Pediatric Kidney Disease and Its Laboratory Challenges

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Children

are not small adults,

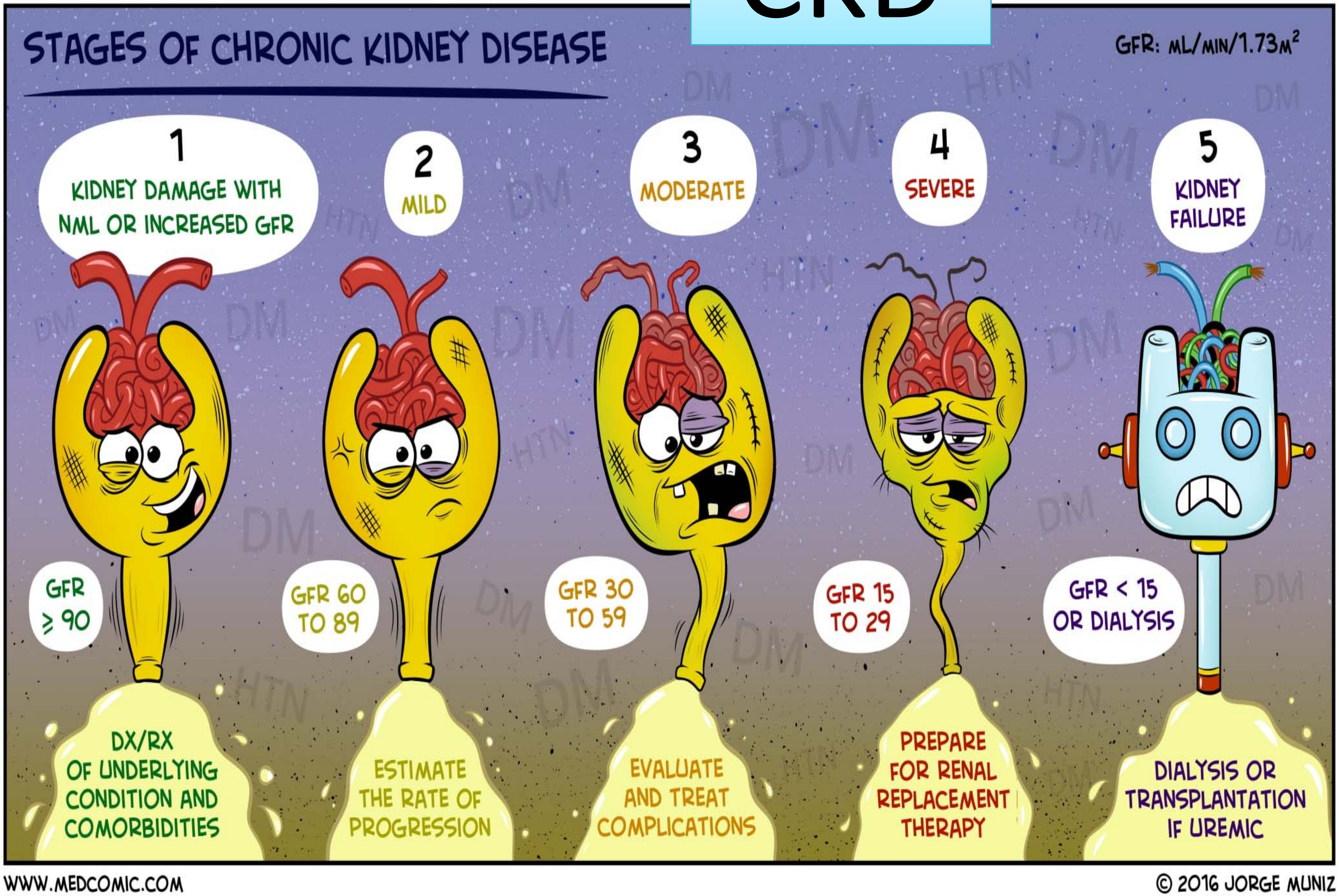
they require

treatment tailored

to **their needs**

Creatinin and eGFR

CKD



STAGES OF CHRONIC KIDNEY DISEASE
GFR: ML/MIN/1.73M²
1
KIDNEY DAMAGE WITH NML OR INCREASED GFR
GFR ≥ 90
DX/RX OF UNDERLYING CONDITION AND COMORBIDITIES
2
MILD
GFR 60 TO 89
ESTIMATE THE RATE OF PROGRESSION
3
MODERATE
GFR 30 TO 59
EVALUATE AND TREAT COMPLICATIONS
4
SEVERE
GFR 15 TO 29
PREPARE FOR RENAL REPLACEMENT THERAPY
5
KIDNEY FAILURE
GFR < 15 OR DIALYSIS
DIALYSIS OR TRANSPLANTATION IF UREMIC
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AKI

RIFLE criteria

	Creatinine	GFR	Urine
Risk	1.5x ↑	↓ 25%	<0.5ml/kg for 6h
Injury	2x ↑	↓ 50%	<0.5ml/kg for 12h
Failure	3x ↑	↓ 75%	<0.5ml/kg for 24h or anuria for 12h
Loss	Need for RRT for >4 weeks		
ESRD	Need for RRT for >3 months		

Crit Care 2004; 8:R204.

WORKUP

FOCUSED ON THE CAUSE

1) PRE-RENAL

FENa<1% → PRE-RENAL FAILURE

FENa>2% → ATN

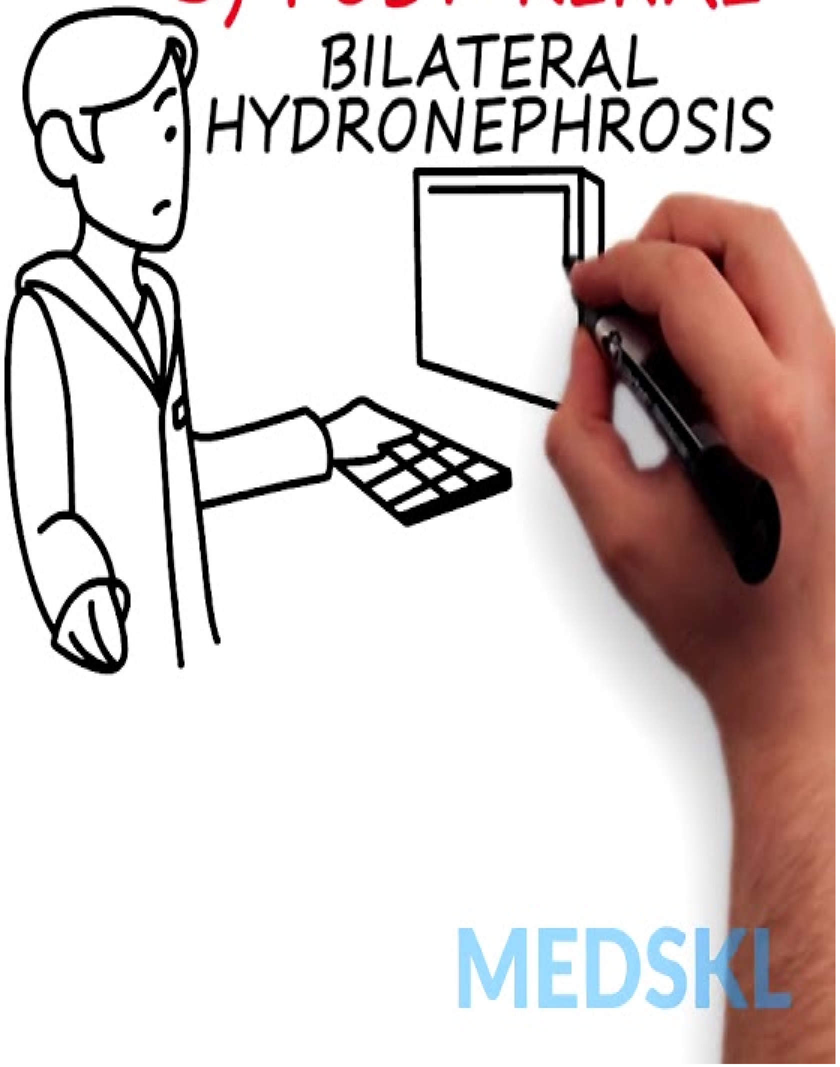
2) RENAL

-CHECK FENa

-USE URINALYSIS

3) POST-RENAL

BILATERAL HYDRONEPHROSIS



eGFR

- Renal function of a graft
- Drug adjustment
- Decision for initiation of RRT

Table 1 Plasma creatinine reference intervals (2.5–97.5th percentiles) [9]

	Enzymatic creatinine		Jaffe creatinine		
Age group	mg/dL	umol/L	Age group	mg/dL	umol/L
0–14 days	0.32–0.92	28–81	0–14 days	0.42–1.05	37–93
15 days to <2 years	0.1–0.36	9–32	15 days to <1 year	0.31–0.53	27–47
2 to <5 years	0.2–0.43	18–38	1 to <4 years	0.39–0.55	34–49
5 to <12 years	0.31–0.61	27–54	4 to <7 years	0.44–0.65	39–57
12 to <15 years	0.45–0.81	40–72	7 to <12 years	0.52–0.69	46–61
15–19 years male	0.62–1.08	55–95	12 to 15 years	0.57–0.80	50–71
15 to <19 years female	0.49–0.84	43.3–74	15 to <17 years male	0.65–1.04	57–92
			15 to <17 years female	0.59–0.86	52–76
			17 to <19 years male	0.69–1.10	61–97
			17 to <19 years female	0.60–0.88	53–78

eGFR

Age	Recommended equation
<18 years	Bedside IDMS-traceable Schwartz eGFR for children <18 years old [19]

Mass units – mg/dL, height in cm
$GFR = (0.413 \times height)/creat$

Age in years	^{51}Cr-EDTA clearance (mL/min/1.73 m^2)
≤0.1	34–70
0.1–0.3	33.1–90.3
0.3–0.66	43.9–99.5
0.66–1	48–117.2
1–1.5	55.9–127.1
1.5–2	58.3–130.7
≥2	63.6–145.2

Calculating Peritoneal Clearance

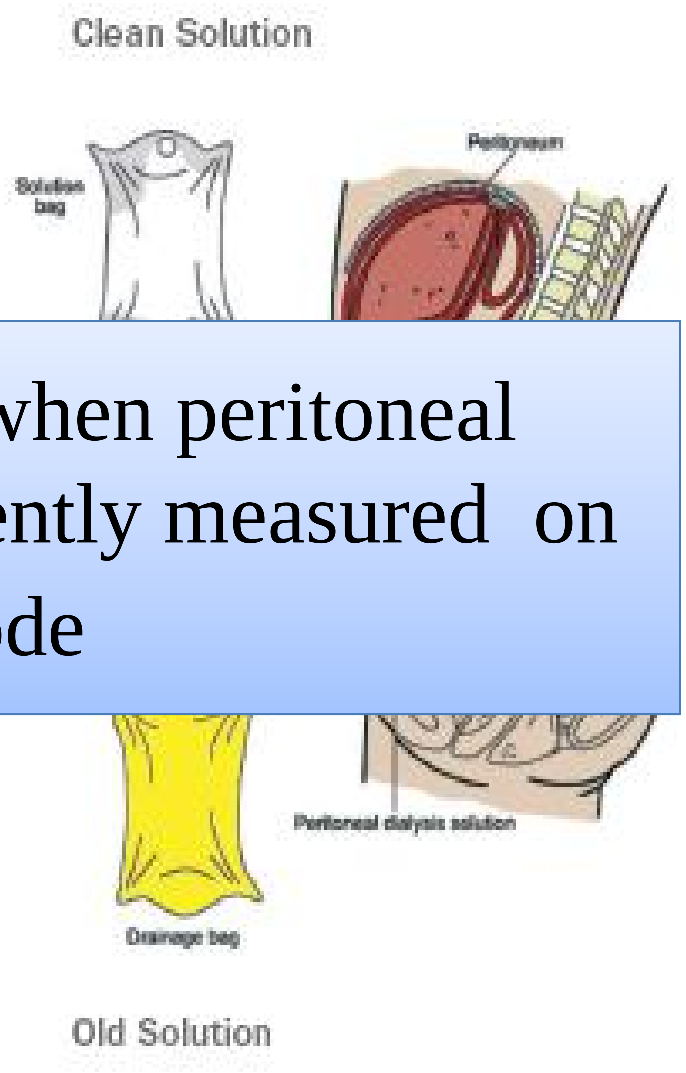
- Wkly CrCl (L)= [total DV (Dcr/Pcr) x7]x1.73/m2

- Wkly KT/V= [(DV/V of distri.) x (D urea/P urea)] x7

Table 1 Peritoneal dialysate effluent urea nitrogen and creatinine (in mg/dl) measured on ‘urine’ and ‘serum’ modes of Vitros chemistry analyzer showing marked discrepancy between the serum and urine modes

Urea nitrogen (mg/dl)			Creatinine (mg/dl)	
Sample	Urine mode	Serum mode	Urine mode	Serum mode
9	79	49	14.2	7.9
10	70	15	7.0	1.0
11	71	22	9.3	3.6
12	72	23	8.9	3.2
13	70	15	7.7	1.6
14	72	27	9.6	4.2
15	69	12	7.7	1.6

Error in assay would occur when peritoneal dialysate effluent was inadvertently measured on the "**urine**" mode



Urine Protein

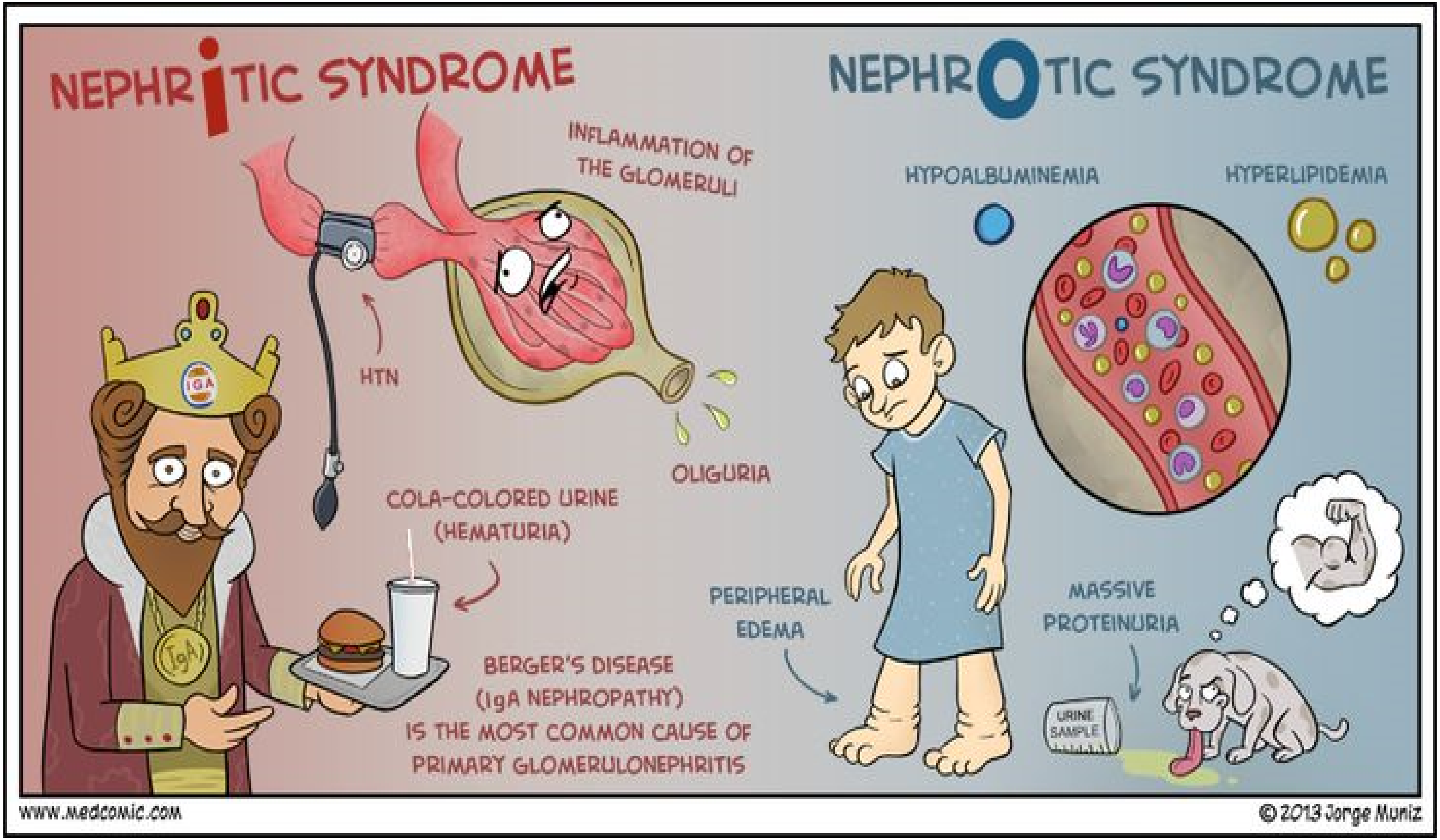


Table 6 Normal values of protein excretion as a function of age

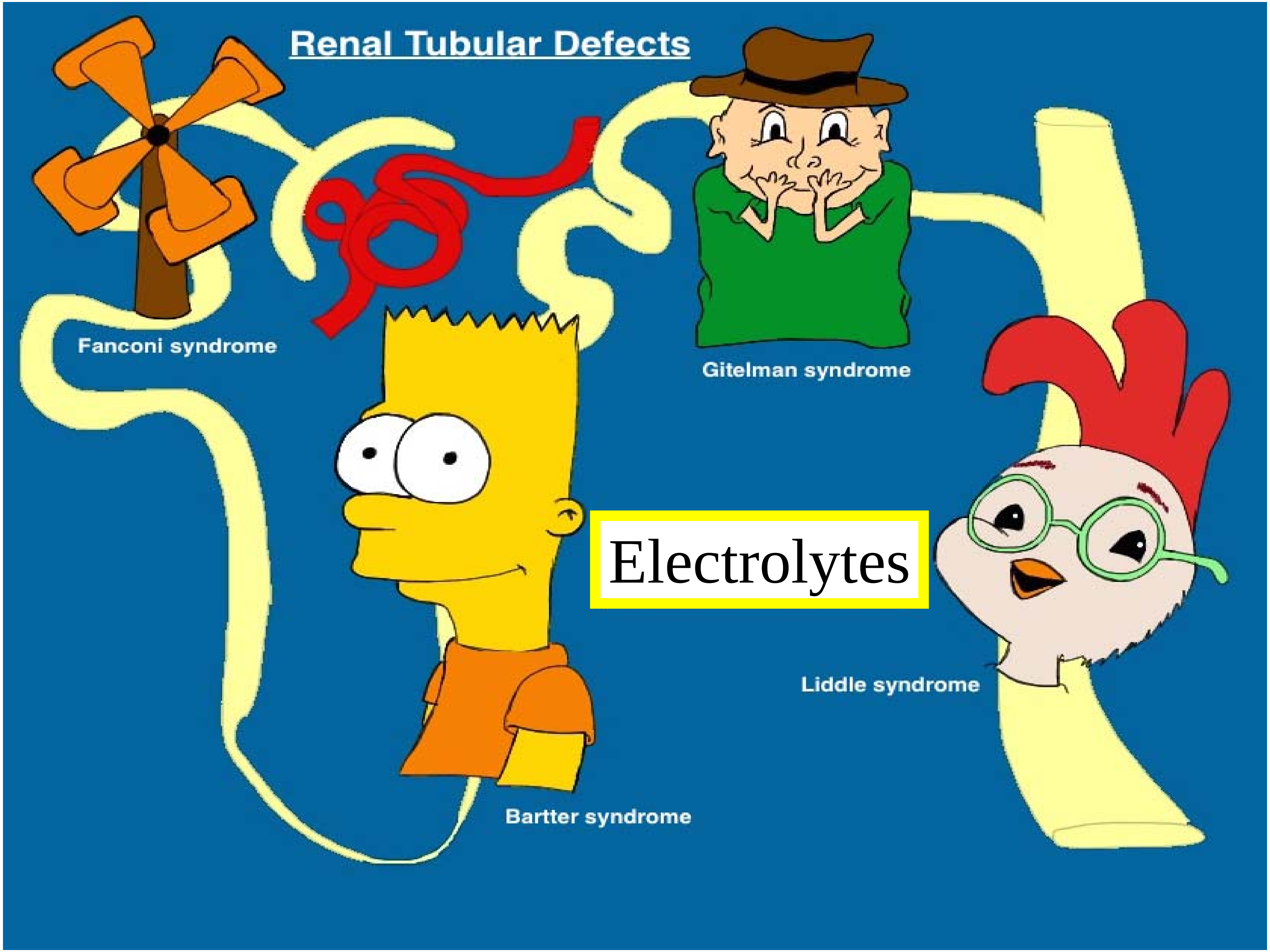
Age	g/g creatinine	g/mol creatinine
0–6 months	0.70	80
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
3–5 years	0.20	20
5–7 years	0.15	19
7–17 years	0.15	18

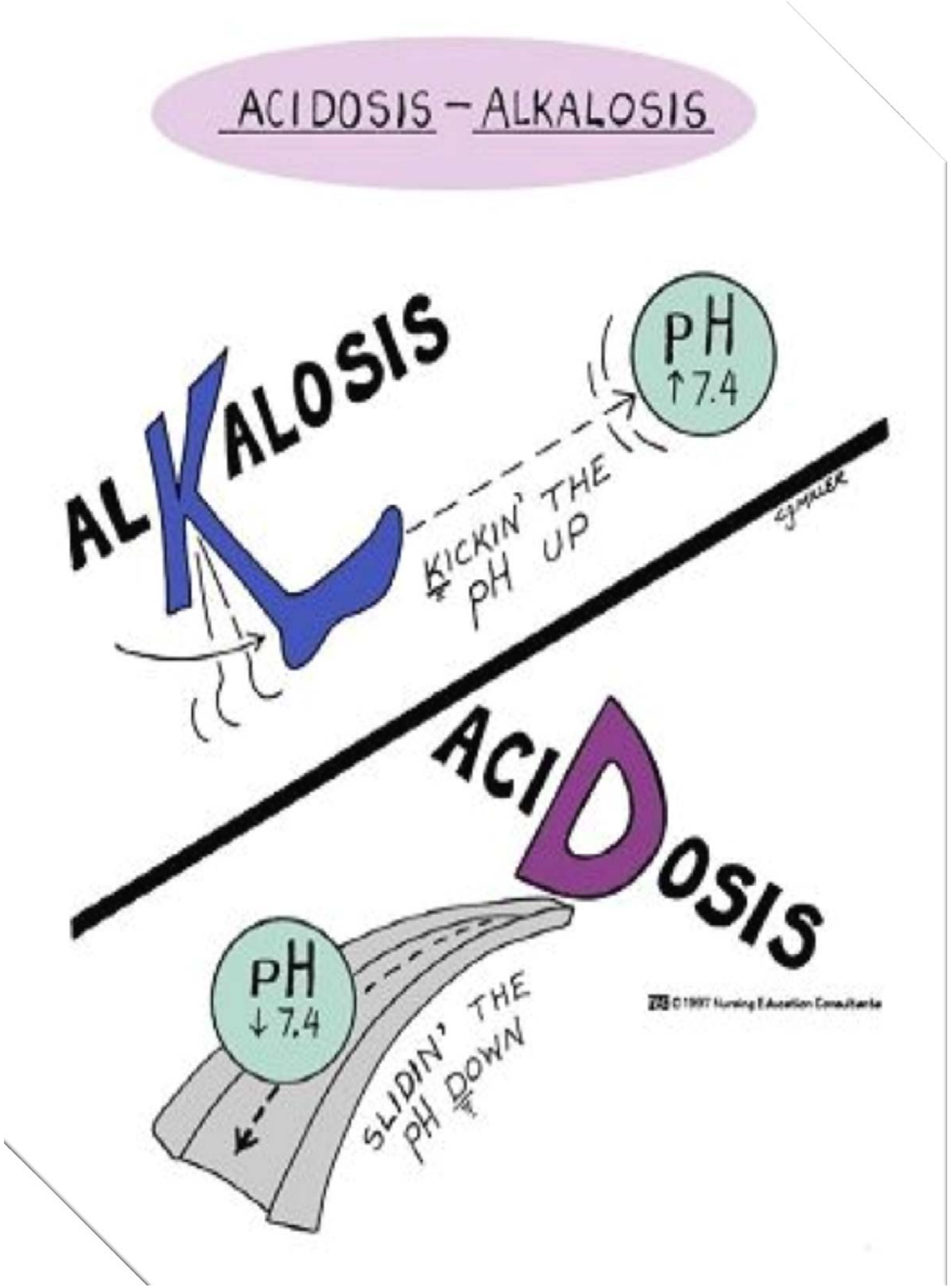
UPr/Cr >0.2
for children 6 to 24 months of age >0.5
is abnormal

Stone

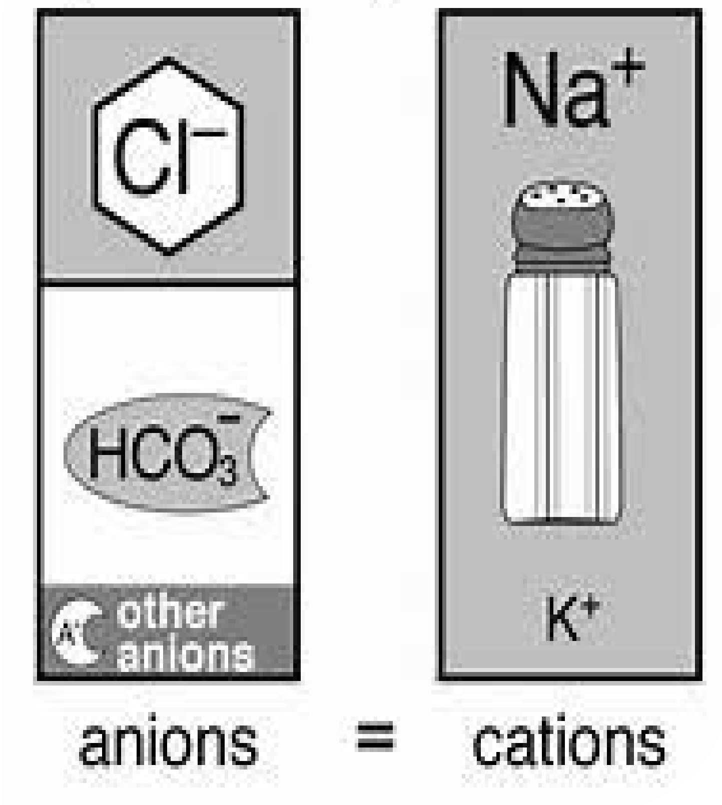
Evaluation

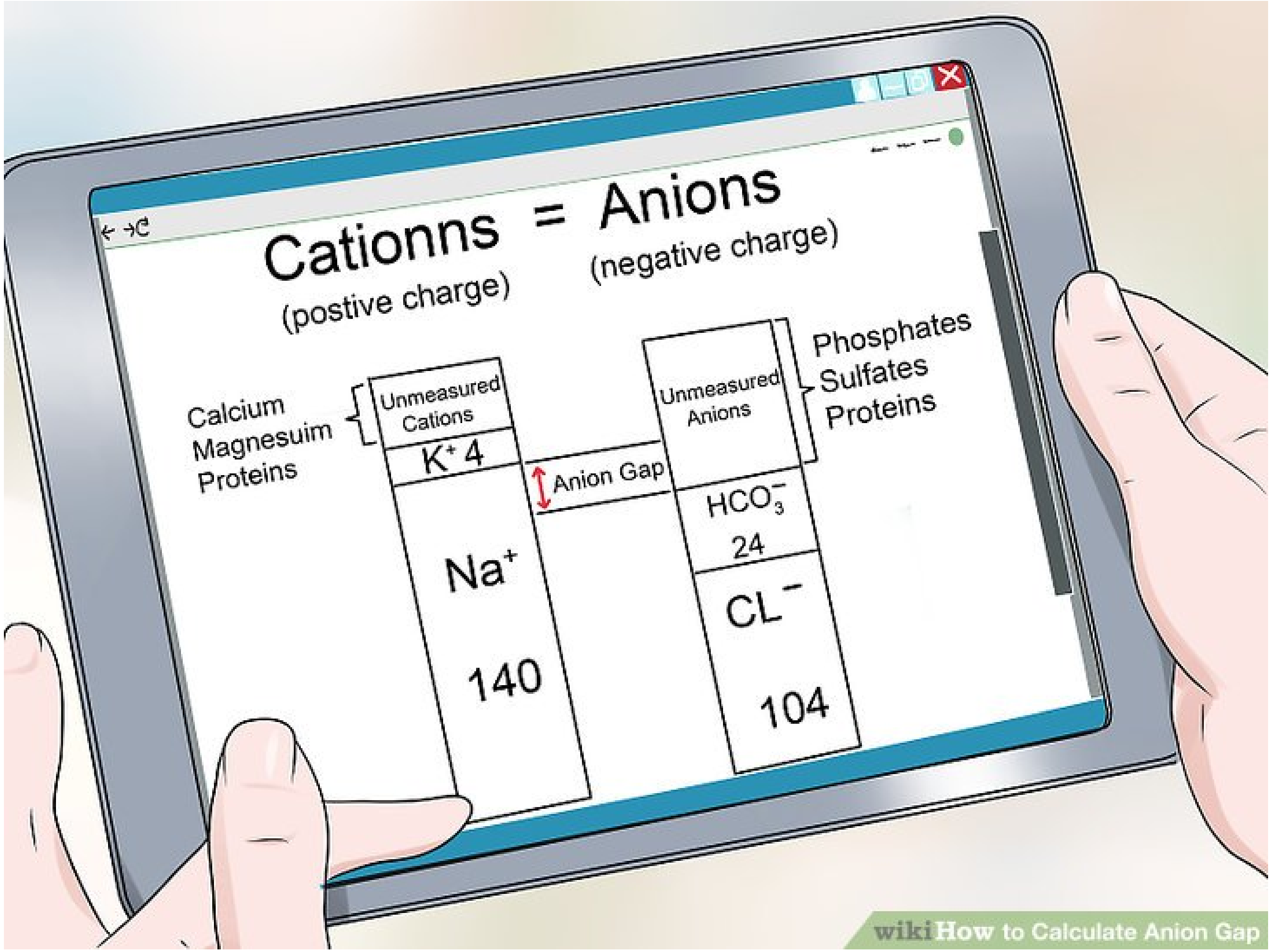
Table 562.3	Urine Chemistry: Normal Values			
URINE CONSTITUENT	**AGE**	**RANDOM**	**TIMED**	**COMMENTS**
Calcium	0-6 mo 7-12 mo ≥2 yr	<0.8 mg/mg creat <0.6 mg/mg creat <0.21 mg/mg creat	<4 mg/kg/24 hr	Prandial variation Sodium-dependent
Oxalate*	<1 yr 1-<5 yr 5-12 yr >12 yr	0.15-0.26 mmol/mmol creat 0.11-0.12 mmol/mmol creat 0.006-0.15 mmol/mmol creat 0.002-0.083 mmol/mmol creat	≥2 yr: <0.5 mmol/1.73 m^2/24 hr	Random urine mmol/mmol highly age-dependent Excretion rate/1.73 m^2 constant through childhood and adulthood
Uric acid	Term infant >3 yr	3.3 mg/dL GFR† <0.53 mg/dL GFR	<815 mg/1.73 m^2/24 hr	Excretion rate/1.73 m^2 from >1 yr age; constant through childhood
Magnesium	>2 yr	<0.12 mg/mg creat	<88 mg/1.73 m^2/24 hr	Excretion rate/1.73 m^2 constant through childhood
Citrate		>400 mg/g creat		Limited data available for children
Cystine		<75 mg/g creat	<60 mg/1.73 m^2/24 hr	Cystine >250 mg/g creat suggests homozygous cystinuria


Renal Tubular Defects
Fanconi syndrome
Gitelman syndrome
Electrolytes
Liddle syndrome
Bartter syndrome

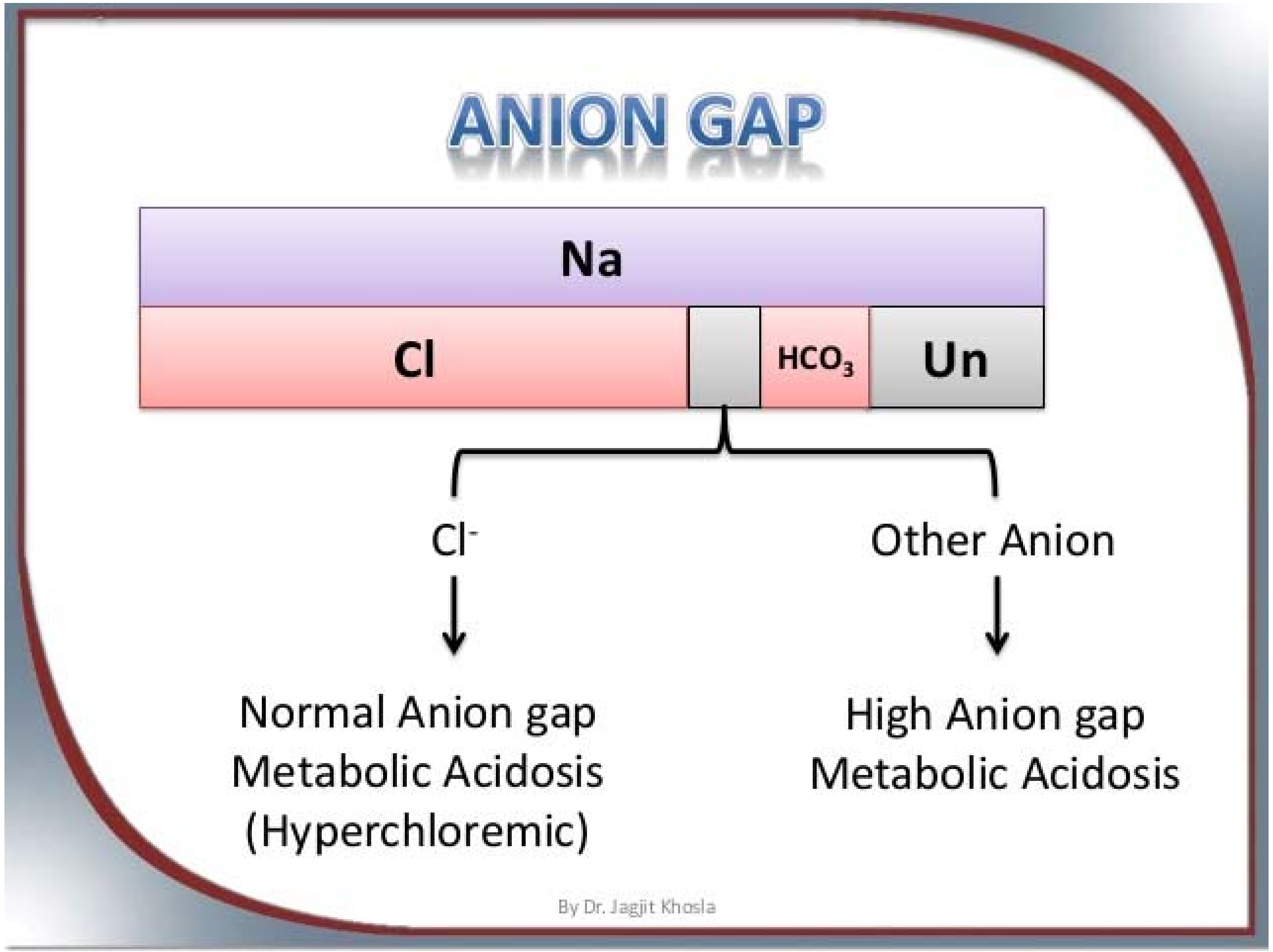

ACIDOSIS – ALKALOSIS
ALKALOSIS
KICKIN' THE pH UP
pH ↑7.4
ACIDOSIS
SLIDIN' THE pH DOWN
pH ↓7.4

Urine & Blood


Cl^-
HCO_3^-
other anions
Na^+
K^+
anions = cations



Cationns = Anions
(postive charge)
(negative charge)
Calcium
Magnesuim
Proteins
Unmeasured Cations
K+ 4
Na+
140
Anion Gap
Unmeasured Anions
HCO3-
24
CL-
104
Phosphates
Sulfates
Proteins
wikiHow to Calculate Anion Gap


ANION GAP
Na
Cl
HCO_3
Un
Cl^-
Other Anion
Normal Anion gap
Metabolic Acidosis
(Hyperchloremic)
High Anion gap
Metabolic Acidosis
By Dr. Jagjit Khosla

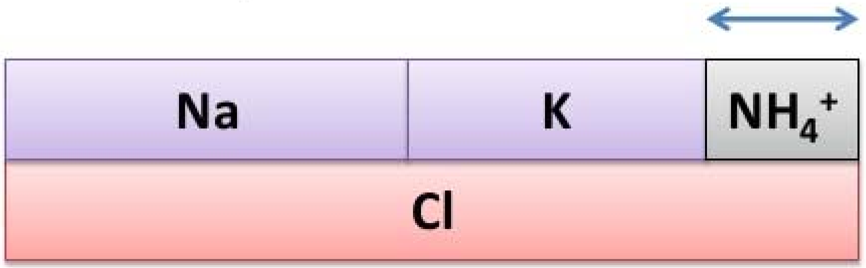
URINE ANION GAP

$U_{Na+} + U_{K+}$ + Unmeasured cations = U_{Cl-} + Unmeasured anions

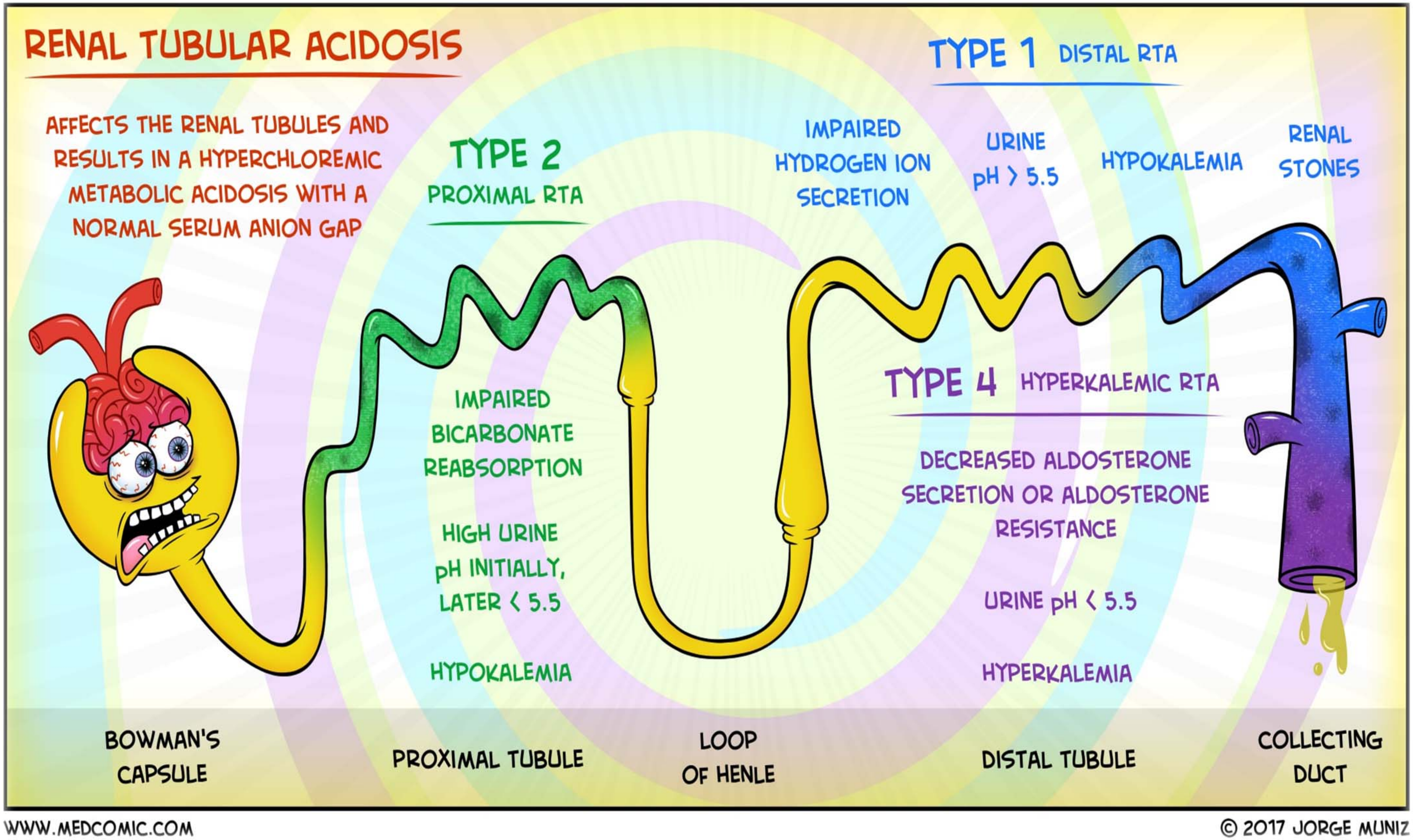
Or, Unmeasured anions – Unmeasured cations = $(U_{Na+} + U_{K+}) - U_{Cl-}$

Urine Anion Gap (UAG) = $(U_{Na+} + U_{K+}) - U_{Cl-}$

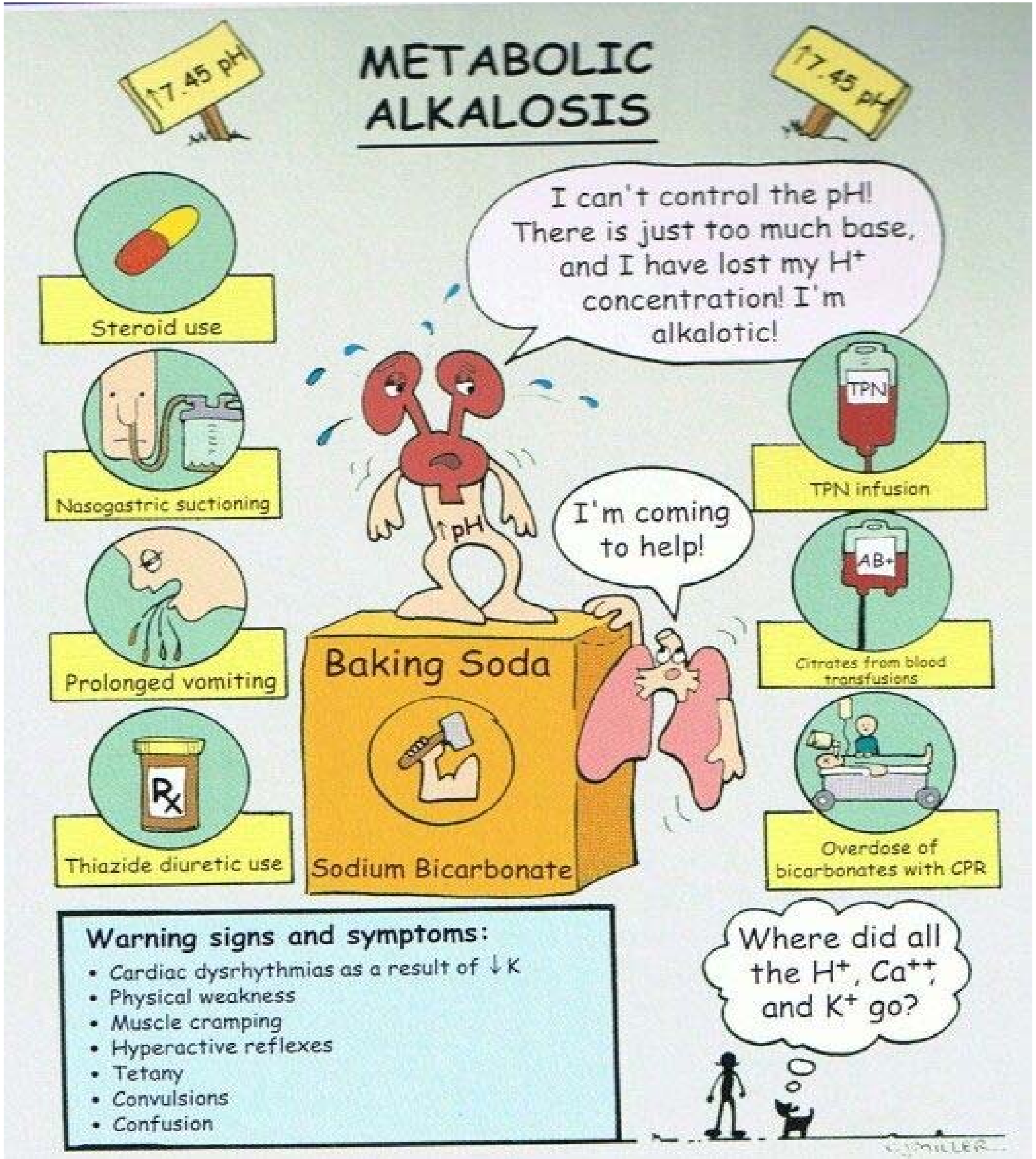
- **NH_4^+** is the primary unmeasured cation which is not balanced by anions.
- **UAG as indirect assay for renal NH4+ excretion**



Normal Anion Gap



High Anion Gap



METABOLIC ALKALOSIS
↑7.45 pH
↑7.45 pH
I can't control the pH! There is just too much base, and I have lost my H+ concentration! I'm alkalotic!
Steroid use
Nasogastric suctioning
Prolonged vomiting
Thiazide diuretic use
↑pH
I'm coming to help!
Baking Soda
Sodium Bicarbonate
TPN
TPN infusion
AB+
Citrates from blood transfusions
Overdose of bicarbonates with CPR
Warning signs and symptoms:
• Cardiac dysrhythmias as a result of ↓K
• Physical weakness
• Muscle cramping
• Hyperactive reflexes
• Tetany
• Convulsions
• Confusion
Where did all the H+, Ca++, and K+ go?

Table 2 Variations in urine chloride measured using an ion-selective electrode between instruments and between different laboratories using the same instrument (adapted from College of American Pathologists 2005 Survey data)

Method instrument Ion selective electrode	No. labs	Mean	S.D.	C.V.	Median	Low value	High value
Sample #1							
ABBOTT AEROSET	31	61.8	1.0	1.6	62	59	63
BAYER ADVIA 1650/2400	**63**	**90.1**	**5.5**	**6.1**	**90**	**80**	**102**
BECKMAN SYNCHRON LX20	**487**	**60.7**	**1.5**	**2.5**	**61**	**56**	**65**
DADE BEHRG DIM QUICKLYTE	421	70.7	1.6	2.3	71	66	75
OLY 400–640/2700/5400	126	89.6	6.3	7.0	89	76	106
ROCHE COBAS INTEGRA	187	79.1	9.7	12.2	76	64	108
ROCHE MODULAR	131	63.5	2.1	3.4	63	58	70
VITROS 250 CHEM SYSTEM	64	62.8	2.0	3.2	63	58	67
Sample #2							
ABBOTT AEROSET	31	103.0	1.1	1.0	103	101	105
BAYER ADVIA 1650/2400	**63**	**133.2**	**5.8**	**4.3**	**132**	**123**	**150**
BECKMAN SYNCHRON LX20	**487**	**101.9**	**1.4**	**1.4**	**102**	**98**	**106**
DADE BEHRG DIM QUICKLYTE	418	113.4	2.2	1.9	113	108	120
OLY 400–640/2700/5400	125	134.6	6.4	4.8	134	119	151
ROCHE COBAS INTEGRA	188	126.9	10.9	8.6	125	110	159
ROCHE MODULAR	133	107.2	2.0	1.9	107	102	112
VITROS 250 CHEM SYSTEM	65	105.1	2.3	2.2	105	101	112

Take home message

- When confronting an “unacceptable” test result, the clinician should consult with the laboratory for better clarification of the potential reasons for the discrepancy.