Nutrition in Paediatric Chronic Renal Failure

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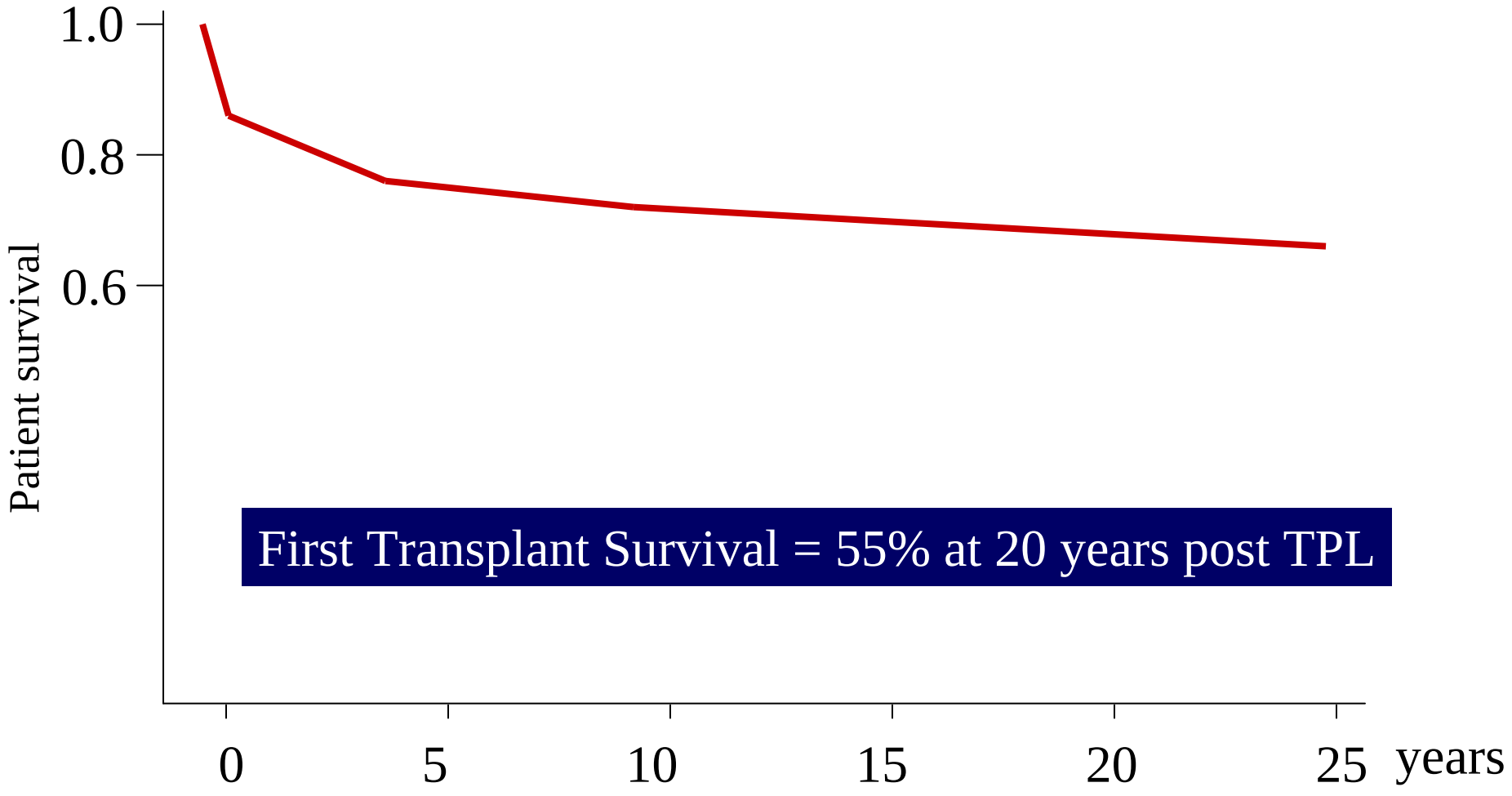
Patient survival <20 ml/min/1.73m^2 at 0.3 yrs



Nutritional Support

(101 patients with GFR <20 ml/min/1.73m^2 in 1st yr of life)

Support	All	+Co-morbidities	w/o Co-morbidities
Tube fed	66	36	30
duration	1.7 (0.1-6.9)	1.6	1.7
Age start	0.8 (0.0-4.9)	1.0	0.6
Age stop	2.5 (0.1-8.7)	2.6	2.4
Gastrostomy	37	24	13
Nissen FP	13	9	4

Mekahli, GOSH, London, 2010

Nutritional Support

ALL PATIENTS

↓

2/3 require tube feeding

↓

2/3 require gastrostomy

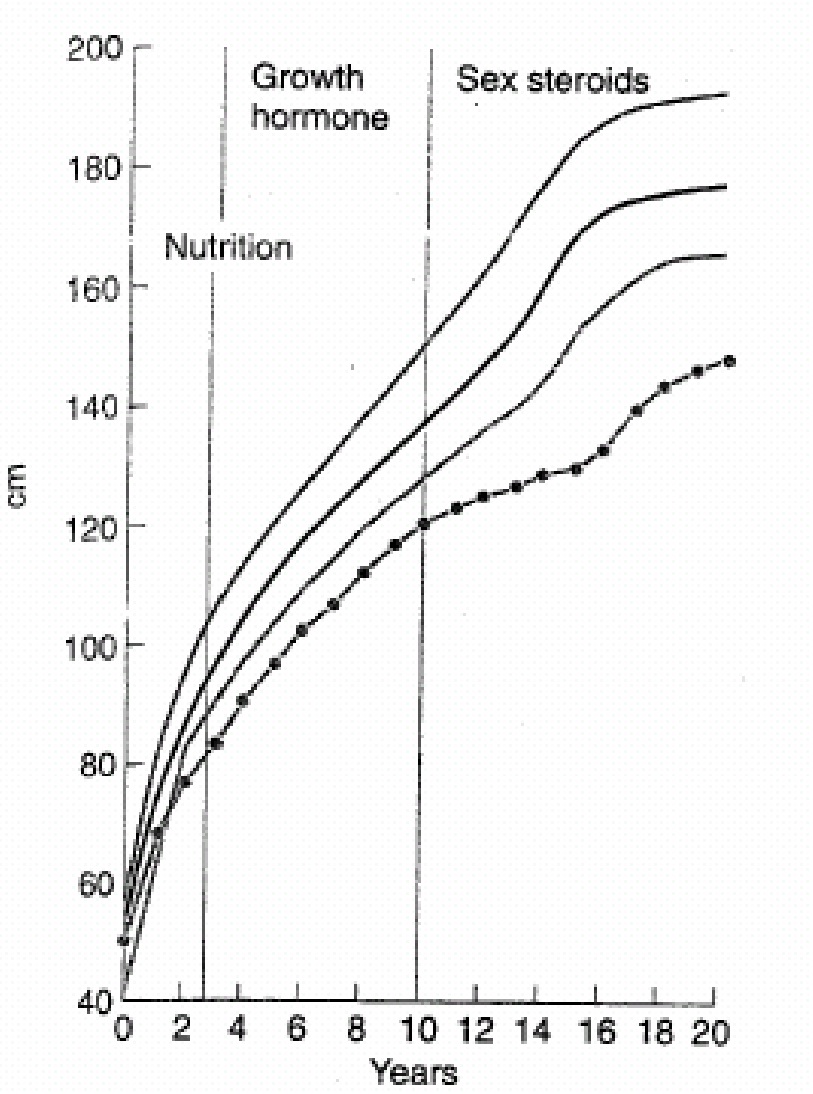
↓

½ with Nissen fundoplication

Mekahli, GOSH, London, 2010

Growth in CRF

- Birht to 2 yrs
  - Growth velocity +++
  - Growth failure potentially +++ severe
  - Nutrition
- 2 yrs to puberty
  - Growth velocity +/-
  - No spontaneous catch up
- Puberty
  - Puberty delayed
  - Growth spurt reduced

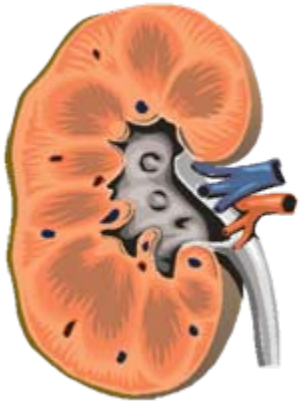


Growth

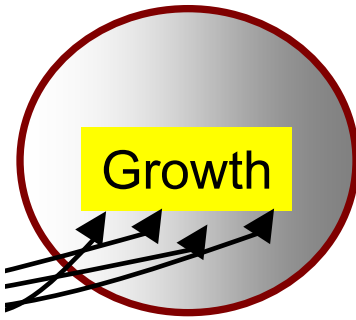
AGE (years)	0	0.5	1	5	10	15	>18
HEIGHT (SDS)	-0.42	-2.1	-1.9	-1.1	-1.0	-1.8	-1.7

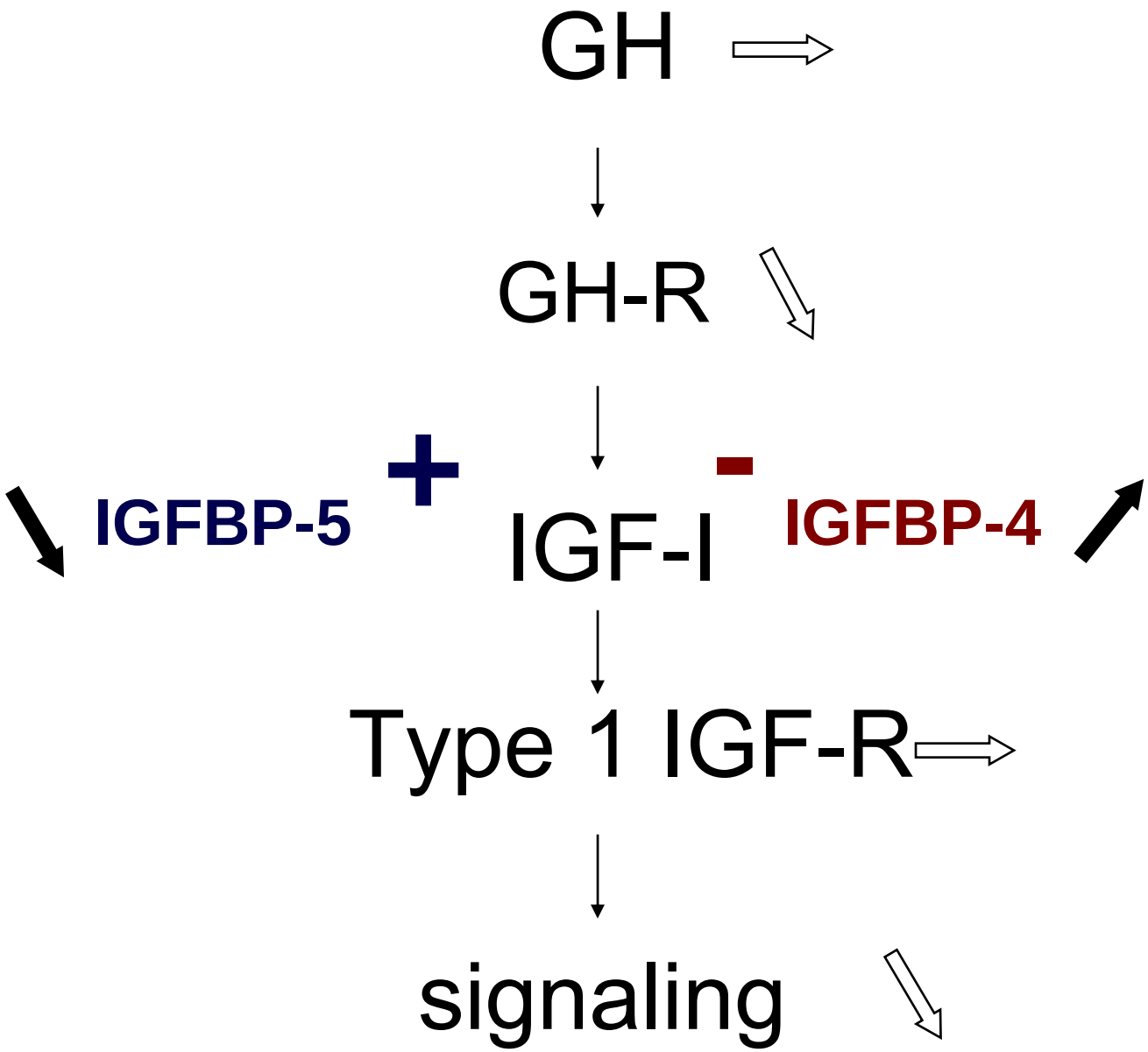
-1.1 SDS
w/o comorbidities

No significant difference between those with *versus* those w/o rhGH



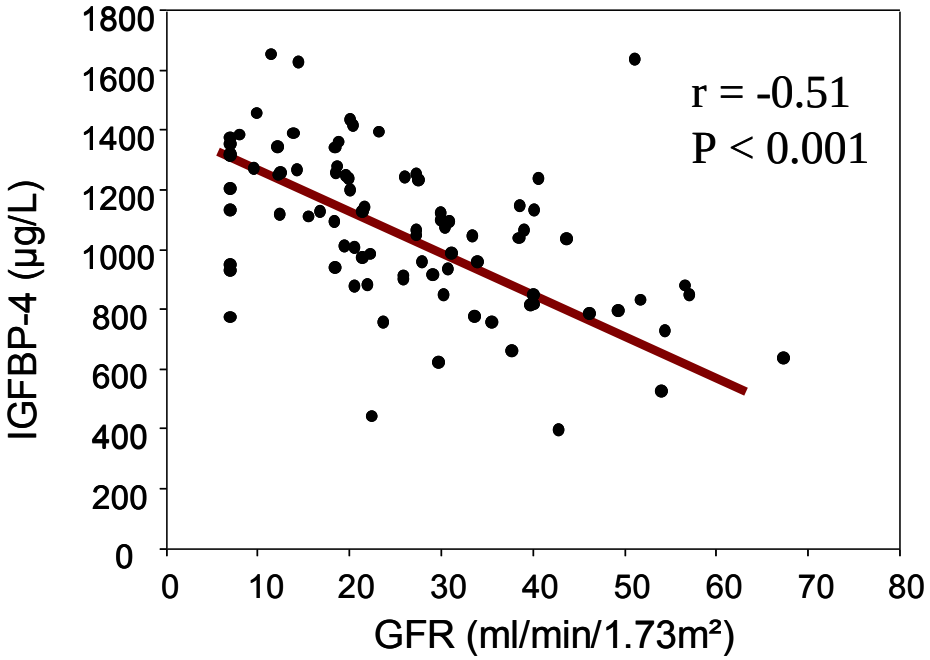
IRC



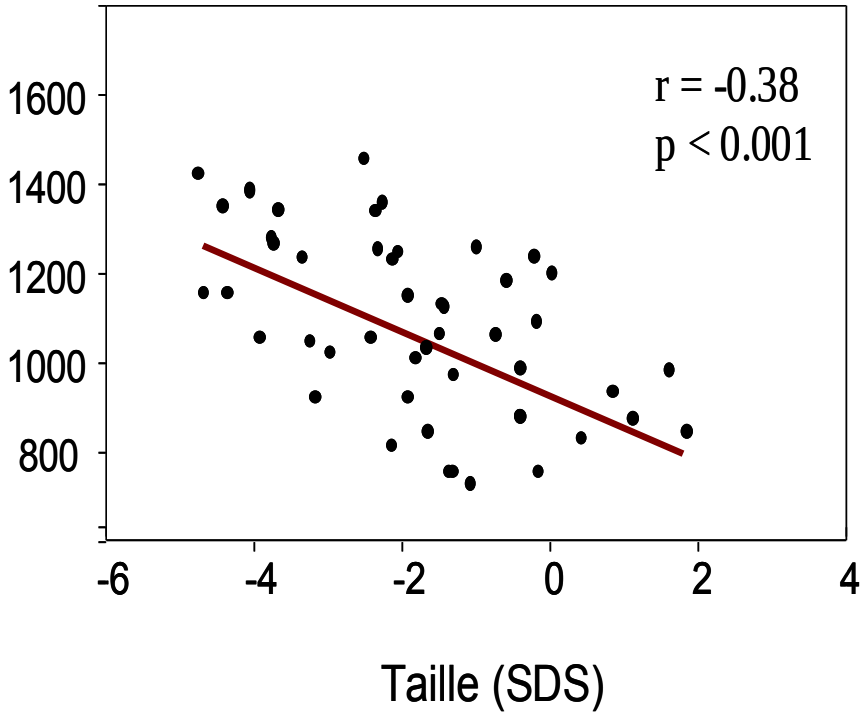

GH
GH-R
IGFBP-5
+
IGF-I
-
IGFBP-4
Type 1 IGF-R
signaling

IGFBP-4 serum levels in children with CRF

IGFBP-4 accumulates in CRF



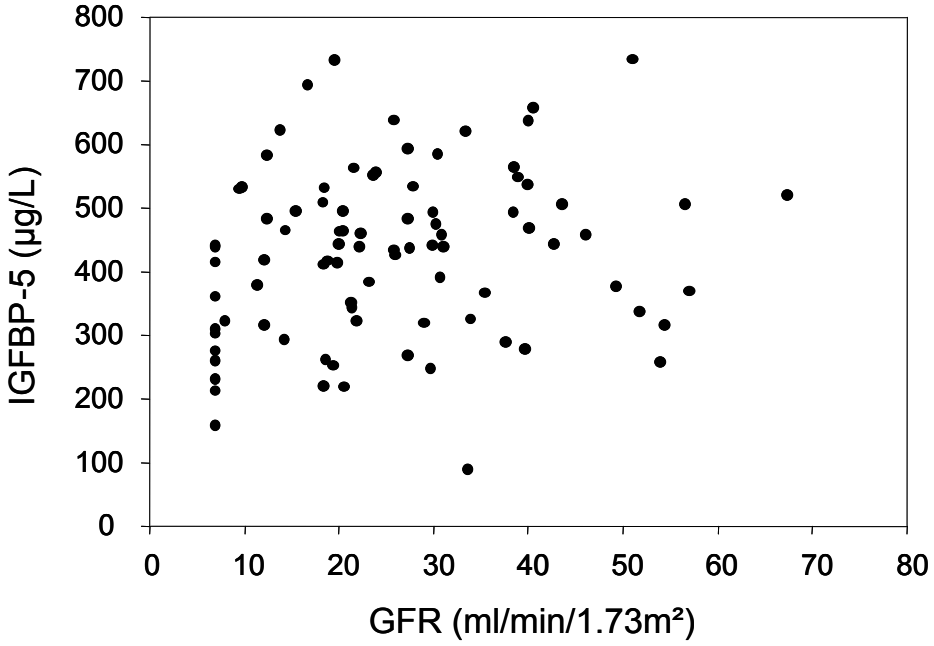
IGFBP-4 levels are inversely correlated with height



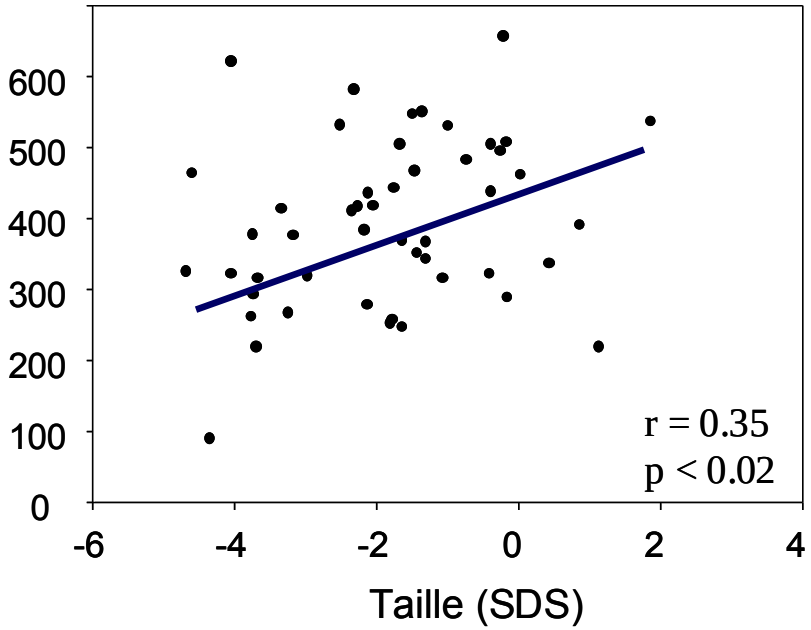
Ulinski et al, 2000

IGFBP-5 serum levels in children with CRF

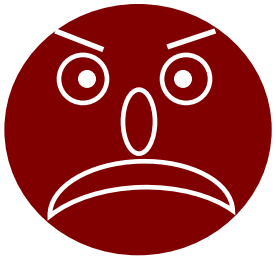
IGFBP-5
No accumulation in CRF

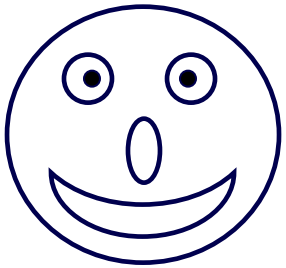


IGFBP-5 levels are positively correlated with height



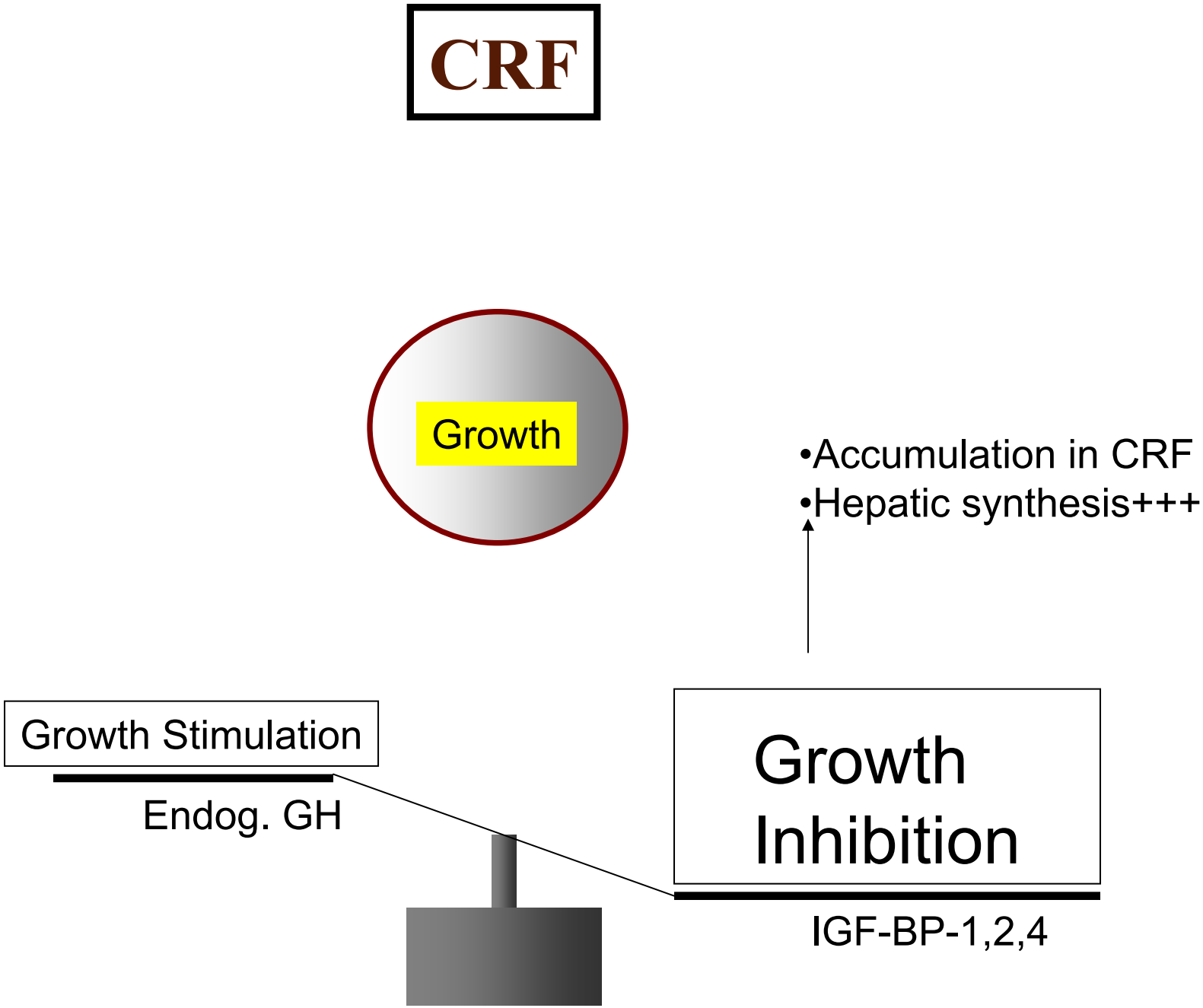
IGFBP-4 ≠ **IGFBP-5**

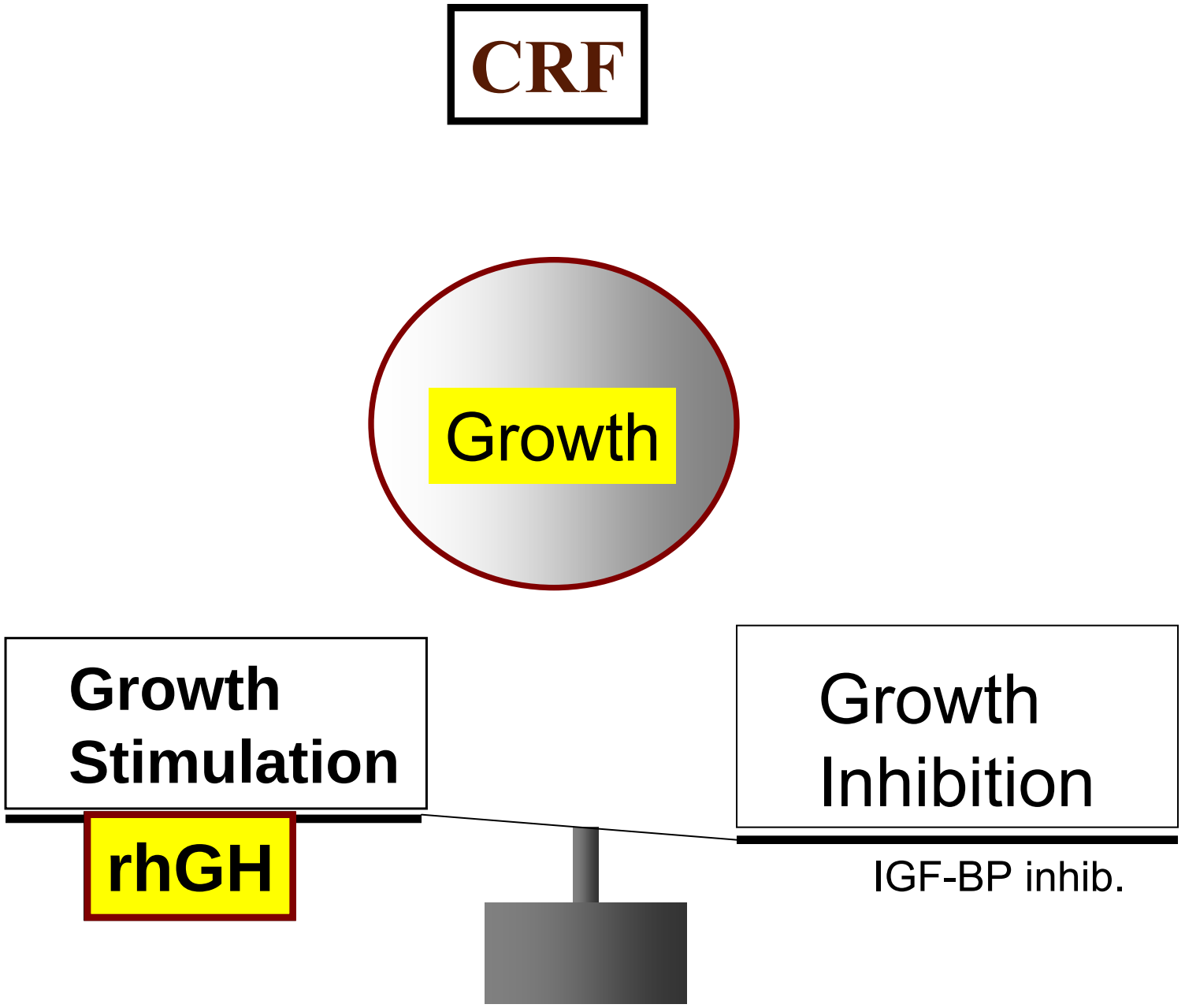




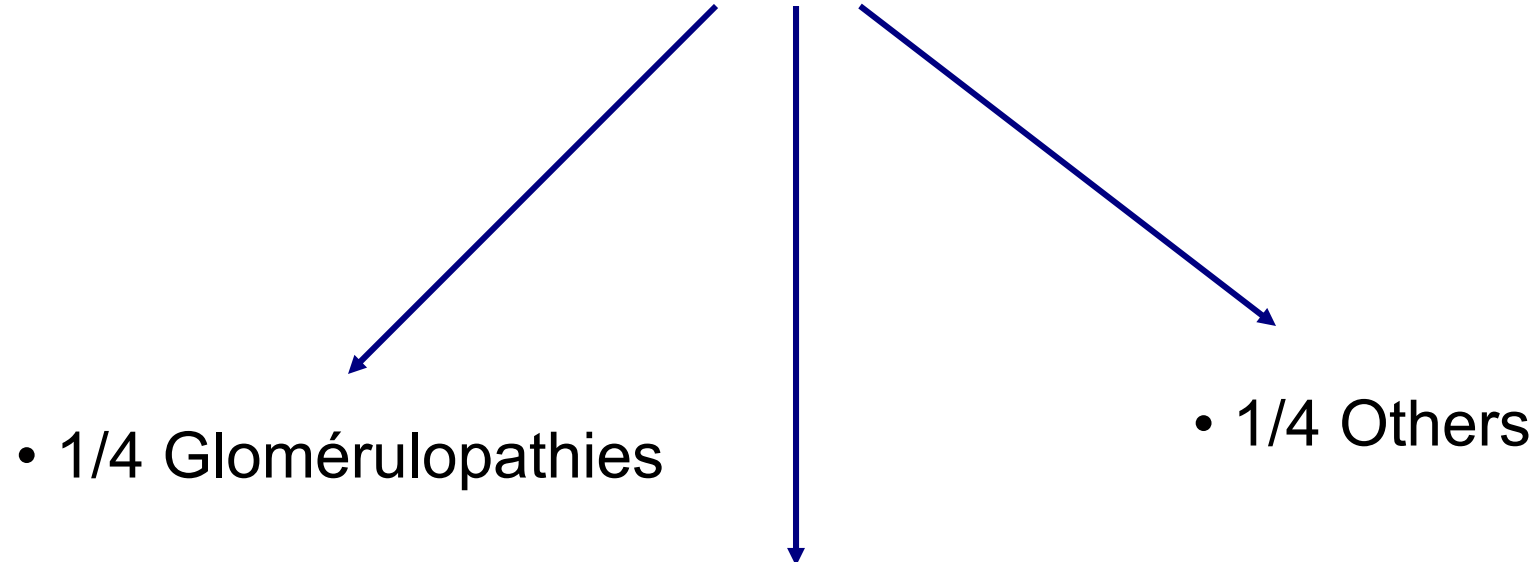
Dialysis of inhibitory IGFBPs

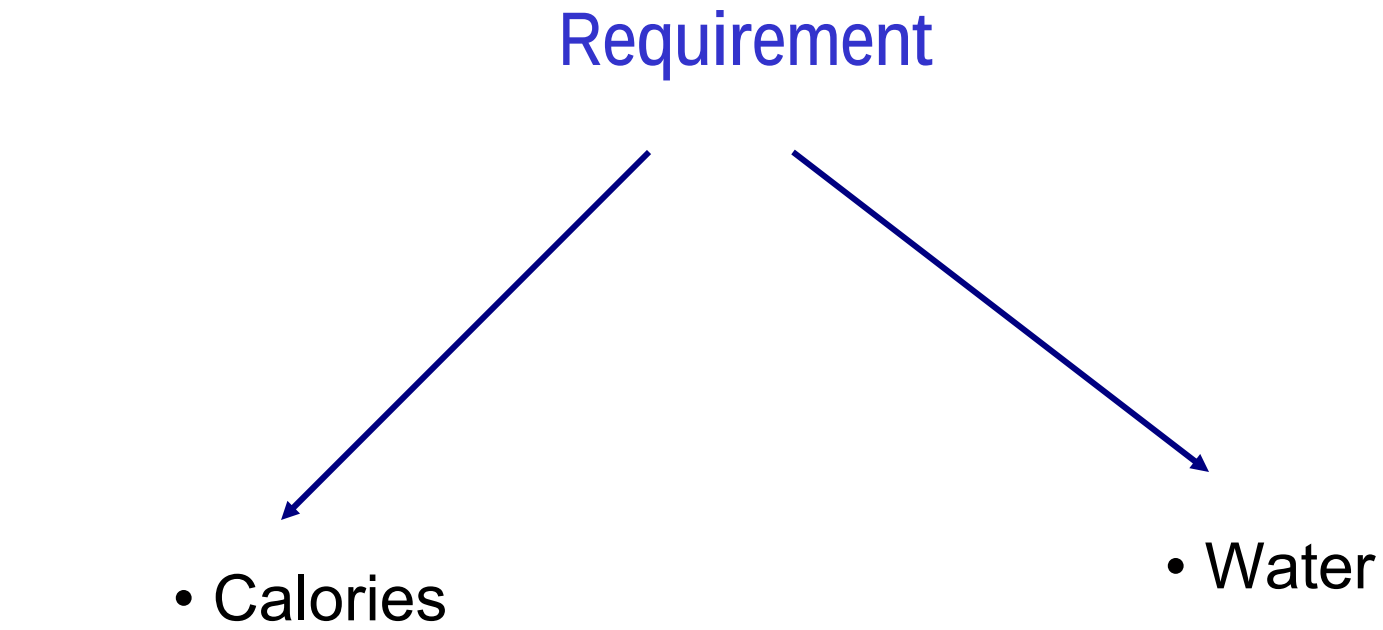
- ‘high flux’ membranes
- daily hemodiafiltration quotidienne


CRF
Growth
•Accumulation in CRF
•Hepatic synthesis+++
Growth Stimulation
Endog. GH
Growth Inhibition
IGF-BP-1,2,4


CRF
Growth
Growth Stimulation
rhGH
Growth Inhibition
IGF-BP inhib.

Etiologies of CRF in Children





Tube Feeding / Gastrostomy

Estimation of GFR

- Schwartz Formula

$$\frac{k \times \text{height (cm)}}{\text{Serum Creatinine (µmol/l)}}$$

Age	k
Prema.	29
0-2 y	40
2-12 y	48
13-21 y	48 (♀) ou 62 (♂)

Attention if
-enzymatique technique for serum creatinine
-reduced muscles / denutrition

Schwartz. *J Pediatr* 1984;104:849-54 ; Pediatr Clin North Am 1987;34:571-90

Estimation of GFR

- NEW Schwartz - Formula

DFG (ml/min/1m²73) = 39,1[Taille (m)/**créatininémie** (mg/dl)] 0,516 x [1,8/**cystatine C** (mg/l)] 0,294[30/**urée** (mg/dl)] 0,169[1,099] homme[Taille (m)/1,4] 0,188

CRF
Water intake

Water restriction….

Only in case of oligo-anuric ESRD

→ This is generally the time when dialysis becomes unavoidable.

CRF
Fluid management

Goal: compensation of polyuria (present in most of the cases)

→ In general 200 à 300 ml/kg/j during the 1st month of life.

→ 1 st year of life: propose water every 2h during the day and 2 to 3 times during the night.

« Thirst-Reflex » from age 8-10 months, even during the night.

Thirst is a good regulator for water intake: « free access » to water

CRI
In case of urine concentration deficiency

$$\text{Fluid} = \text{skin water losses} + \frac{\text{Qosm}}{\text{Uosm}}$$

Qosm = charge osmotique du régime

Uosm = osmolalité urinaire

$$\text{Qosm} = [\text{protides (g)} \times 4] + [\text{Na (mmol)} + \text{K (mmol)}] \times 2 + \frac{\text{phosphore (mg)}}{31}$$

Uosm = 2/3 of PCM (maximal urine concentration)

CALCULATION of Fluid intake in case of urinary concentration defect Example

Infant, 1 year, 10 kg, creat clearance 20 ml/min/1,73 m²
urine concent$_{MAX}$ 250 mOsm

Proteins:	20 g (80 mOsm)	
Sodium:	Nutrition 20 mmol Bicarbonate Na 12 mmol NaCl 8,5 mmol	(80 mOsm)
Potassium:	Nutrition 20 mmol (40 mOsm)	
Phosphate:	Nutrition 600 mg (19 mOsm)	

→ Qosm = (80) + (120) + (19) = **219 mOsm**

Qosm = 219 mOsm requires urine volume of **1,46 l** if

Uosm$_{max}$ = 150 mOsm/l

→ Water intake = 200 ml (perspiratio insensibilis) + 1.46 l = **1.660 l** =

166 ml/kg/jour

CRI
Sodium management

Sodium restriction (0,3 à 0,9 mmol/kg/j) not always required:

only -if nephrotic syndrome + edema

-if high blood pressure

In all other cases (CAKUT) :

-No salt restriction

-Sodium intake normal (1-2 mmol/kg/j)

-Often sodium supplementation required: NaCl or $NaHCO_3$

1-2 mmol/kg/j to 4-6 mmol/kg/j

CRI
POTASSIUM INTAKE

Creat-Clearance ml/min/1,73 m²	Potassium-Intake	Recommandations
> 20	Free	- Aldosterone-Antagonists - ACE-inhibitor
10-20	1-2 mm/kg/jour	Restriciton bananas, Oil seeds and oleaginous fruit dry fruits, muesli* dry vegetables Chocolat (K = 10-12 mmol/100g 'Dialyse' potatoes
< 10	1 mm/kg/jour	Reduce fruits and fresh vegetables Avoid potatoes (rather use → pasta, rice, etc).

All categories: No K in infusions

*permitted cereals: Smacks, Honeyloops, Rice Crispies, Honey Pops (Kellog's), Crousty Honey (Quaker)

High Potassium

Oriental cakes/cookies

Very High Potassium














HYPERKALIEMIE

If K+ > 5.8 - 6 mmol/l

→ dietary restrictions

→ Ion-exchanger

Kayexalate® (1 g = 1 mmol Na)

Calcium Sorbisterit® (1 g = 1 mmol (40 mg) Ca

0.5 à 1 g/kg after meals

CALCIUM

Calcium Intake

< 5 years : 500 mg/day

5 - 12 years : 800 mg/day

> 12 years : 1 000 - 1 200 mg/day

In a child with CRF, daily Ca intake between 400 et 800 mg/day
→ supplementation: calcium carbonate

Phosphate Intake

400 à 800 mg/day

(50% of usual intake)

Phosphate and proteins come together!!!

Energy and Protein Intake

Calculated from « Recommended Dietary Allowances » (RDA) for healthy children in France AFFSA 2001

Energy and Protein Requirements in Healthy Children AFSSA 2001

Age	Calories Kcal	protéines g
0 - 6 months	92/kg (400-650)	1.2 - 2.2/kg ou 10 g
6 - 12 months	92/kg (700-950)	1 - 1.1/kg ou 10 g
1 - 3 yrs	84/kg (1100-1200)	12 g
4 - 6 yrs	75/kg (1200-1400)	16.5 g
7 - 10 yrs	1700-2000	22 g
Garçon		
10 - 12 yrs	2000-2100	29 g
13 - 15 yrs	2400-2800	41.5 g
16 - 18 yrs	2800-3100	50 g
Filles		
10 - 12 yrs	1900-2100	29.5 g
13 - 15 yrs	2400-2500	40.5 g
16 - 18 yrs	2500-2600	43.5 g

Energy intake

- Generally, spontaneous calory intake insufficient, 60-80% (anorexia)
- If <70 % of recommandation → growth failure

•Treatment: 100-120 % of recommendation until 6 years
(80-)100 % after 6 years

Protein intake

•100 % of the recommandation for age

CRI
ENERGY requirements

Given through:

carbohydrate	45-50 %	(50-55 % in healthy children)
lipids	40-45 %	(30-35 % in healthy children)
proteins	10 %	(12-15 % in healthy children)

CRF
Max. protein intake in % of recommandation (Agence francaise de sécurité des aliments AFSSA 2001)

Creatinine clearance (ml/min/1.73 m²)

	60 - 30	30 - 10	<10 ou HD/DP
0 to 10 yrs	200 %	170 %	130 %
After 10 yrs	180 %	150 %	120 %

** If PD: + 3 to 5 g/day of protein intake (PD losses)*

Protein Intake and Glomerular Filtration Rate and Age, AFSSA 2001

	Creatinine clearance (ml/min/1.73 m²)		
	60 - 30	10 - 30	<10
0-6 mois	← 2-2.2 g/kg →		
6-12 mois	← 1.9-2 g/kg →		
2-3 ans	24 g	20	16-17
4-6 ans	33	28	21-25
7-10 ans	42-44	35-37	29-31
Boys			
10-12 ans	52	43	40
13-15 ans	75	62	54-58
16-18 ans	90	75	65-70
Girls			
10-12 ans	53	44	38-41
13-15 ans	73	61	52-57
16-18 ans	78	65	56-61

CRF
Nutrition

In order to avoid increase of lipid profile disturbances in CRF (↑ LDL -, VLDL -, IDL - cholestérol, ↑ triglycérides).

- **Avoid:** mono and disaccharides (sugar, sirop, honey)
- **Use:** glucose polymeres such as maltodextrines
- **Avoid** animal fat (butter, creme)
- **Use:** lipids with mono and polyunsaturated fatty acids:
  -sun flower oil, olive oil, margarine

If necessary use calory supplementation: Supersoluble® (glucidolipids) ou Calogen® strawberry or caramel

Which Proteins in CRF ?

Use: animal proteins (++ essential amino acids)

-1st year of life: 100% (breast milk)

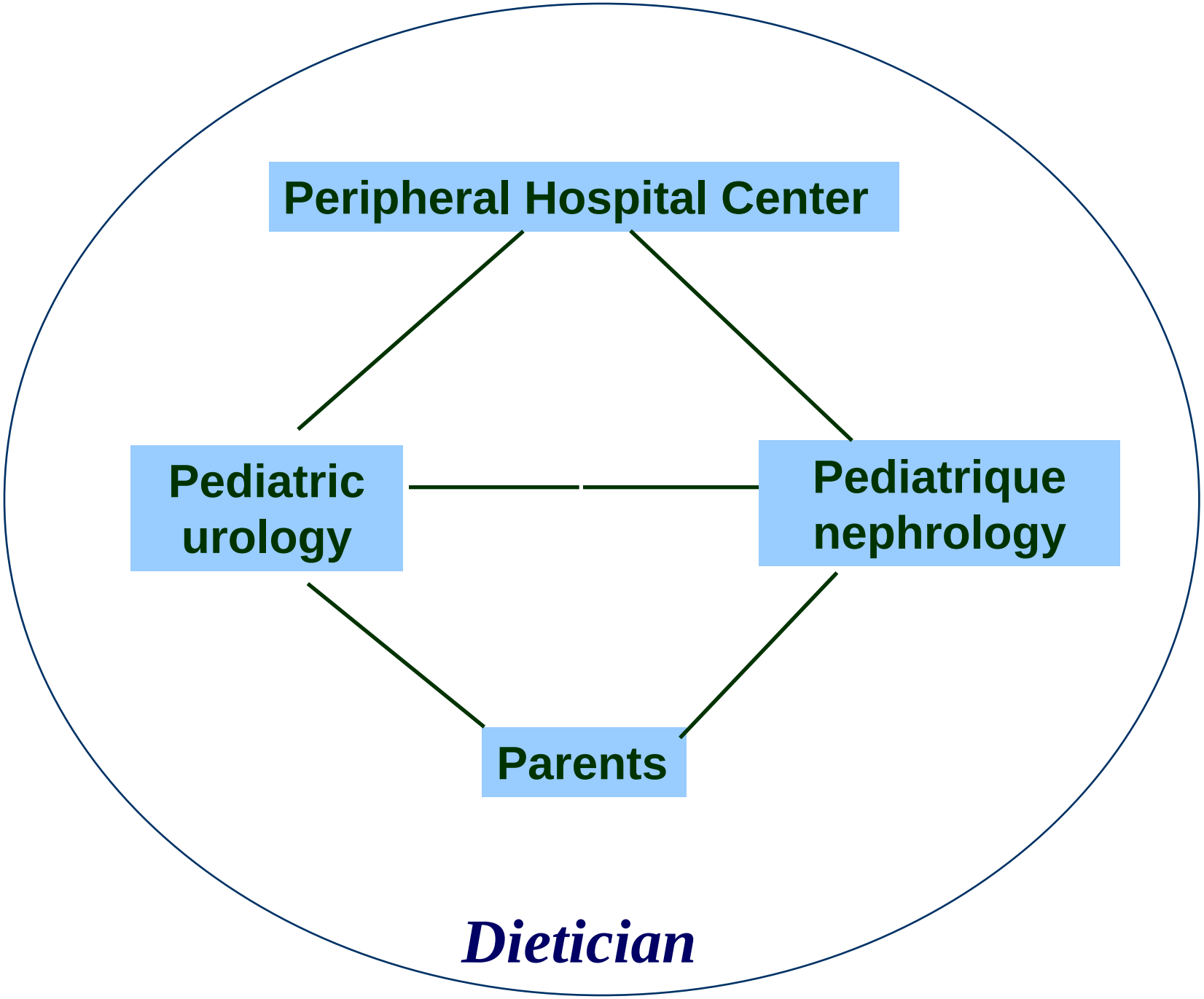
delay diversification until 8-9 months

-Later: 2/3 animal proteins, 1/3 vegetal proteins

(normal child : 1/2 + 1/2)

BENEFITS of limited protein intake

- Lower osmotic load, which increases polyuria and water requirements
- Lower H+ load
- Lower phosphate intake, better PTH control


Peripheral Hospital Center
Pediatric urology
Pediatrique nephrology
Parents
Dietician

CRF
MANAGEMENT and CHECK-UP FREQUENCY

National Kidney Foundation, Am J Kidney Dis 2000 ; 35 (suppl 2) : S 105 - 36

Frequency of consultation and adjustments

	<2 ans	>2 ans
Nutritional evaluation	1/ month	1/3-4 month
Weight-Height	1/ month	1/3-4 month
Head perimeter (< 3 ans)	1/ month	1/3-4 month

1st year of life

Anorexia +++
Gastro-intestinal « coordination »
« Electro-Gastro-Gramme »
vomitting +++

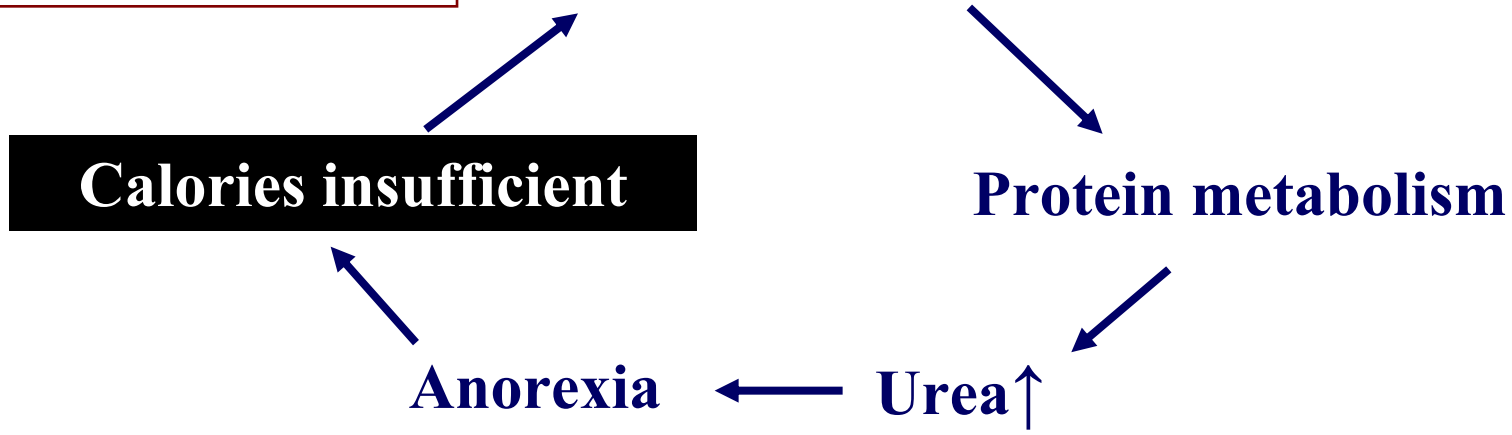
| *disturbances*

→ **Enteral tube feeding** with constant volume flow
by gastric tube or gastrostomy, over night, at home
→ catch up growth

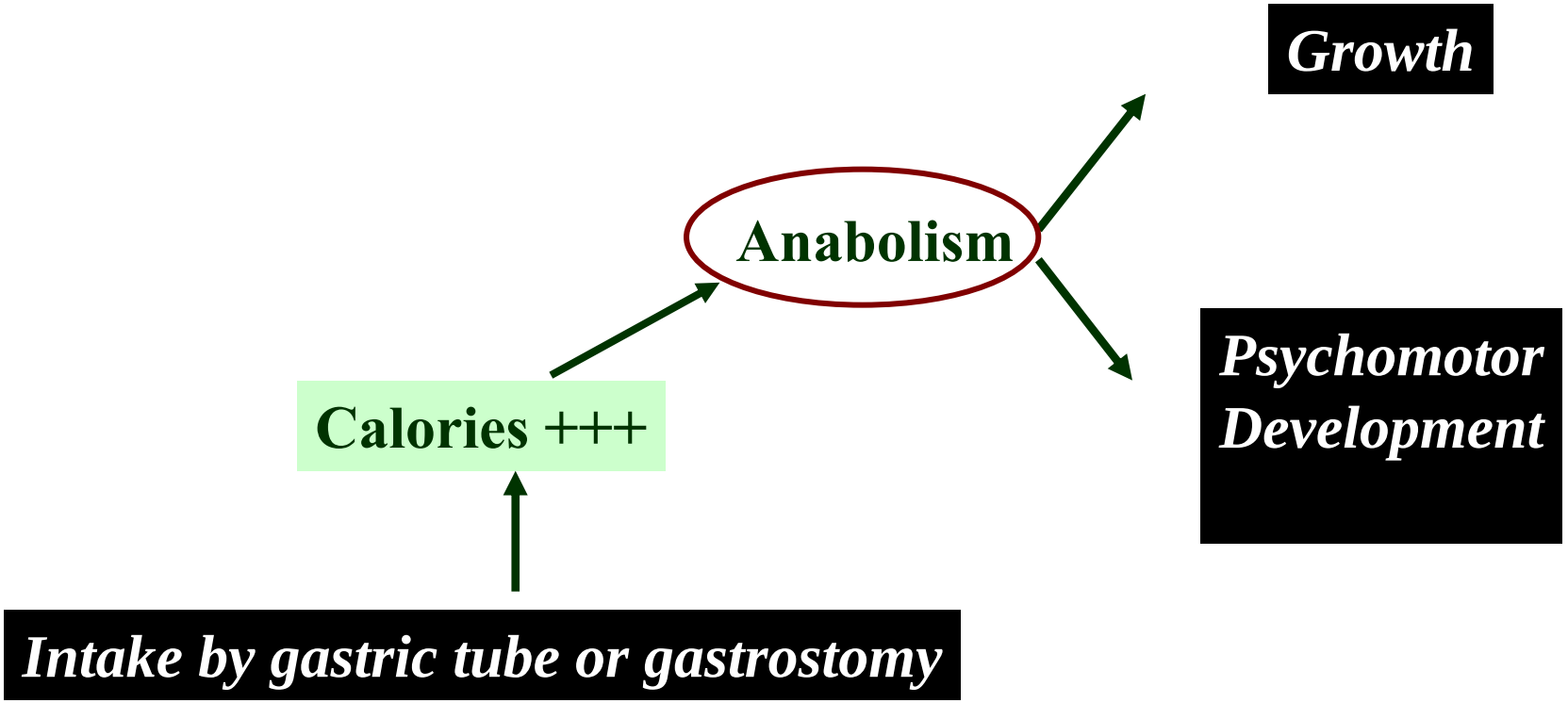
→ **Keep small oral** bottle feeding/small solid food at daytime
in order to maintain ***oral development***.

CRF

Vicious circle



Psychomotor and growth deficiency

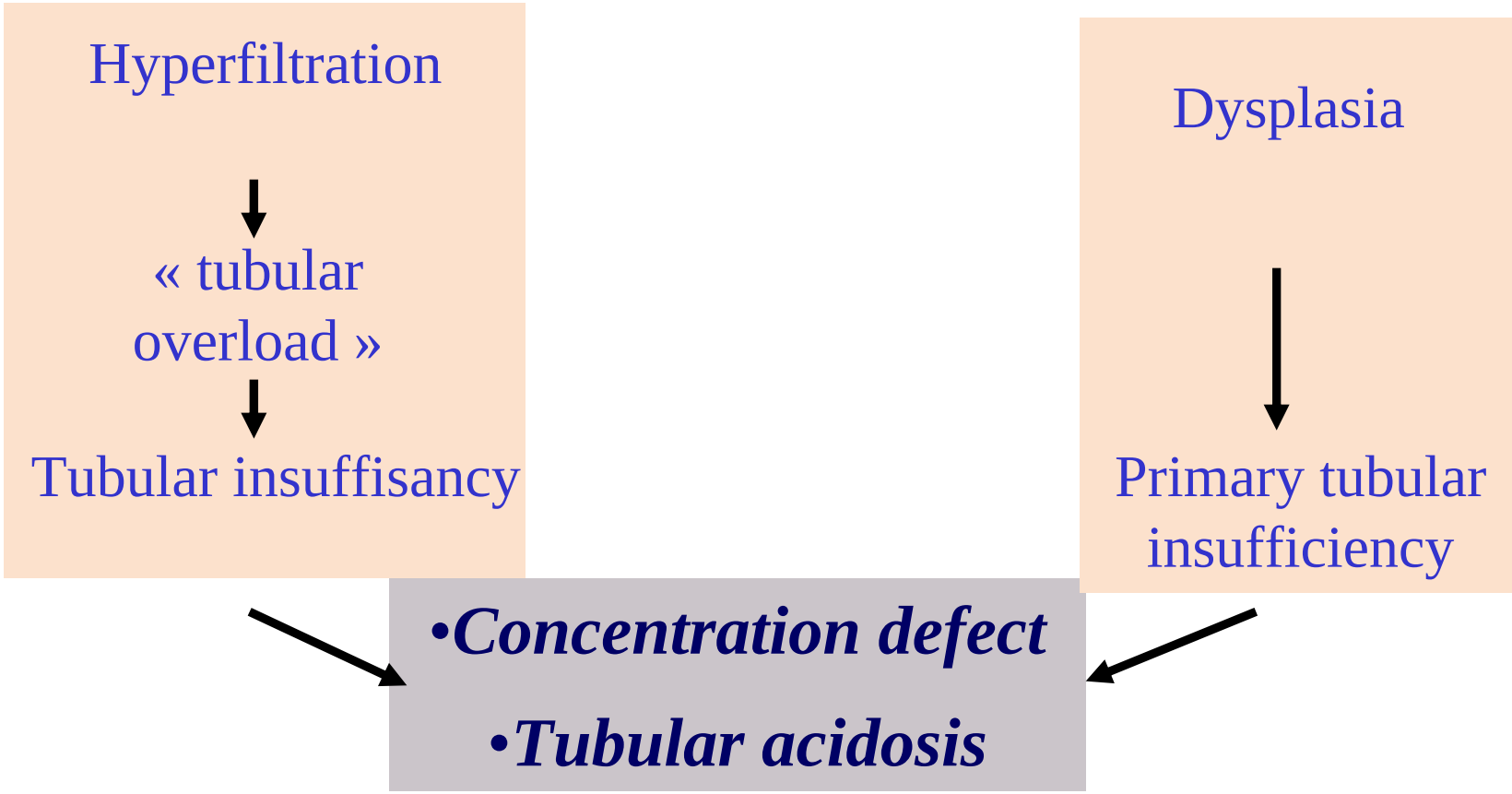


BUN may stay normal despite ESRD

CAKUT

Problem

Tubular dysfonction

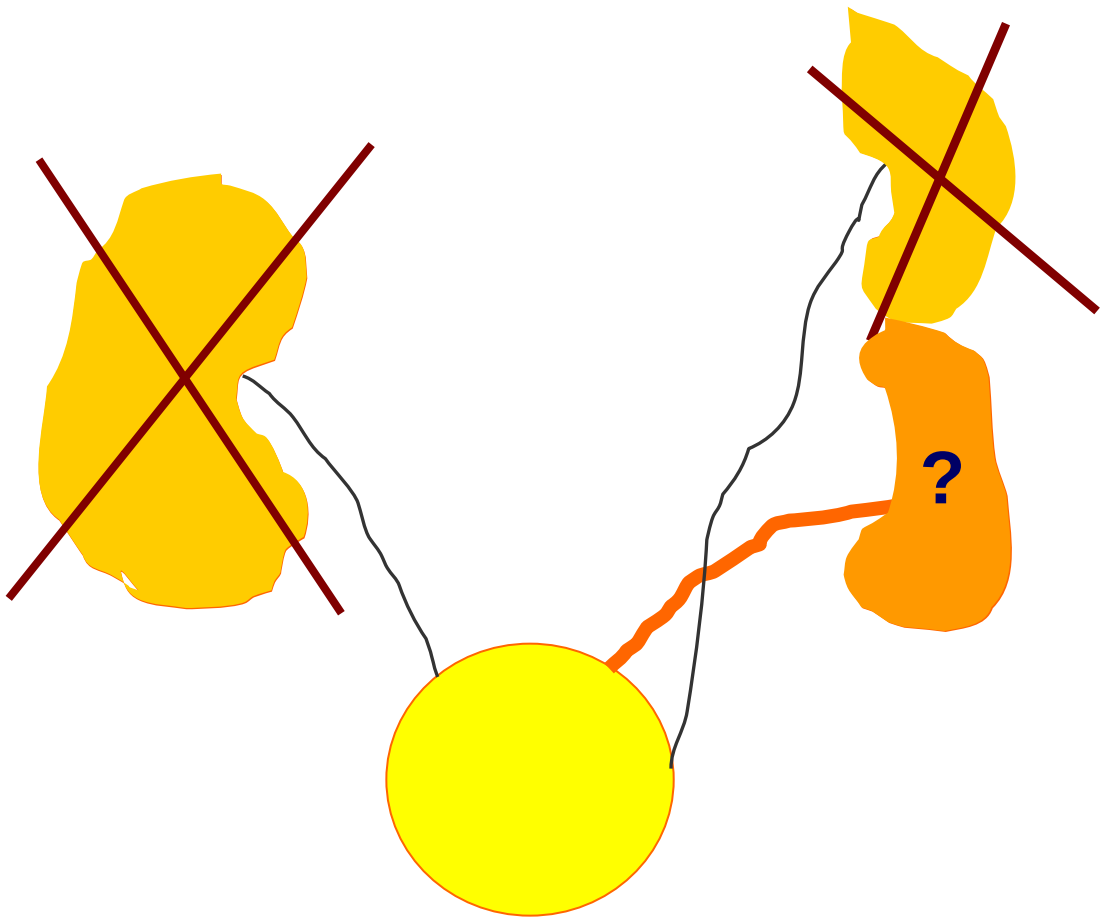


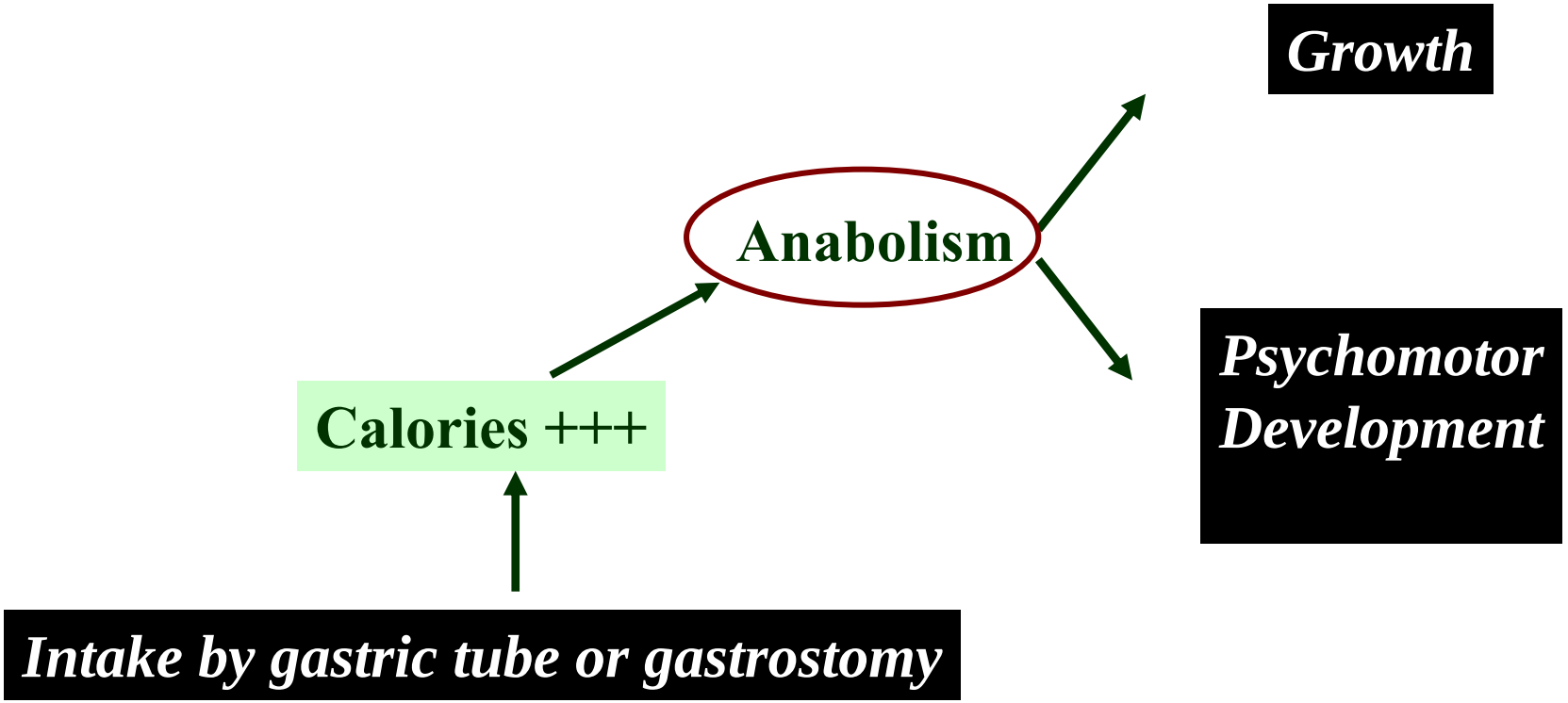
Supplementation with Water and sodium (+ Bicarbonate)

Creatinine:
173 µmol/L

BUN:
6 mmol/L

Clearance:
1,4 ml/min/1,73m²

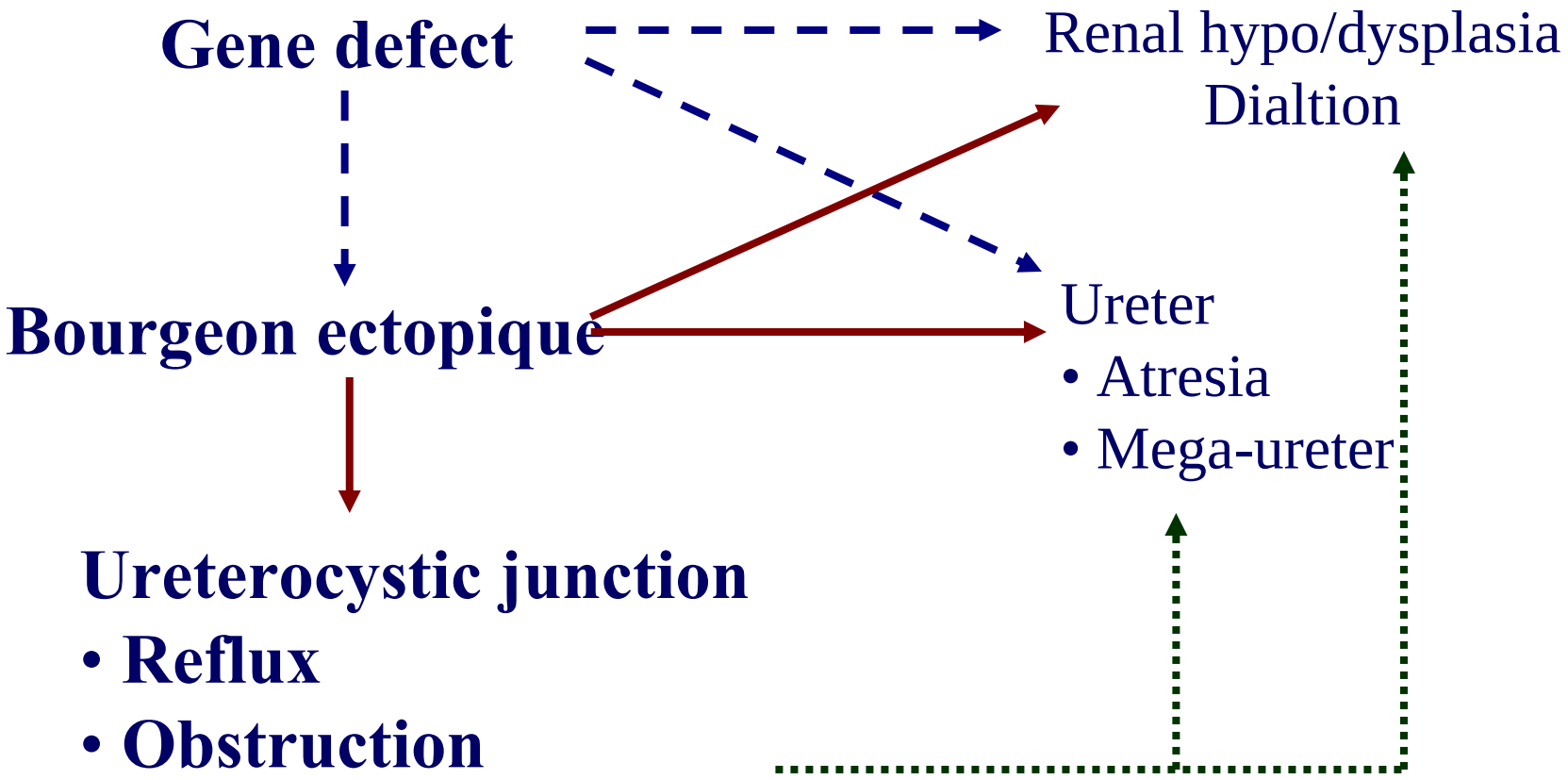



Growth
Anabolism
Psychomotor Development
Calories +++
Intake by gastric tube or gastrostomy

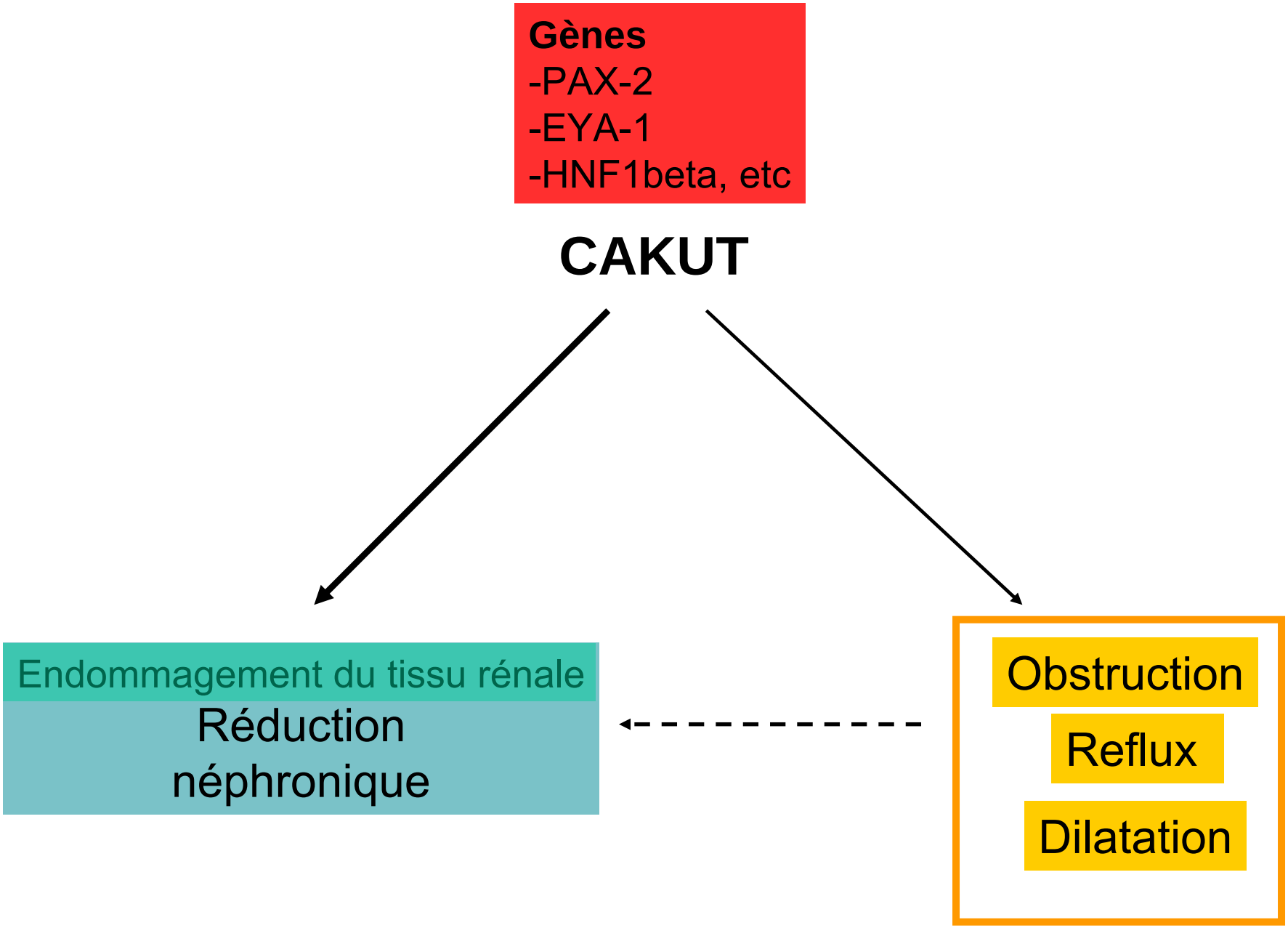
BUN: 6 mmol/L

Dietary prescription

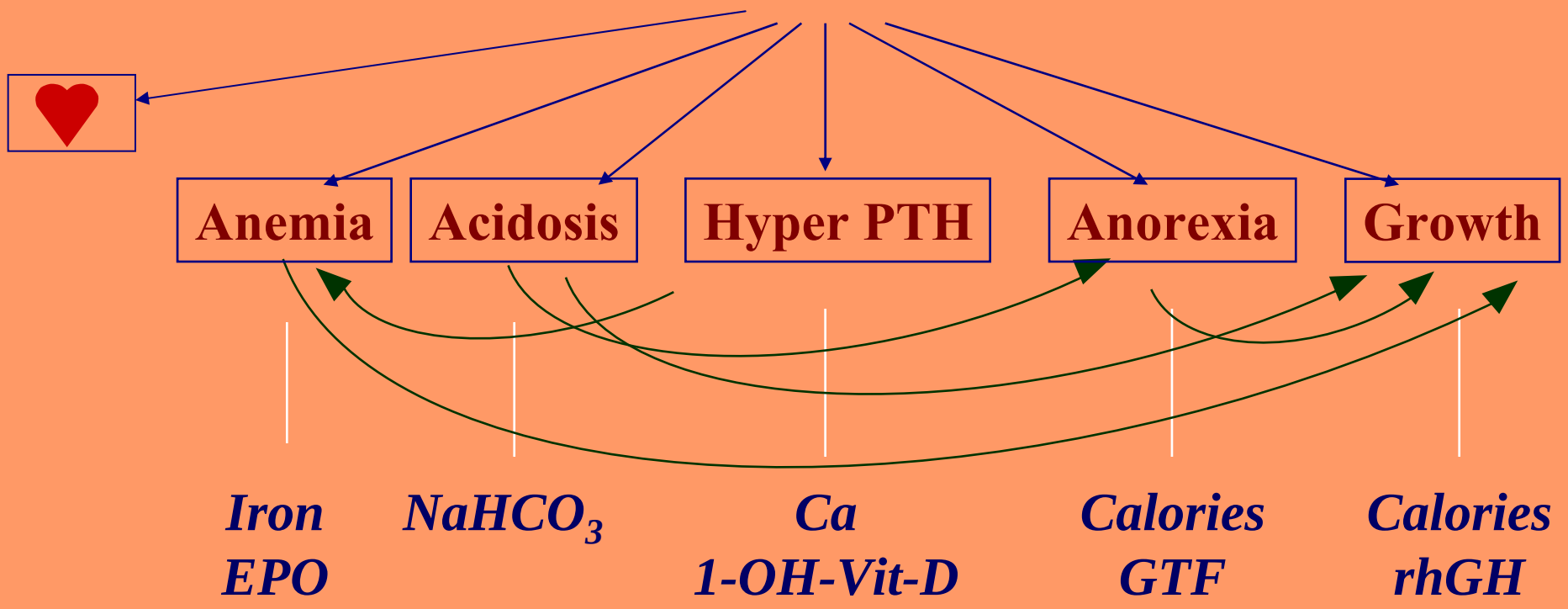
- Weight, height
- Calory intake: % du RDA
- Protein intake: give upper and lower limit for creat-clearance
- Sodium intake: free, without supplement, strictly forbidden
- K+ intake: in mmol/kg
- Fluid



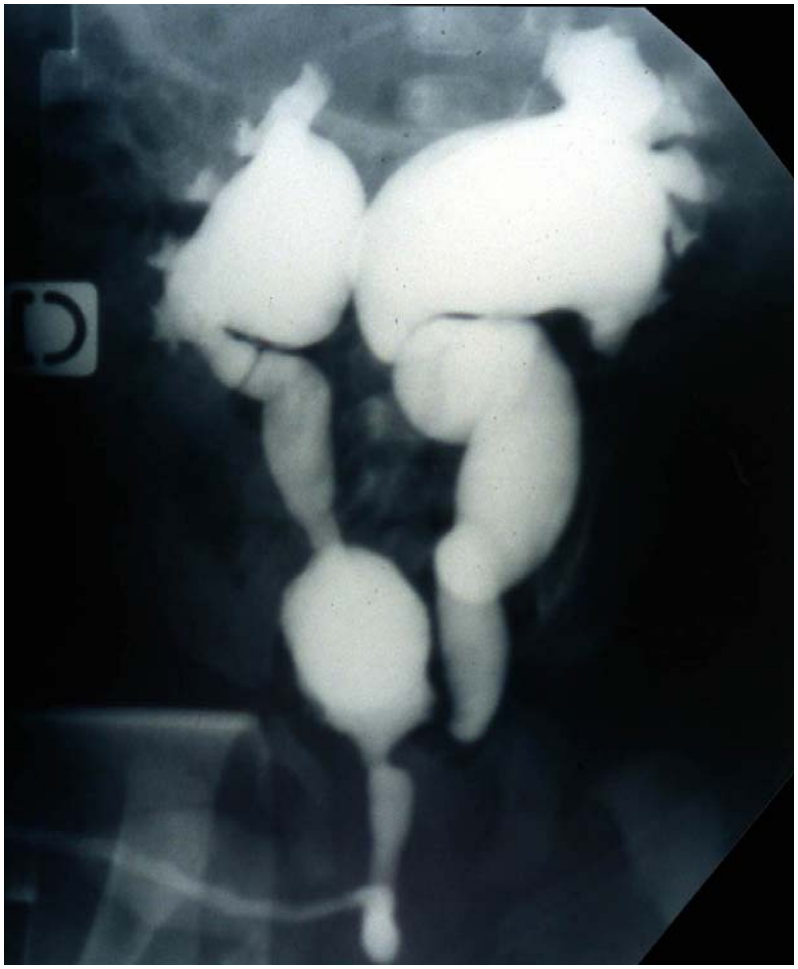
Ichikawa, Kidney International, 20


Gènes
-PAX-2
-EYA-1
-HNF1beta, etc
CAKUT
Endommagement du tissu rénale
Réduction
néphronique
Obstruction
Reflux
Dilatation

Chronic renal failure



Reflux and UTI



VITAMINES

Only vitamine D and activated derivates

Never vitamine A (accumulation of retinol in CRF)

(liver and bone toxicity)