonged deficits in energy/nutrients

Condition resulting from imbalanced nutrition

MALNUTRITION

Clinical Insult

Loss of normal body function

Changes in body size/shape/composition

Short-term consequences

Medium-term consequences

Impact on clinical outcomes

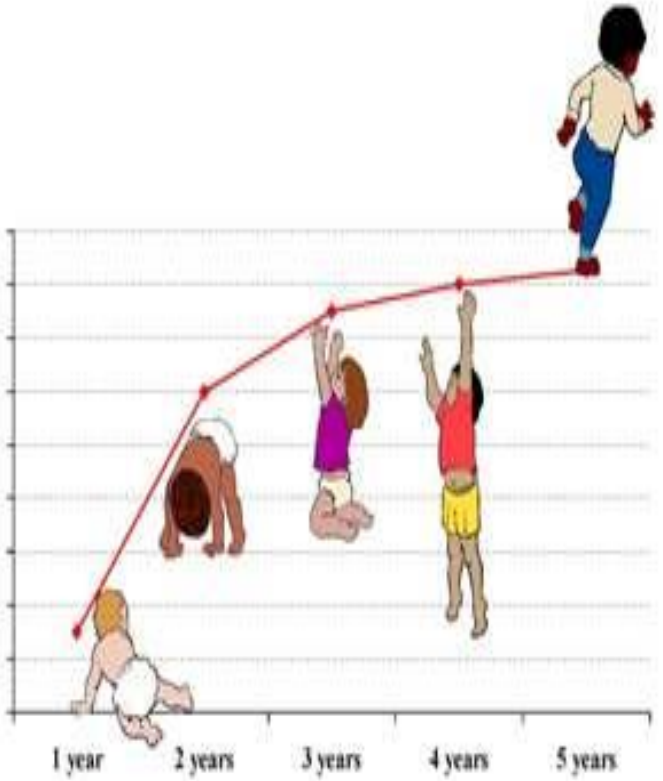
Long-term consequences

Mainstream approaches to assess nutritional status

- Anthropometric measurements
- Biochemical measurements
- Clinical examination (“eyeballing”)
- Dietary intake
- Environment

Anthropometry & growth charts

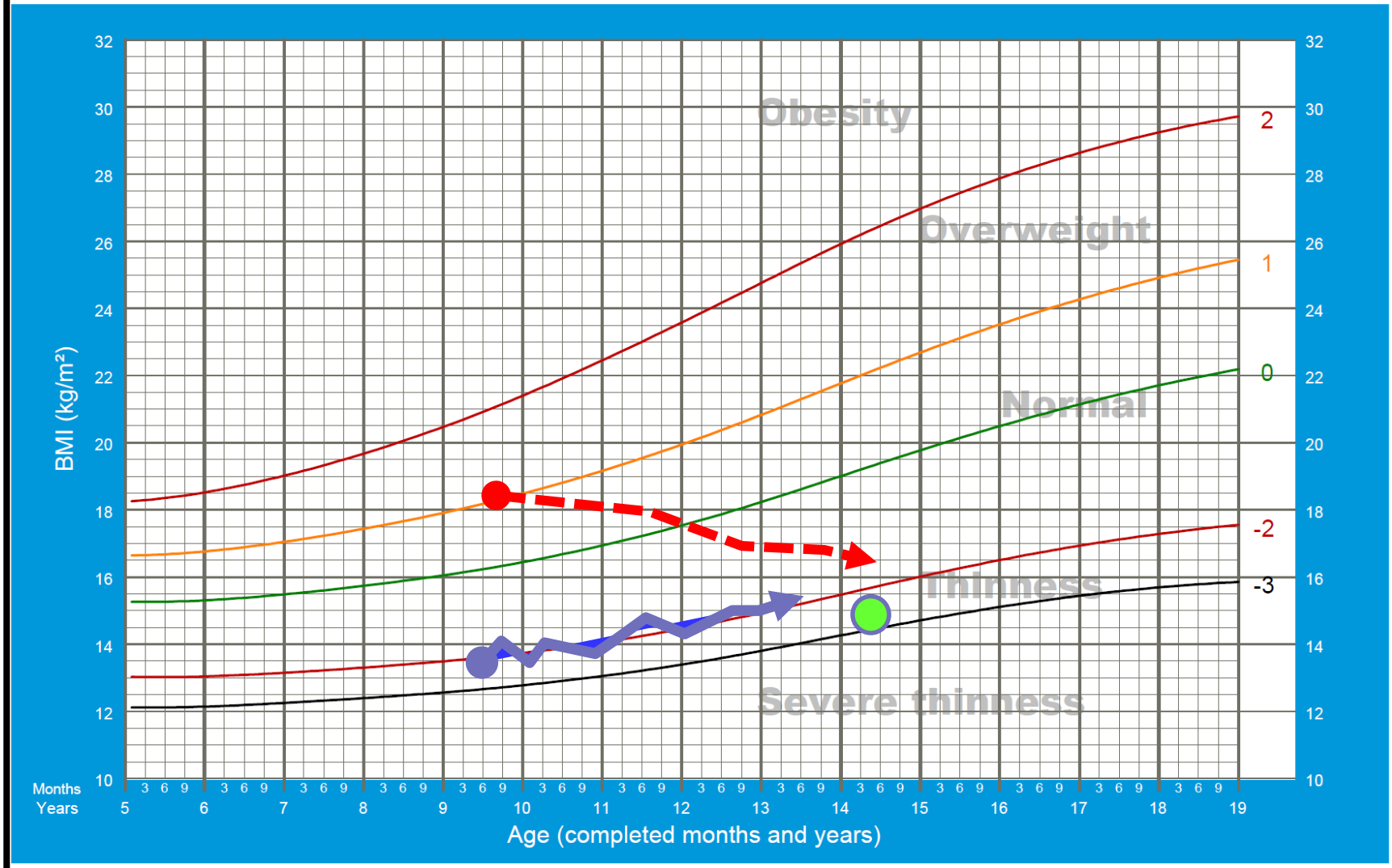
- The minimum and foremost minimum screening method
- Serial measurements more informative than a single/spot measurements
- Interpretation of patterns is important



BMI-for-age BOYS

5 to 19 years (z-scores)

World Health Organization



2007 WHO Reference

Opportunistic measurements of weight and height on admission

Milani et al JHND 2013; 26:294-7

Acta Pædiatrica ISSN 0803-5253

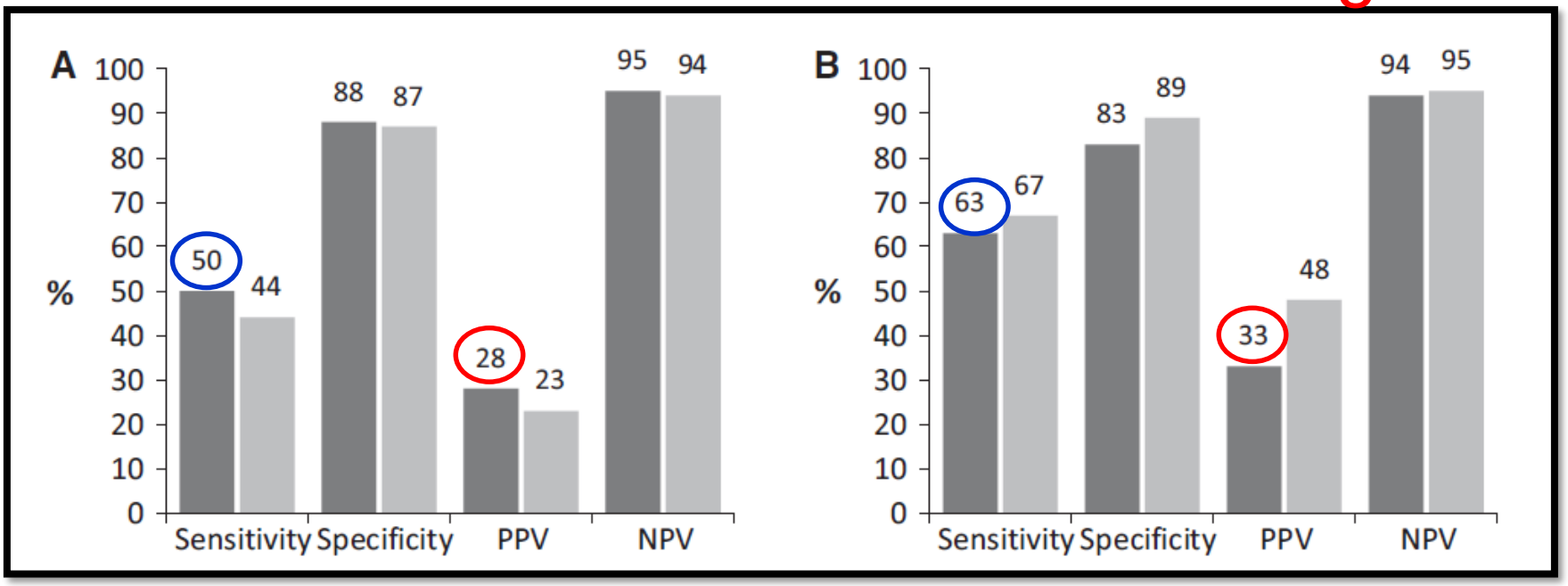
SHORT COMMUNICATION

Visual inspection is not a substitute for anthropometry in screening for nutritional status and growth in sick children

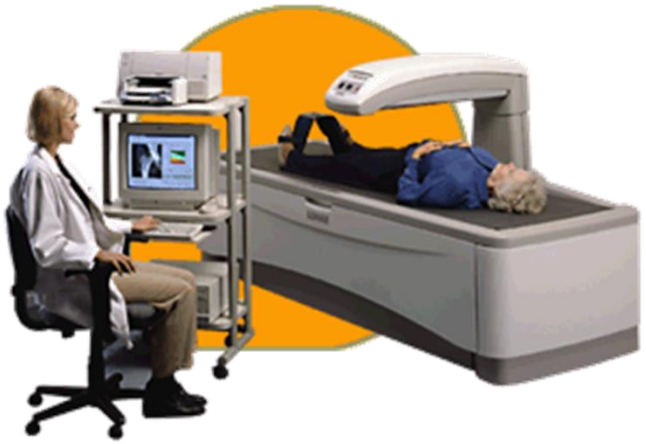
Jennifer McKechnie, Konstantinos Gerasimidis (konstantinos.gerasimidis@glasgow.ac.uk)
Human Nutrition, School of Medicine, College of Medicine, Veterinary and Life Sciences, Glasgow Royal Infirmary, University of Glasgow, Glasgow, UK

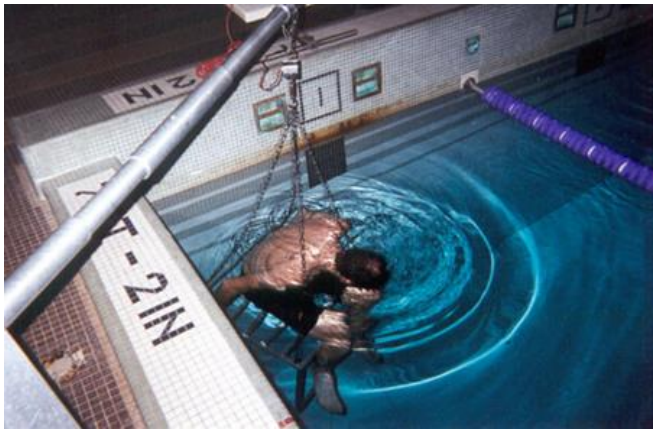
Short

Underweight

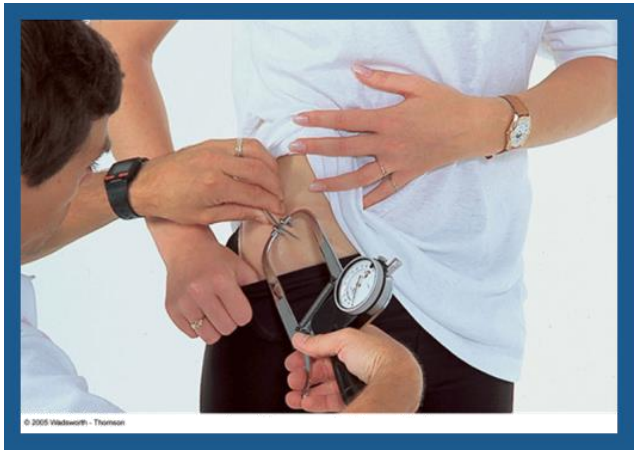


McKechnie & Gerasimidis 2015 Acta Paed Aug;104(8):e375-7

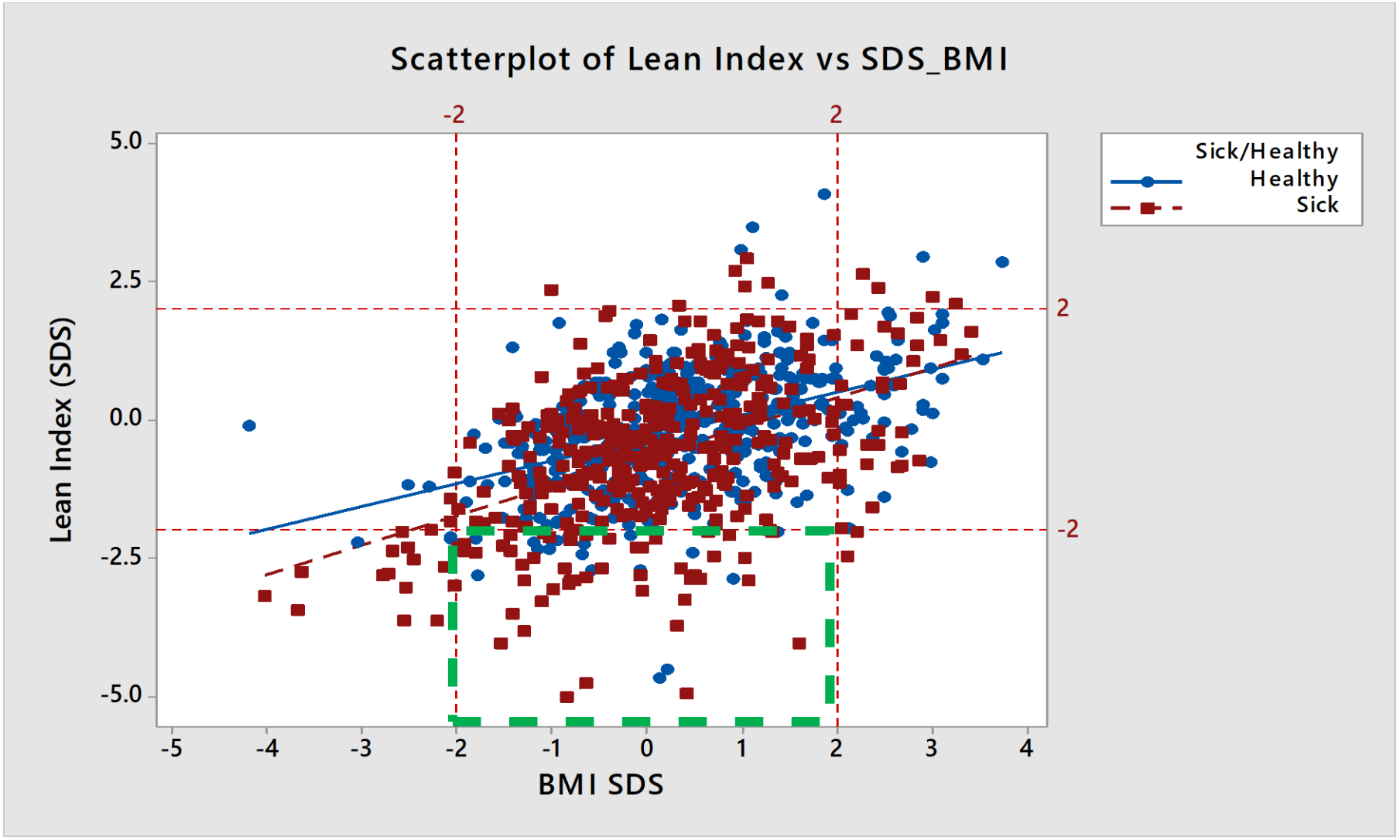




© 2006 Wadsworth - Thomson



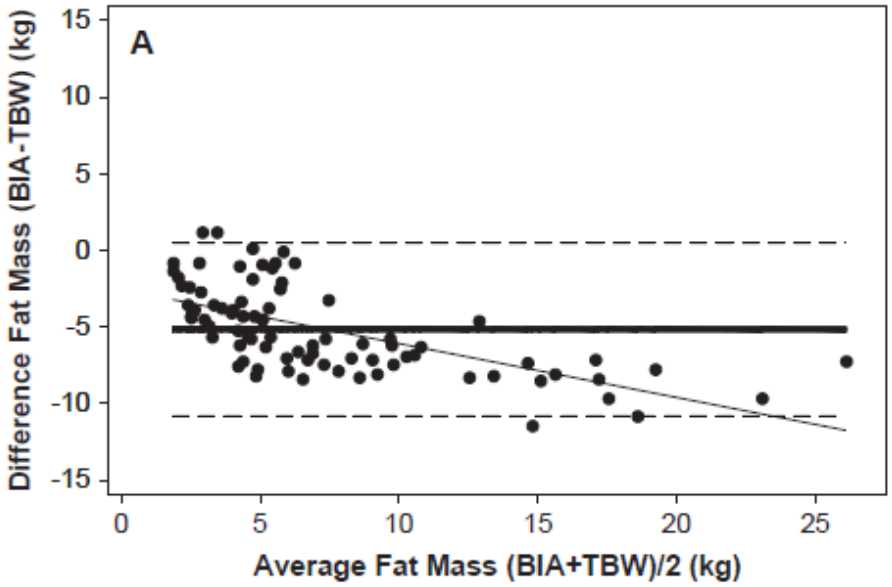
Set-up shown is typical of ImpediMed devices intended for estimation of whole body composition

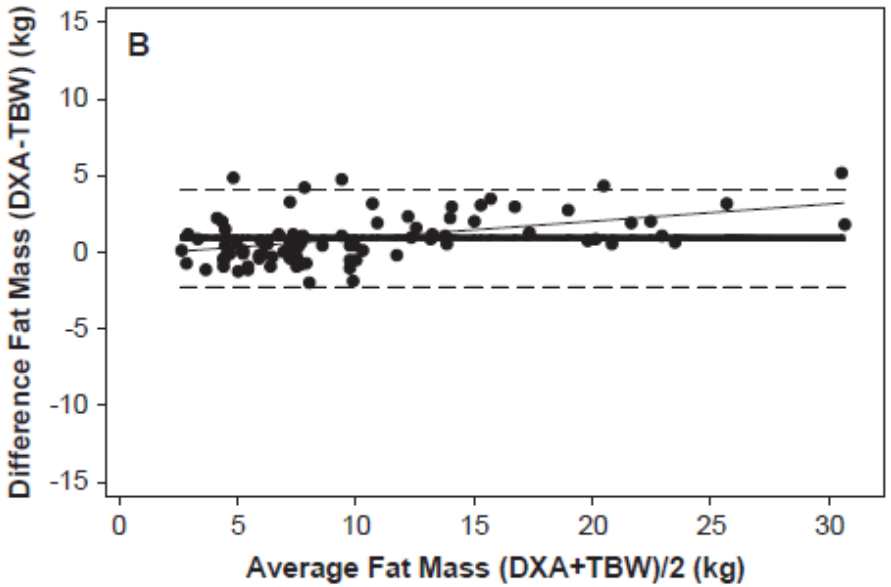

Scatterplot of Lean Index vs SDS_BMI
-2
2
5.0
2.5
0.0
-2.5
-5.0
Lean Index (SDS)
2
-2
-5
-4
-3
-2
-1
0
1
2
3
4
BMI SDS
Sick/Healthy
Healthy
Sick

Validation of dual-energy x-ray absorptiometry and foot-foot impedance against deuterium dilution measures of fatness in children

JOHN J. REILLY[1], KOSTAS GERASIMIDIS[1], NATASA PAPARACLEOUS[1], ANDREA SHERRIFF[1,2], AMANDA CARMICHAEL[3], ANDREW R. NESS[4] & JONATHAN C. WELLS[5]

Bedside vs Reference methods





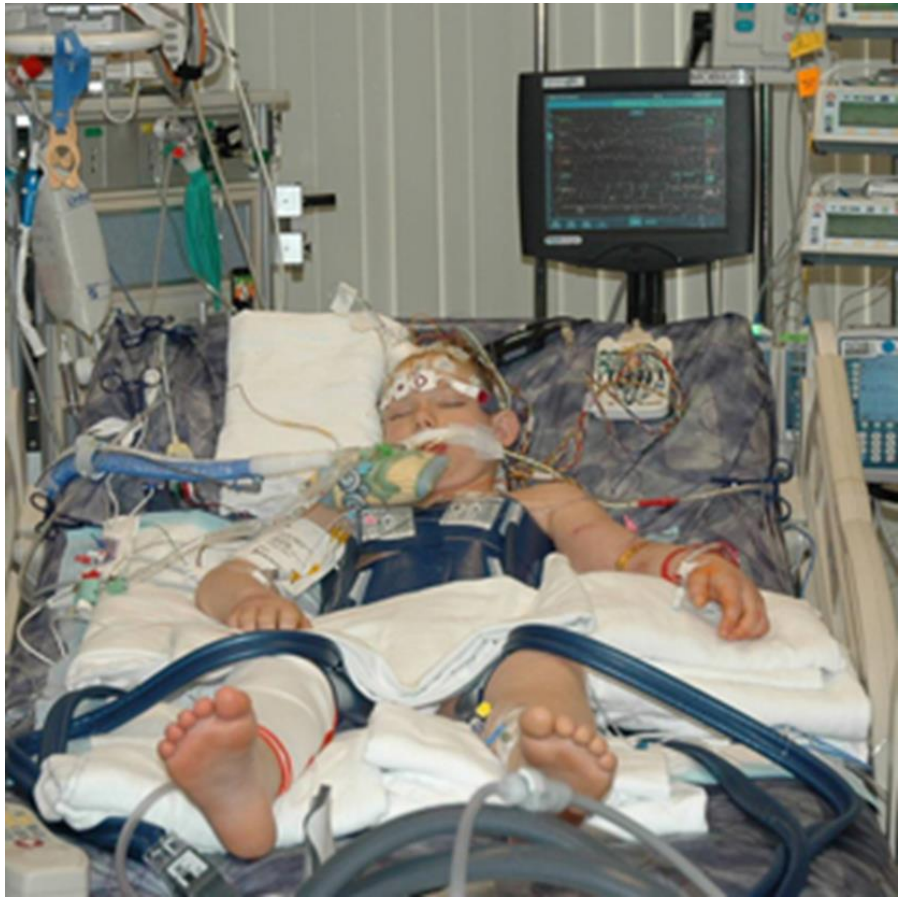
Estimation bias is random and unpredictable in healthy and patient groups

TABLE 5
Bland-Altman analysis of mean bias in fat mass (FM), fat-free mass (FFM), weight, and percentage fat measured by dual-energy X-ray absorptiometry (DXA) compared with the 4-component model[1]

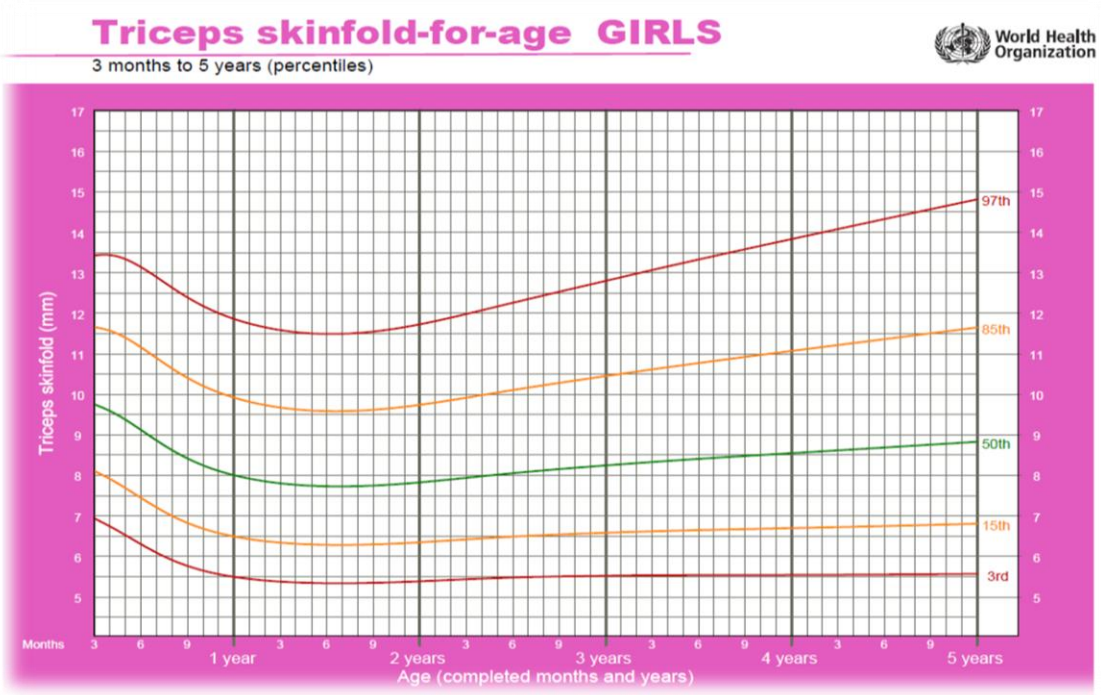
	Absolute bias[2]	Absolute 95% limits of agreement	Bias as a percentage of the mean[3]	95% limits of agreement as a percentage of the mean	*P* for the bias from zero[4]	r[5]	*P* for the correlation
			%	%			
FM							
Adults							
Nonobese men ($n = 26$)	1.35	±2.82	12.4	±25.3	< 0.001	0.38	NS
Nonobese women ($n = 44$)	1.21	±2.29	6.19	±14.8	< 0.001	0.58	< 0.01
Obese women ($n = 14$)	1.58	±3.50	4.60	±11.0	< 0.01	−0.04	NS
Children							
Nonobese boys ($n = 30$)	−0.52	±1.17	−10.9	±23.8	< 0.001	0.10	NS
Nonobese girls ($n = 22$)	0.01	±1.24	9.72	±10.6	NS	0.46	< 0.05
Obese boys ($n = 11$)	0.93	±1.86	3.52	±7.06	< 0.01	−0.08	NS
Obese girls ($n = 17$)	0.46	±2.42	2.26	±9.39	NS	−0.24	NS
Boys with CF ($n = 12$)	−0.14	±1.83	0.38	±29.9	NS	−0.53	NS
Girls with CF ($n = 14$)	0.18	±1.42	0.77	±26.6	NS	0.48	NS
Boys and girls with GSD ($n = 12$)	−0.06	±2.28	−3.67	±22.6	NS	0.63	< 0.05

Williams et al Am J Clin Nutr 2006;83:1047–54.

Which is the method of body composition to use in routine practice ?



Which is the method of body composition to use in routine practice ?



Biochemical markers on malnutrition?

No biomarkers for protein/energy stores!

Serum albumin, prealbumin

- Expensive, time consuming, need blood
- Are **NOT** marker of malnutrition but disease activity index

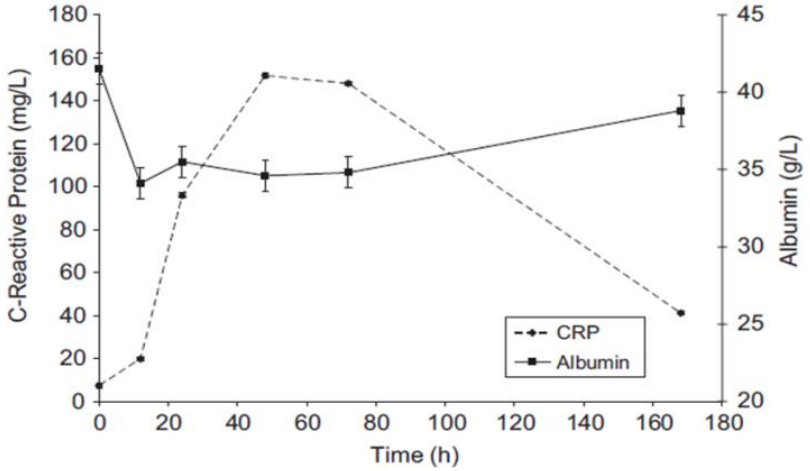


Fig. 1 The concentration changes of albumin and CRP (mean ± SE).

Gerasimidis et al JPGN 2013; 50-1

Serum Albumin

Table 1 Albumin and Body Mass Index (BMI)

Study (First Author)	Year	# of Subjects	Age (years)	Sex	Reason for Nutrition Restriction	Duration of Nutrition Restriction	BMI (kg/m^2) ± SD	Albumin (g/dL) ± SD
Nishida[13]	2010	210	29.9 ± 5.31	F	BMI <18.5 but no anorexia nervosa		17.5 ± 0.78	4.49 ± 0.2
		118	32.9 ± 4.29	F	Self-reported wt loss >1 kg		20.7 ± 3.33	4.45 ± 0.21
Rigaud[14]	2000	5	29.8 ± 9.3	F	Near-death anorexia nervosa		9.77 ± 0.1	3.35 ± 0.28
		16	25.2 ± 3.9		Anorexia nervosa		13.6 ± 1.1	4.05 ± 0.58
Chui[15]	2008	63	21.3 ± 2.3	F	Anorexia nervosa	6.5 ± 1.7 years	21.8 ± 3.4	4.13 ± 0.28
Dostalova[16]	2010	16	24.9 ± 1.34	F	Anorexia nervosa		15.7 ± 0.3	4.38 ± 0.112
Gendall[17]	1999	152	25.9 ± 6.0	F	Bulimia nervosa	71.1 ± 65.6 months	23 ± 2.7	4.87 ± 0.34
Gentile[18]	2011	298	19.8 ± 6.1	278 F, 20 M	Anorexia nervosa, eating		14.6 ± 2.1	4.8 ± 0.5
Krantz[31]	2005	1	52	F	Anorexia nervosa	20 years	17	4
Lawson[32]	2009	10	27.5 ± 2.4	F	Anorexia nervosa		18.3 ± 0.3	4.7 ± 0.1
		10	25.8 ± 1.1	F	Anorexia nervosa		18 ± 0.4	4.4 ± 0.1
Nova[33]	2004	14	15.1 ± 2.56	F	Anorexia nervosa	9.4 ± 6.3 months	15.24 ± 1.71	4.51 ± 0.69
Olubodun[34]	1996	81	27.7 ± 5.9	M	Prisoners	229.1 ± 210.1 days	20 ± 2.7	3.66 ± 0.63
Rigaud[35]	2009	16	26 ± 9 (all)	115 F, 5 M (all)	Anorexia nervosa		11.1 ± 0.65	3.24 ± 0.51
		35			Anorexia nervosa		13.1 ± 0.5	4.02 ± 0.69
		35			Anorexia nervosa		15 ± 0.49	4.18 ± 0.63
		21			Anorexia nervosa		16.8 ± 0.51	4.34 ± 0.64
		13			Anorexia nervosa		19.5 ± 2.4	4.11 ± 0.72
Rock[36]	1995	13	26 ± 8	12 F, 1 M	Anorexia nervosa, Bulimia nervosa	6.4 ± 3.3 years	17.4 ± 2.9	4.1 ± 0.5
Smith[37]	1996	6	27.2 ± 2.36	F	Anorexia nervosa		15.35 ± 0.694	3.7 ± 0.193
Van Binsbergen[38]	1988	20	24.7	F	Anorexia nervosa	4.9 years	14.4	4.07

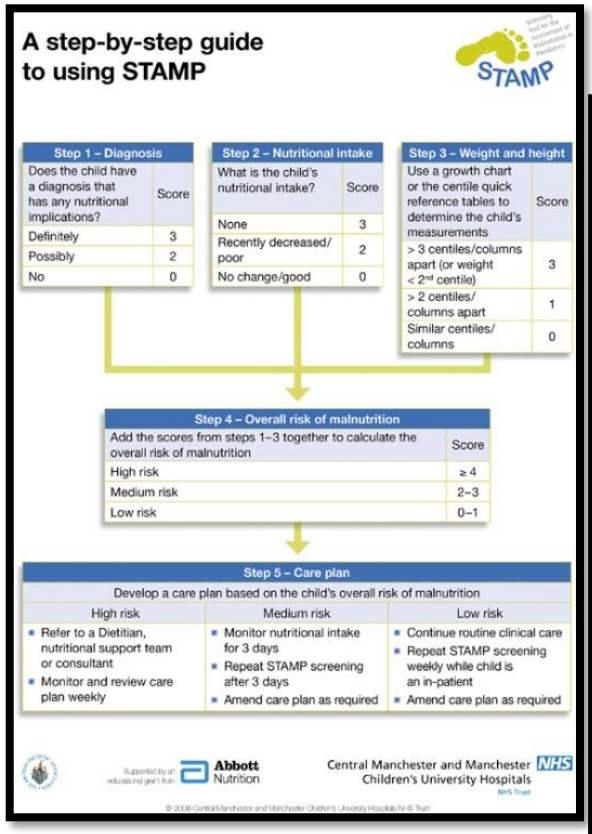
1023.e4

Medicine, Vol 128, No 9, September 2015

In these otherwise healthy subjects, serum albumin and prealbumin levels were not "markers of nutritional status." The "markers" failed to identify subjects with severe protein-calorie malnutrition until extreme starvation (BMI <12 kg/m^2)

Lee et al, Am J Med. 2015 Sep;128(9):1023.e1-22

Nutrition Screening Tool (NST)



A step-by-step guide to using STAMP

STAMP

Step 1 – Diagnosis	
Does the child have a diagnosis that has any nutritional implications?	Score
Definitely	3
Possibly	2
No	0

Step 2 – Nutritional intake	
What is the child's nutritional intake?	Score
None	3
Recently decreased/ poor	2
No change/good	0

Step 3 – Weight and height	
Use a growth chart or the centile quick reference tables to determine the child's measurements	Score
> 3 centiles/columns apart (or weight < 2nd centile)	3
> 2 centiles/ columns apart	1
Similar centiles/ columns	0

Step 4 – Overall risk of malnutrition	
Add the scores from steps 1–3 together to calculate the overall risk of malnutrition	Score
High risk	≥ 4
Medium risk	2–3
Low risk	0–1

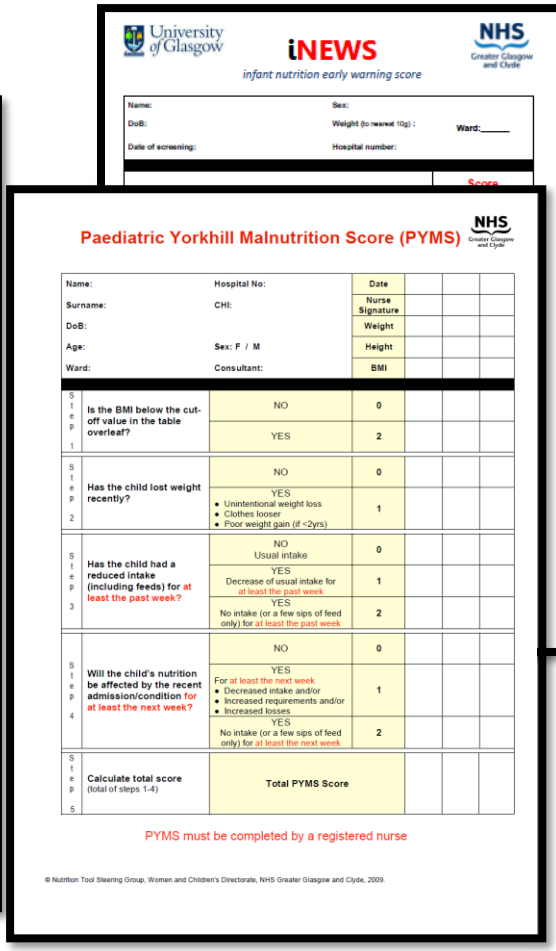
Step 5 – Care plan

Develop a care plan based on the child's overall risk of malnutrition

High risk	Medium risk	Low risk
▪ Refer to a Dietitian, nutritional support team or consultant ▪ Monitor and review care plan weekly	▪ Monitor nutritional intake for 3 days ▪ Repeat STAMP screening after 3 days ▪ Amend care plan as required	▪ Continue routine clinical care ▪ Repeat STAMP screening weekly while child is an in-patient ▪ Amend care plan as required

Supported by an educational grant from Abbott Nutrition

Central Manchester and Manchester Children's University Hospitals NHS Trust



University of Glasgow

iNEWS

infant nutrition early warning score

NHS Greater Glasgow and Clyde

Name: Sex:

DoB: Weight (to nearest 10g) : Ward:

Date of screening: Hospital number:

Score

Paediatric Yorkhill Malnutrition Score (PYMS)

NHS Greater Glasgow and Clyde

Name: Hospital No: Date

Surname: CHI: Nurse Signature

DoB: Weight

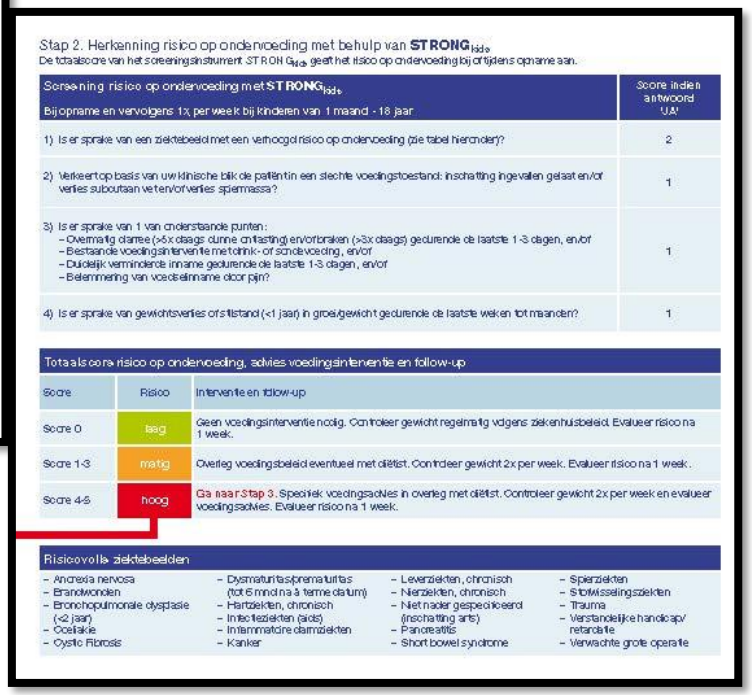
Age: Sex: F / M Height

Ward: Consultant: BMI

Step 1	Is the BMI below the cut-off value in the table overleaf?	NO	0			
		YES	2			
Step 2	Has the child lost weight recently?	NO	0			
		YES • Unintentional weight loss • Clothes looser • Poor weight gain (if <2yrs)	1			
Step 3	Has the child had a reduced intake (including feeds) for at least the past week?	NO Usual intake	0			
		YES Decrease of usual intake for at least the past week	1			
		YES No intake (or a few sips of feed only) for at least the past week	2			
Step 4	Will the child's nutrition be affected by the recent admission/condition for at least the next week?	NO	0			
		YES For at least the next week • Decreased intake and/or • Increased requirements and/or • Increased losses	1			
		YES No intake (or a few sips of feed only) for at least the next week	2			
Step 5	Calculate total score (total of steps 1-4)	Total PYMS Score				

PYMS must be completed by a registered nurse

© Nutrition Tool Steering Group, Women and Children's Directorate, NHS Greater Glasgow and Clyde, 2009.



Stap 2. Herkenning risico op ondervoeding met behulp van STRONGkids

De totaalscore van het screeninginstrument STRONGkids geeft het risico op ondervoeding bij of tijdens opname aan.

Screening risico op ondervoeding met STRONGkids Bij opname en vervolgens 1x per week bij kinderen van 1 maand - 18 jaar	Score indien antwoord 'JA'
1) Is er sprake van een ziektebeeld met een verhoogd risico op ondervoeding (zie tabel hieronder)?	2
2) Verkeert op basis van uw klinische blik de patiënt in een slechte voedingstoestand: inschatting ingevallen gelaat en/of verlies suboutaan vet en/of verlies spiermassa?	1
3) Is er sprake van 1 van onderstaande punten: – Overmatig diarree (>5x daags dunne ontlasting) en/of braken (>3x daags) gedurende de laatste 1-3 dagen, en/of – Bestaande voedingsinterventie met drink- of sondevoeding, en/of – Duidelijk verminderde inname gedurende de laatste 1-3 dagen, en/of – Belemmering van voedselinname door pijn?	1
4) Is er sprake van gewichtsverlies of stilstand (<1 jaar) in groei/gewicht gedurende de laatste weken tot maanden?	1

Totaalscore risico op ondervoeding, advies voedingsinterventie en follow-up

Score	Risico	Interventie en follow-up
Score 0	laag	Geen voedingsinterventie nodig. Controleer gewicht regelmatig volgens ziekenhuisbeleid. Evalueer risico na 1 week.
Score 1-3	matig	Overleg voedingsbeleid eventueel met diëtist. Controleer gewicht 2x per week. Evalueer risico na 1 week.
Score 4-5	hoog	Ga naar Stap 3. Specifiek voedingsadvies in overleg met diëtist. Controleer gewicht 2x per week en evalueer voedingsadvies. Evalueer risico na 1 week.

Risicovolle ziektebeelden

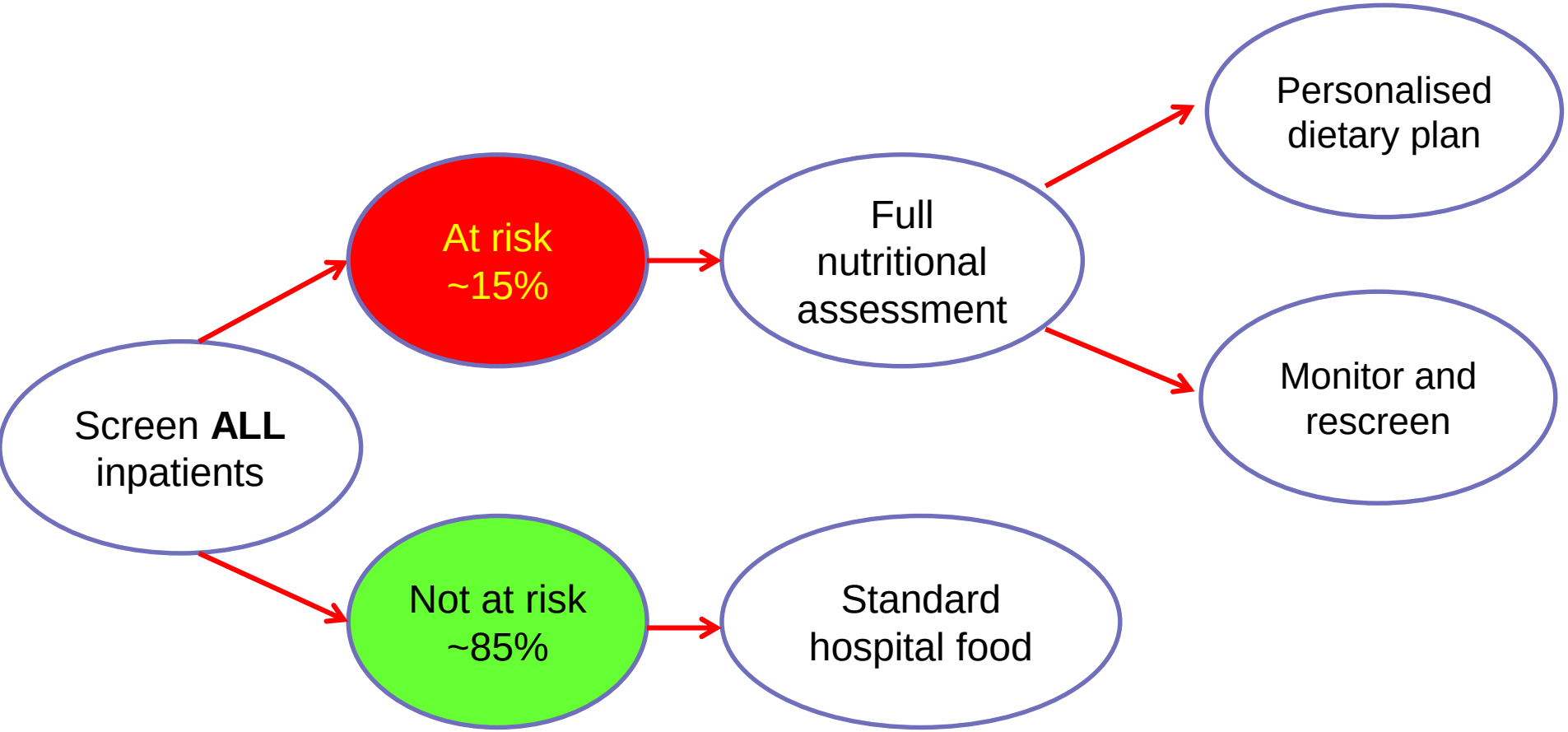
– Anorexia nervosa	– Dysmaturitas/prematuritas (totaal 6 mnd na à terme datum)	– Leverziekten, chronisch	– Spierziekten
– Brandwonden	– Hartziekten, chronisch	– Nierziekten, chronisch	– Stoïwisselingsziekten
– Bronchopulmonale dysplasie (<2 jaar)	– Infectieziekten (aids)	– Niet nader gespecificeerd (inschatting arts)	– Trauma
– Coeliakie	– Inflammatoire darmziekten	– Pancreatitis	– Verstandelijke handicap/ retardatie
– Cystic Fibrosis	– Kanker	– Short bowel syndrome	– Verwachte grote operatie

McCarthy *et al*, JHND 2012

Gerasimidis *et al*, BJN 2010
Gerasimidis *et al,* Clin Nutr 2011
Gerasimidis et al, Clin Nutr 2018

Hulst *et al*, Clin Nutr, 2010

NST are not malnutrition assessment methods but dietetic referral tools



Concurrent/criterion validity

PYMS vs STAMP vs STRONGkids

Chourdakis et al AJCN 2016;103:1301–10.

Characteristics of the “ideal” NST

- Good diagnostic validity
  - Identifies the majority of patients you want to treat (sensitivity)
  - Equally important good positive predictive value (i.e. low false positive rate)

- Practical, quick, cheap, user friendly
- Can be implemented and perform well in clinical practice
- Does not waste resources and does not increase workload substantially
- Make a difference in patients’ care

Gerasimidis *et al,* Clin Nutr 2011

Micronutrient assessment in sick children

ESPEN
The European Society for Clinical Nutrition and Metabolism

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ESPEN guideline: Clinical nutrition in inflammatory bowel disease

Alastair Forbes [a, *], Johanna Escher [b], Xavier Hébuterne [c], Stanisław Kłęk [d], Zeljko Krznaric [e], Stéphane Schneider [c], Raanan Shamir [f], Kalina Stardelova [g], Nicolette Wierdsma [h], Anthony E. Wiskin [i], Stephan C. Bischoff [j]

ECCO

ECCO Topical Review

Research Gaps in Diet and Nutrition in Inflammatory Bowel Disease. A Topical Review by D-ECCO Working Group [Dietitians of ECCO]

Rotem Sigall-Boneh,[a] Arie Levine,[b] Miranda Lomer,[c] Nicolette Wierdsma,[d] Philip Allan,[e] Gionata Fiorino,[f] Simona Gatti,[g] Daisy Jonkers,[h] Jarosław Kierkuś,[i] Konstantinos H. Katsanos,[j] Silvia Melgar,[k] Elif Saritas Yuksel,[l] Kevin Whelan,[m] Eytan Wine,[n] Konstantinos Gerasimidis[o]

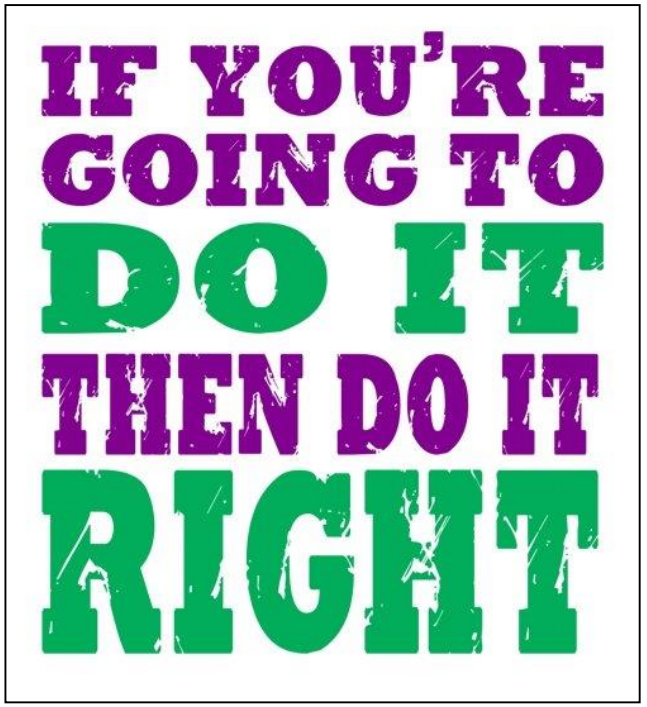
JCC

Nutrition in Pediatric Inflammatory Bowel Disease: A Position Paper on Behalf of the Porto Inflammatory Bowel Disease Group of the European Society of Pediatric Gastroenterology, Hepatology and Nutrition

*Erasmo Miele, †Raanan Shamir, ‡Marina Aloi, †Amit Assa, §Christian Braegger, ||Jiri Bronsky, ¶Lissy de Ridder, ¶Johanna C. Escher, #Iva Hojsak, #Sanja Kolaček, **Sibylle Koletzko, ††Arie Levine, ‡‡Paolo Lionetti, *Massimo Martinelli, §§Frank Ruemmele, ||||Richard K. Russell, ††Rotem Sigall Boneh, ¶¶Johan van Limbergen, ##Gigi Veereman, and *Annamaria Staiano

ESPGHAN

When to do it?



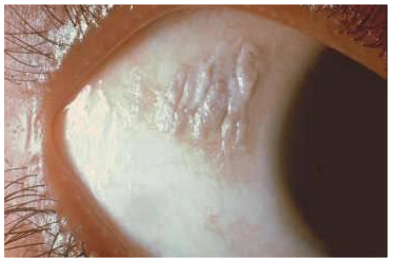
Who?

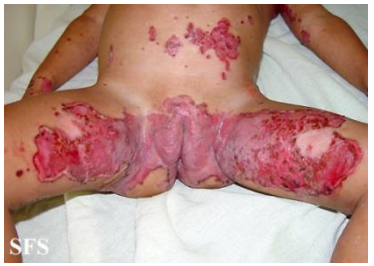
Conventional approaches to assess body micronutrient status

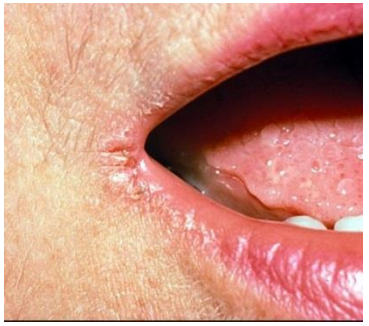
1. Clinical examination/symptoms
2. Dietary assessment
3. Lab biomarkers

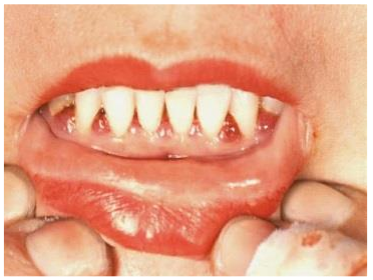
Clinical symptoms

- Clinical relevance and needs clinicians
- Very rare in developed countries
- Present when stores are depleted
- Some specific some very unspecific (e.g. acne, tiredness, dry skin)
- Should be complemented by other assessments







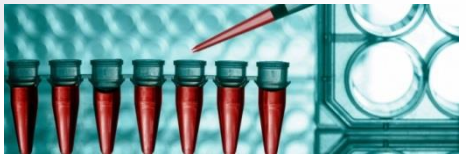


Dietary assessment of micronutrients

- Meet dietary references values=adequate body stores
- Micronutrient needs in disease=health?
- Requires dietitians and laborious dietary assessment (7-14d weighted diaries)
- Fairly imprecise at assessments per individual patient
  - Better for group averages
- Not to be used in isolation but complement other assessment

Henrıquez-Sanchez et al, BJN 2009; S10-S37

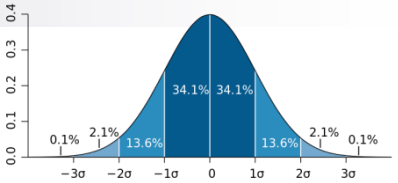
Laboratory biomarkers



- Standard approach in routine clinical practice
- Two common methods
  - *Direct measurements of nutrient (blood, urine)*
  - *Functional markers (glutathione peroxidase, tranketolase activity)*

Caveats in the interpretation of micronutrient biomarkers

1) Reference range/values



- **Excellent "optimal/ideal" references for growth charts (WHO)**
  - Similar ranges for some micronutrients in children are lacking
- **Origin of micronutrient reference values is unknown**
  - Selective or random?
  - Lack of paediatric references and replace with adults
- **How much is the problem in an 'normal' population?**

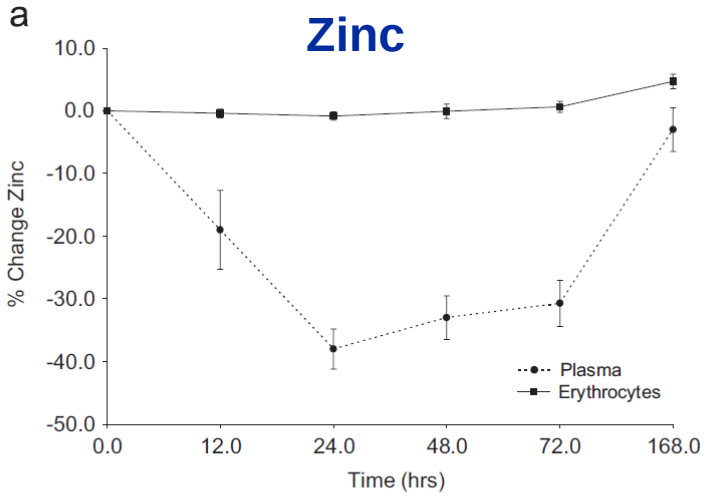
Gerasimidis et al JPGN 2019; *in press*

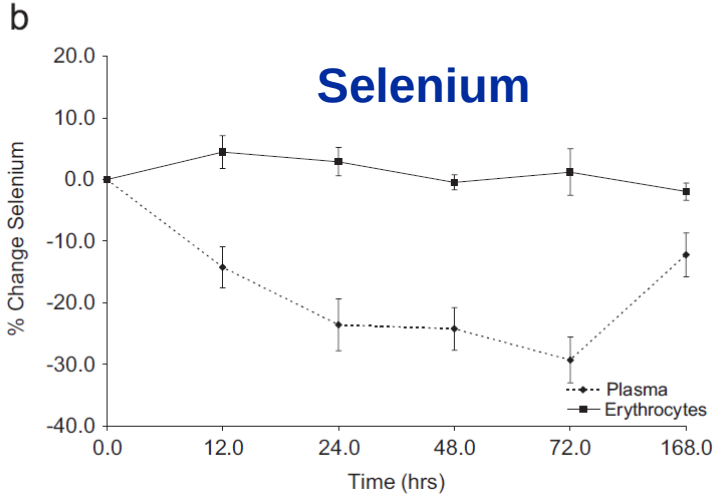
2) Effect of systemic inflammatory response on blood micronutrient levels

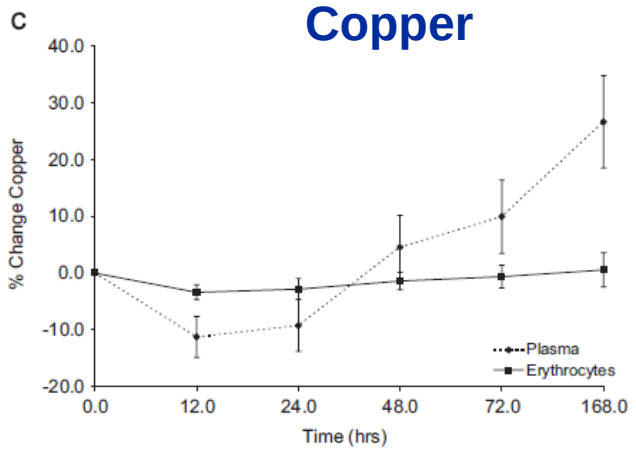
- Systemic inflammatory response (SIR) alters blood micronutrient status independently of actual body stores
  - Redistribution of nutrients to other tissues (liver)
  - Shifts in vascular fluids (dilution effect)
  - Loss of nutrient carrier protein (serum albumin, lipoproteins)
  - Increased excretion (urine)

Gerasimidis et al JPGN 2019; *in press*

Plasma micronutrients & acute phase response



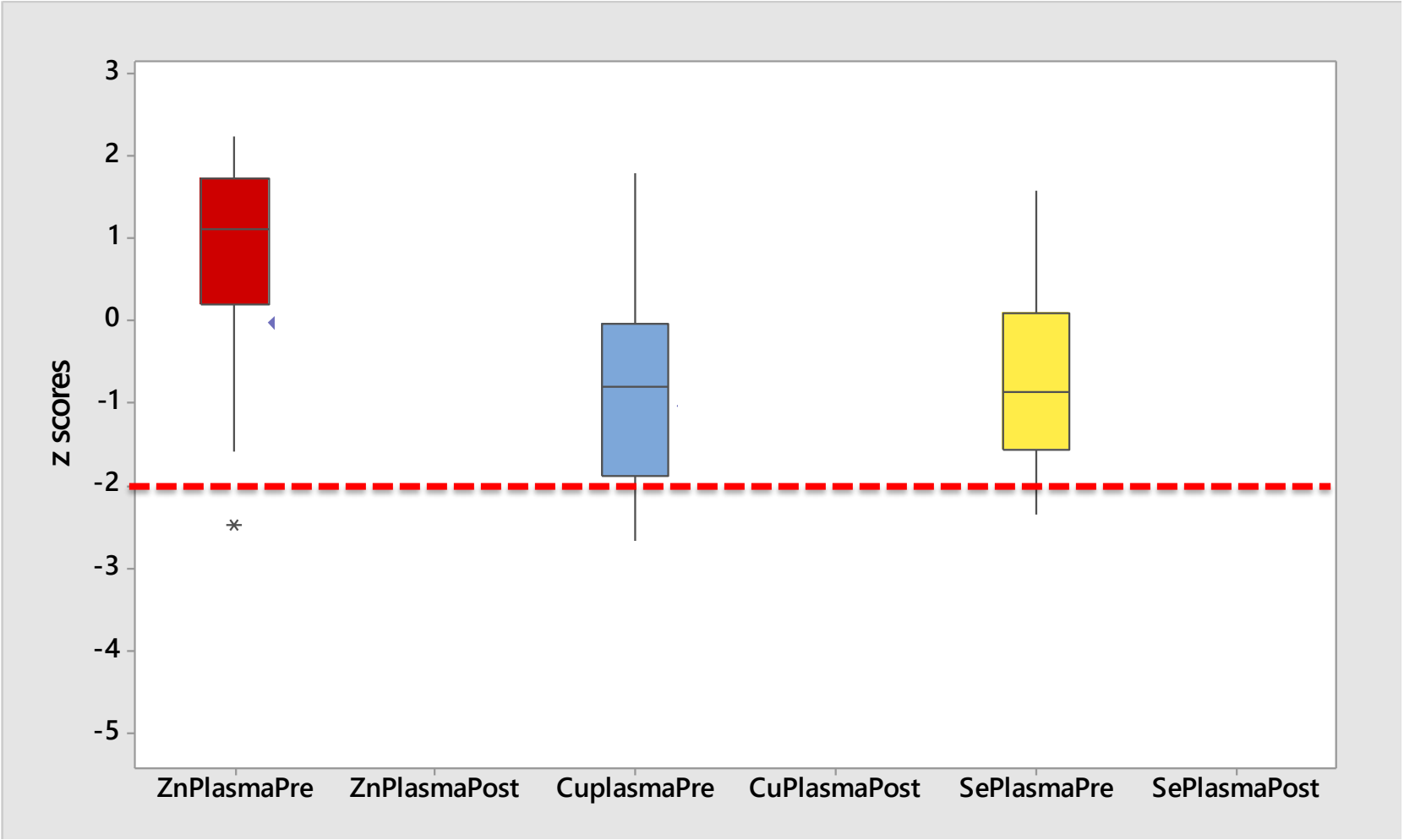




Serial %changes in serum and erythrocyte levels of well nourished healthy subjects who were admitted for elective hip surgery

Oakes et al Clin Nutr, 2008; 27: 115-120

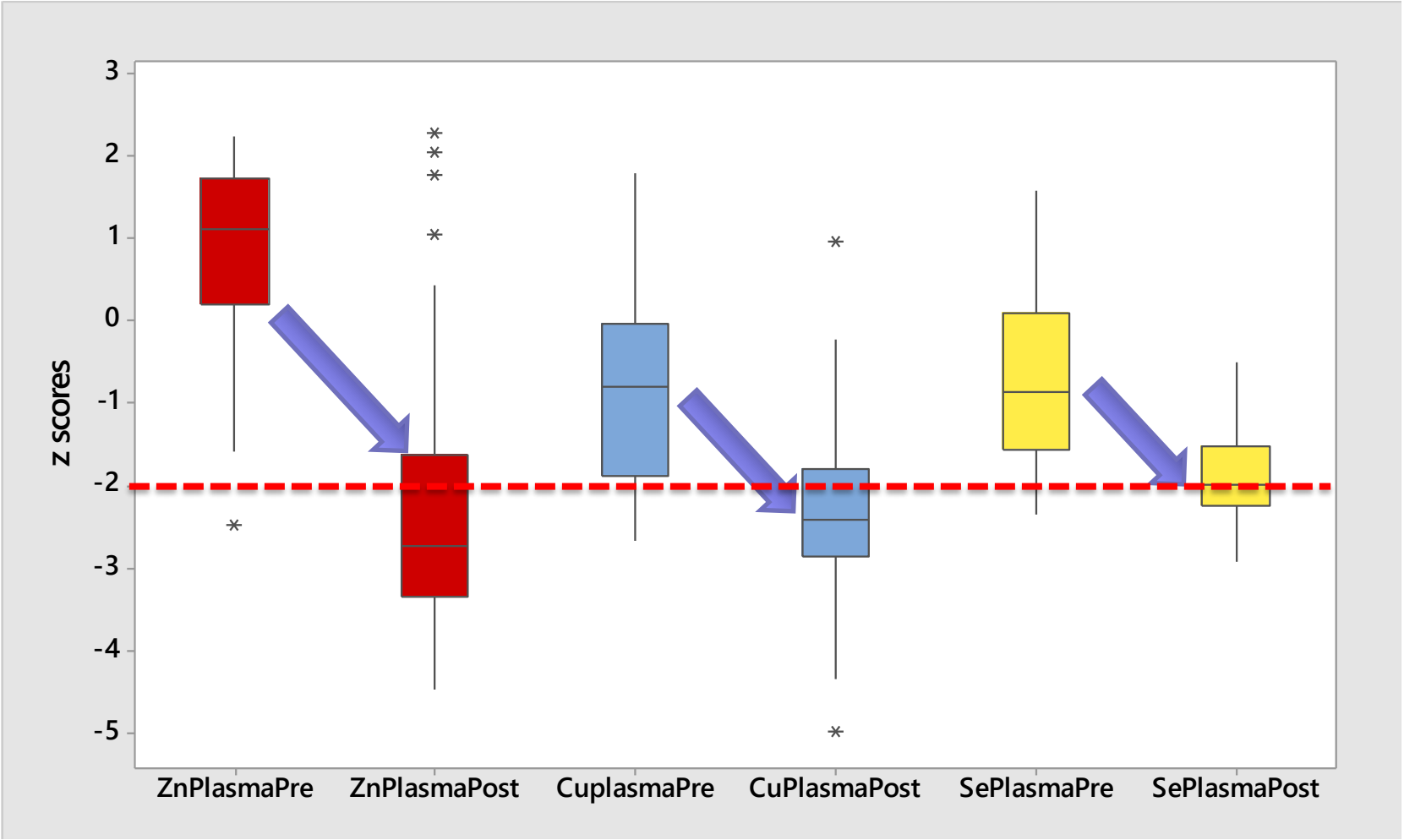
Children (n=50) with congenital heart defects pre-operatively *(46% with BMI < 2nd centile)*



Gerasimidis et al in preparation

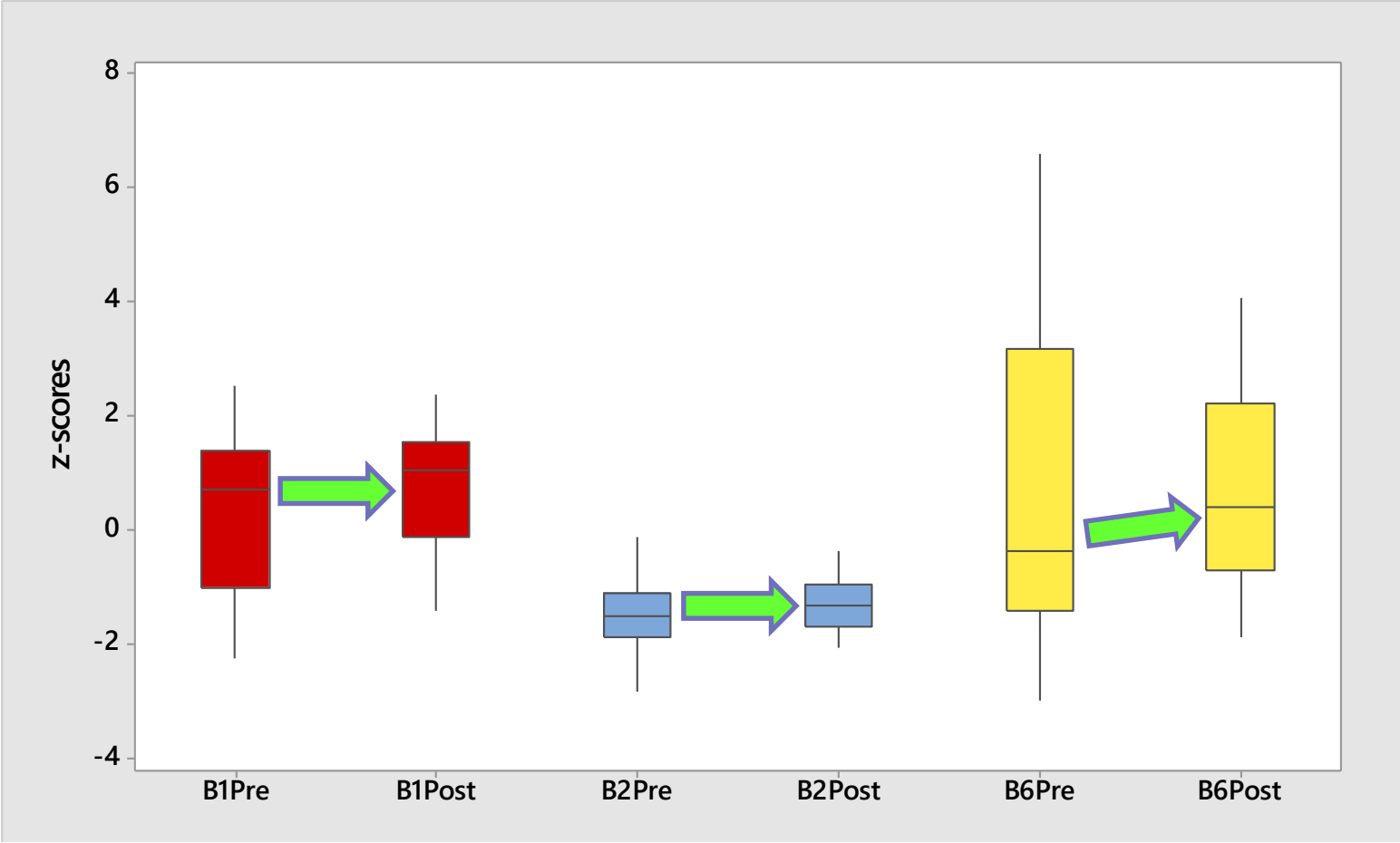
Children with congenital heart defects

24h post-operatively



Gerasimidis et al in preparation

B-complex vitamins pre and post-operatively in erythrocytes



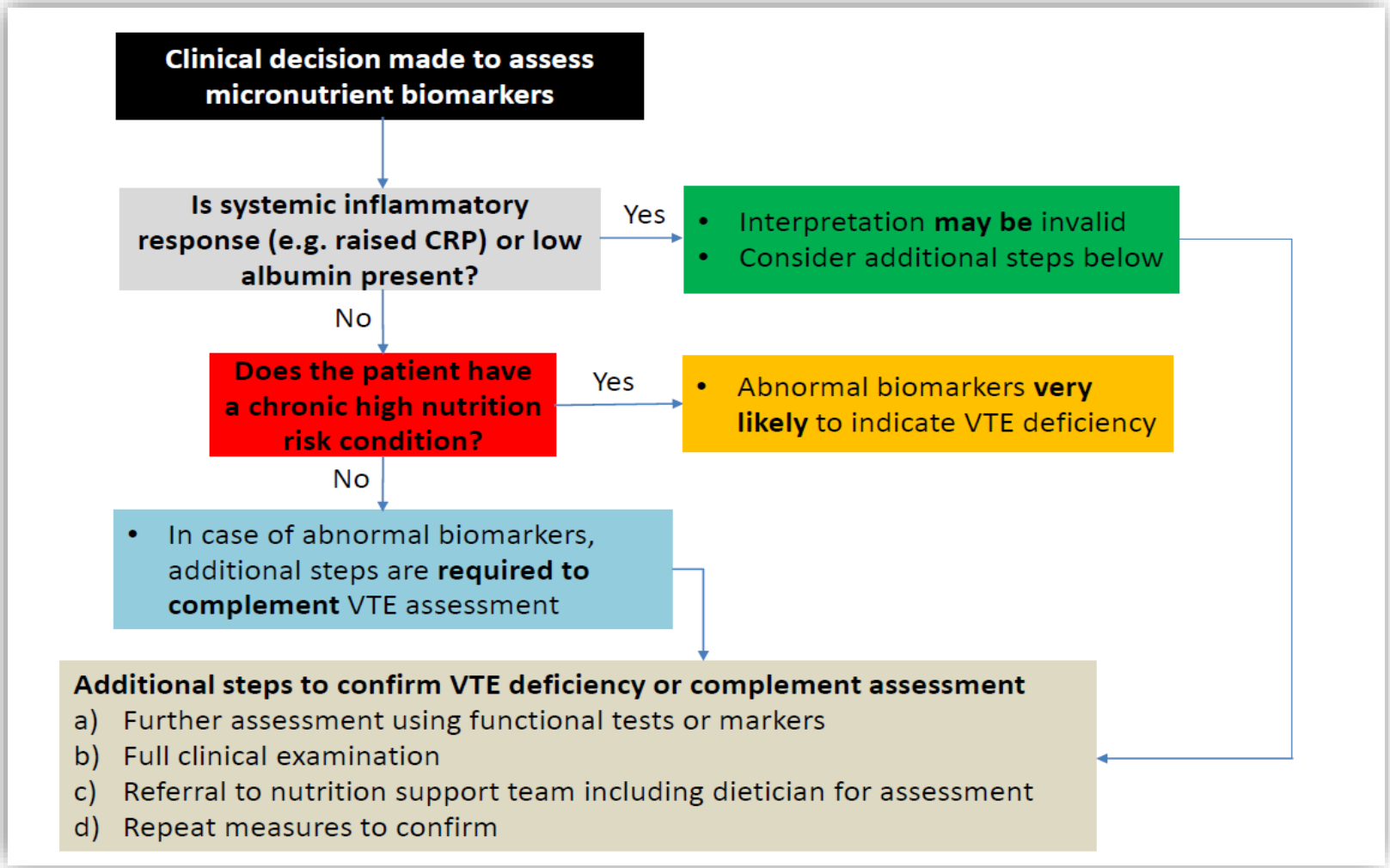
Gerasimidis et al in preparation

Which micronutrients are affected?

Micronutrient	Lowest reported	Highest reported
Zinc	-10	-40
Selenium	-20	-65
Copper	10	15
Vitamin A	-10	-65
Vitamin D	0	-40
Vitamin E	0	-10
Vitamin B2	-10	-60
Vitamin B6	0	-70
Vitamin B12	0	-25
Vitamin C	0	-75
Lutein	-40	-75
Lycopene	0	-95
α-carotene	-20	-80
β-carotene	-20	-90

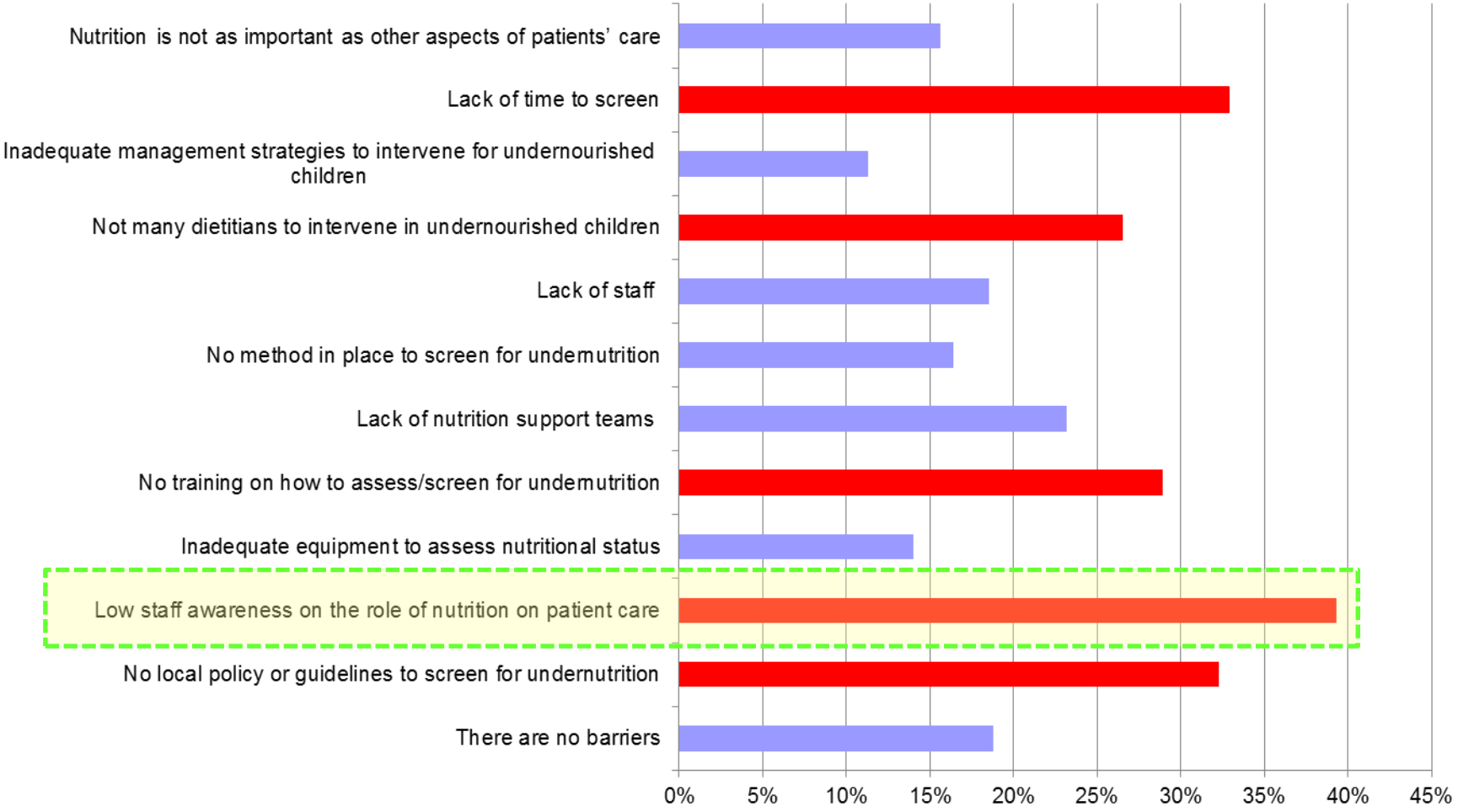
Gerasimidis et al JPGN 2019; *in press*

Decision tree to evaluate micronutrient status using laboratory biomarkers



Gerasimidis et al JPGN 2019; *in press*

Barriers of nutritional screening/assessment



Huysentruyt et al, Clin Nutr 2018 [epub]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Is supplementation effective in the presence of systemic inflammatory response?

Table 1 Characteristics and B complex vitamins of normal subjects and critically ill patients.

	Normal subjects	Critically-ill patients		ANOVA, *P*-value
	No supplementation ($n = 49$)	No supplementation ($n = 18$)	Supplementation ($n = 23$)	
Age (yr)	57 (35–72)	65 (23–85)	60 (22–82)	0.697
Sex (M/F)	26/23	10/8	14/9	0.824
Apache II		24 (13–38)	25 (10–42)	0.298
Predicted mortality (%)		38.6 (5.8–78.9)	57.4 (5.6–93.9)	0.028
Day of sampling (Day 0/1/2/3/4/5/⩾6)		11/2/1/1/1/0/2	0/3/4/2/2/2/10	0.002
C-reactive protein (mg/l)	<10 (<10–<10)	140 (20–290)	134 (16–255)	<0.001
Albumin (g/l)	42 (37–49)	22 (13–33)	25 (10–31)	<0.001
Red cell haemoglobin (g/l)	261 (231–324)	269 (240–310)	270 (230–310)	0.961
Red cell TDP (ng/gHb)	437 (294–647)	600 (320–1252)	906 (390–2420)	<0.001
Plasma FAD (nmol/l)	94 (63–159)	38 (22–76)	44 (16–74)	<0.001
Red cell FAD (nmol/gHb)	2.1 (1.10–3.70)	2.6 (1.3–4.7)	2.8 (0.9–4.6)	0.010
Plasma FAD/red cell FAD	45.9 (26.9–80.0)	15.4 (4.9–39.2)	15.7 (8.6–56.7)	<0.001
Plasma PLP (nmol/l)	43 (26–154)	13 (3–63)	20 (2–121)	<0.001
Red cell PLP (pmol/gHb)	371 (278–774)	363 (209–883)	1000 (267–8491)	<0.001
Plasma PLP/red cell PLP	0.121 (0.082–0.199)	0.035 0.009–0.165)	0.020 (0.002–0.157)	<0.001

Median (range).

Quasim et al, Clinical Nutrition 2005, 24: 956-960