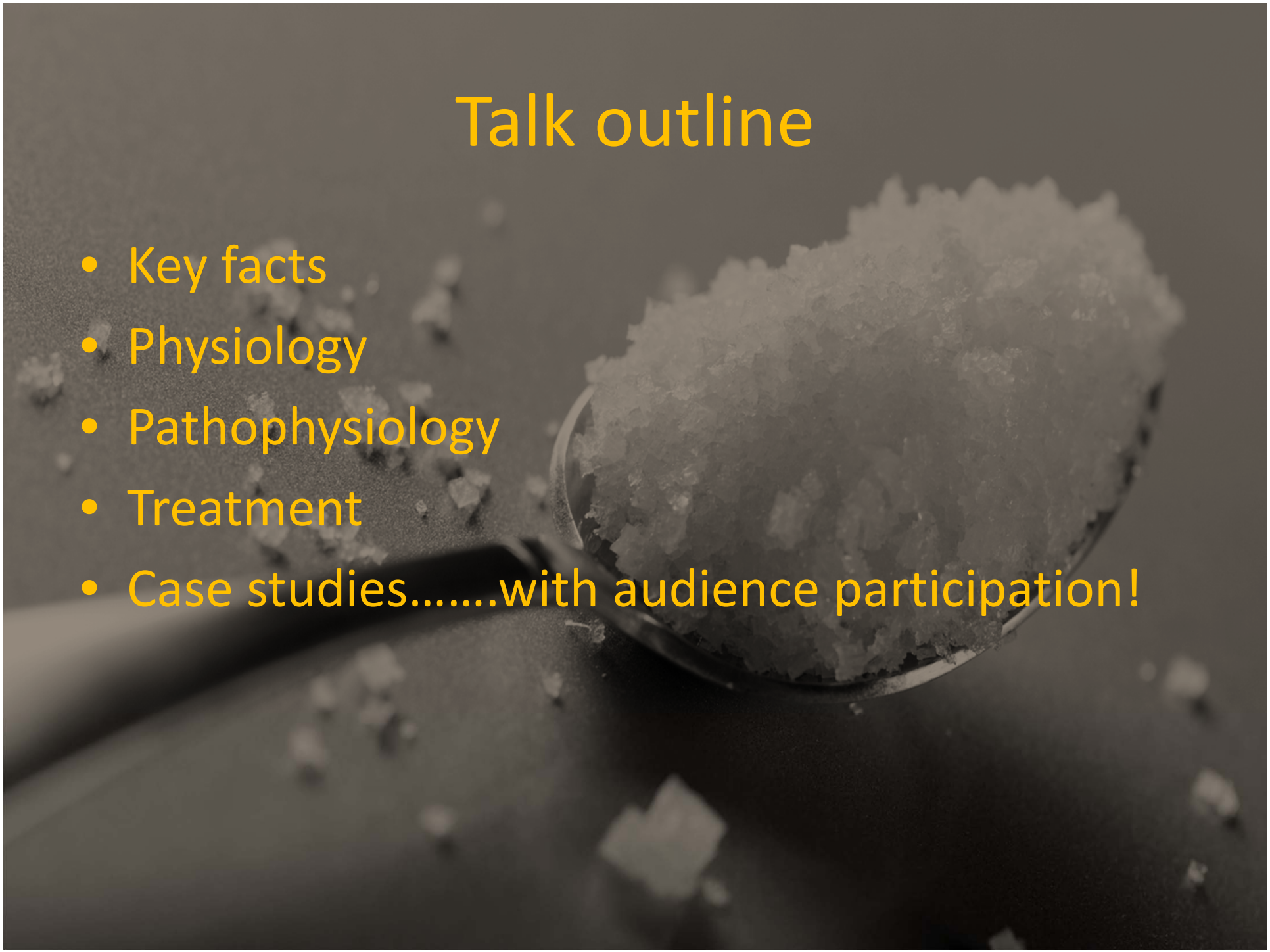
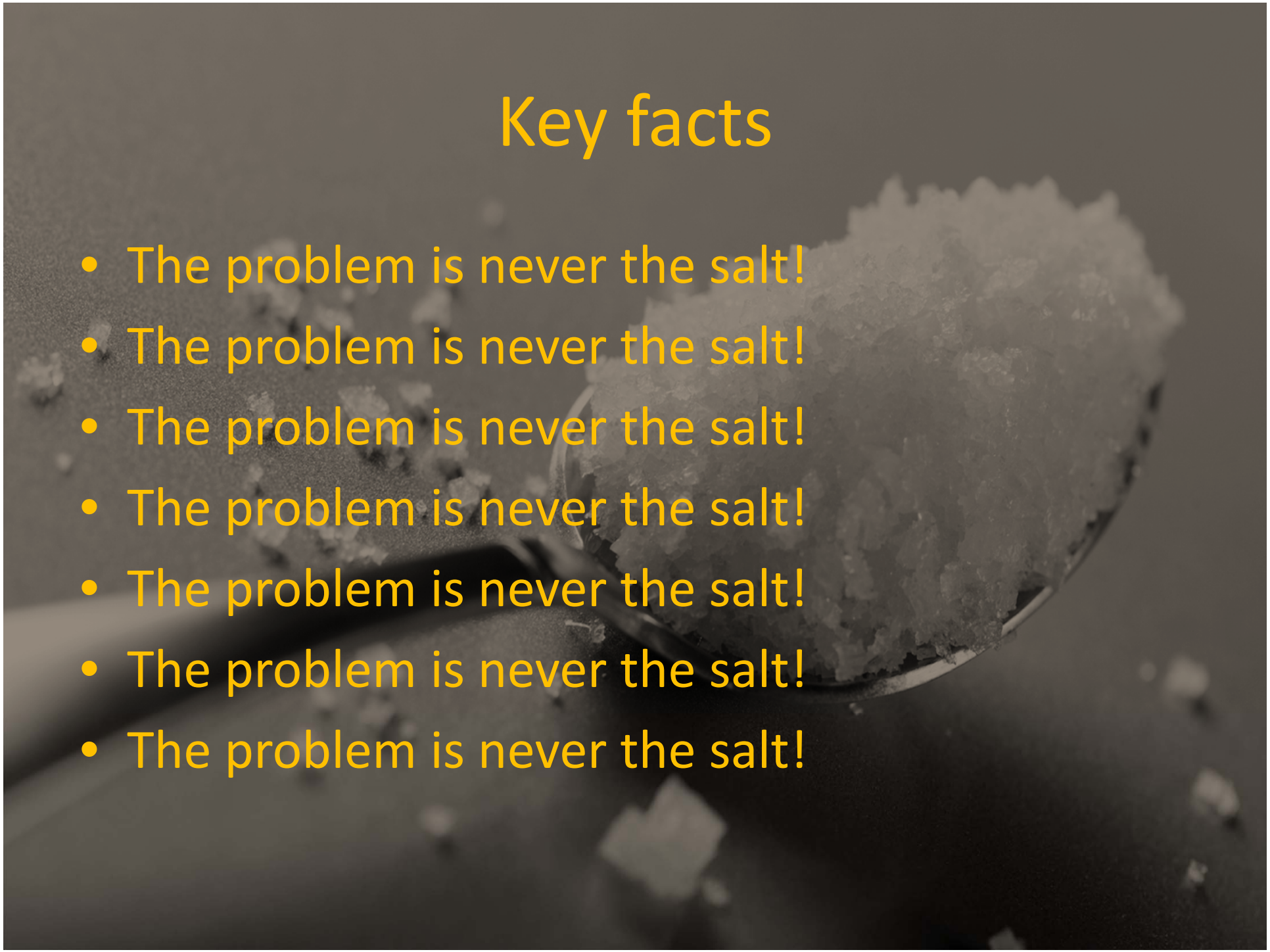

Hyponatraemia



Talk outline

- Key facts
- Physiology
- Pathophysiology
- Treatment
- Case studies…….with audience participation!



Key facts

- The problem is never the salt!
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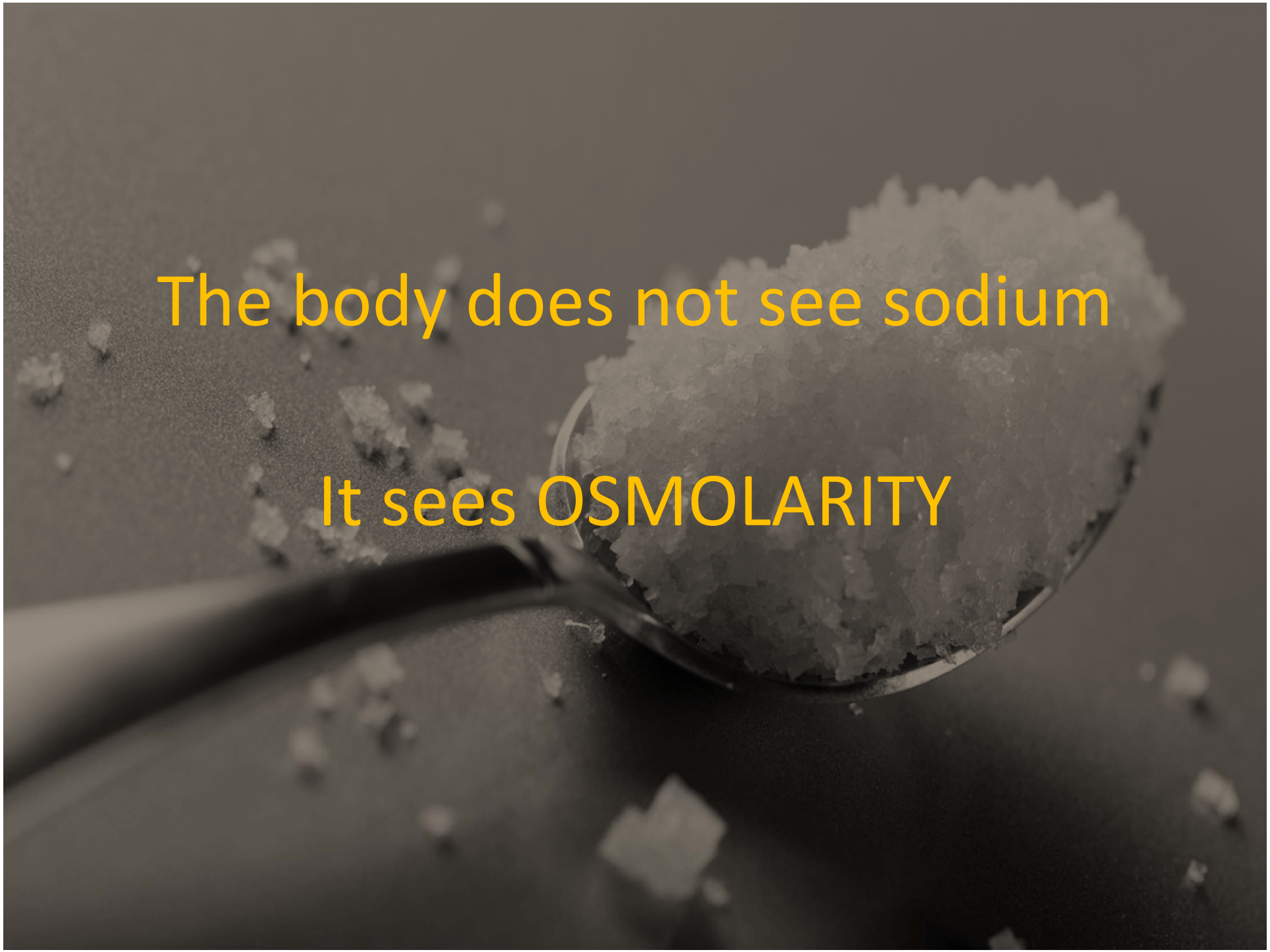
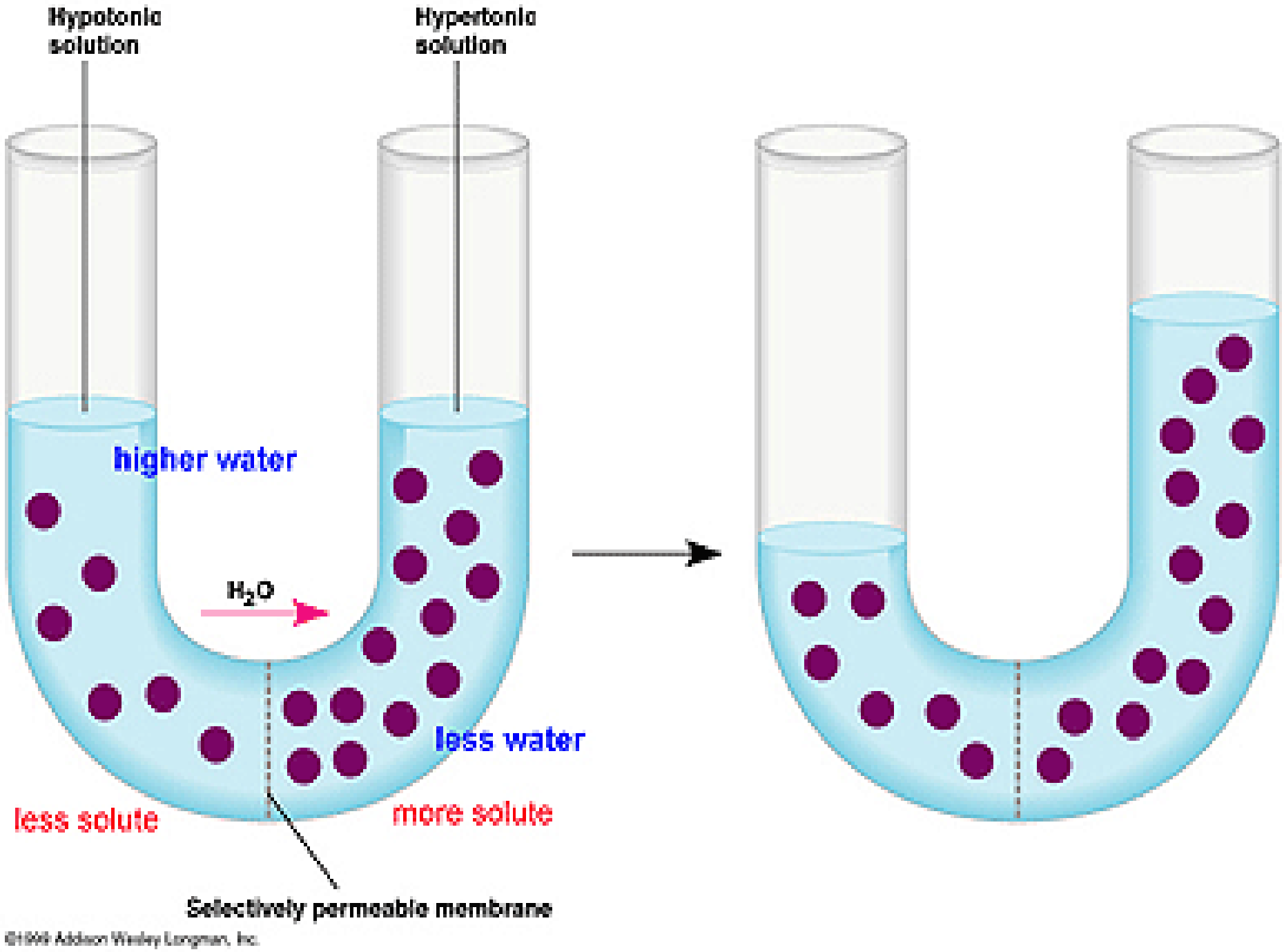
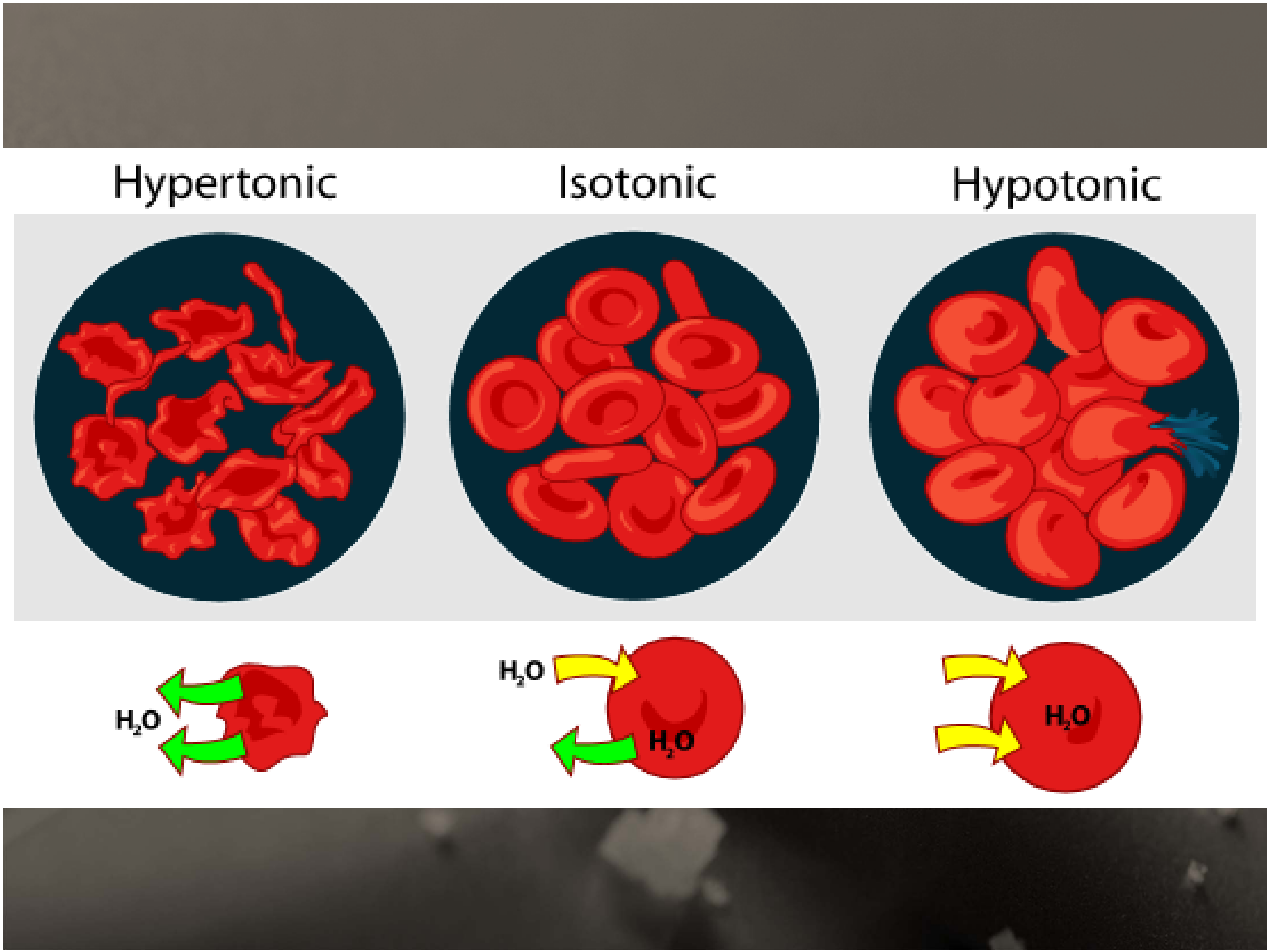
Key facts

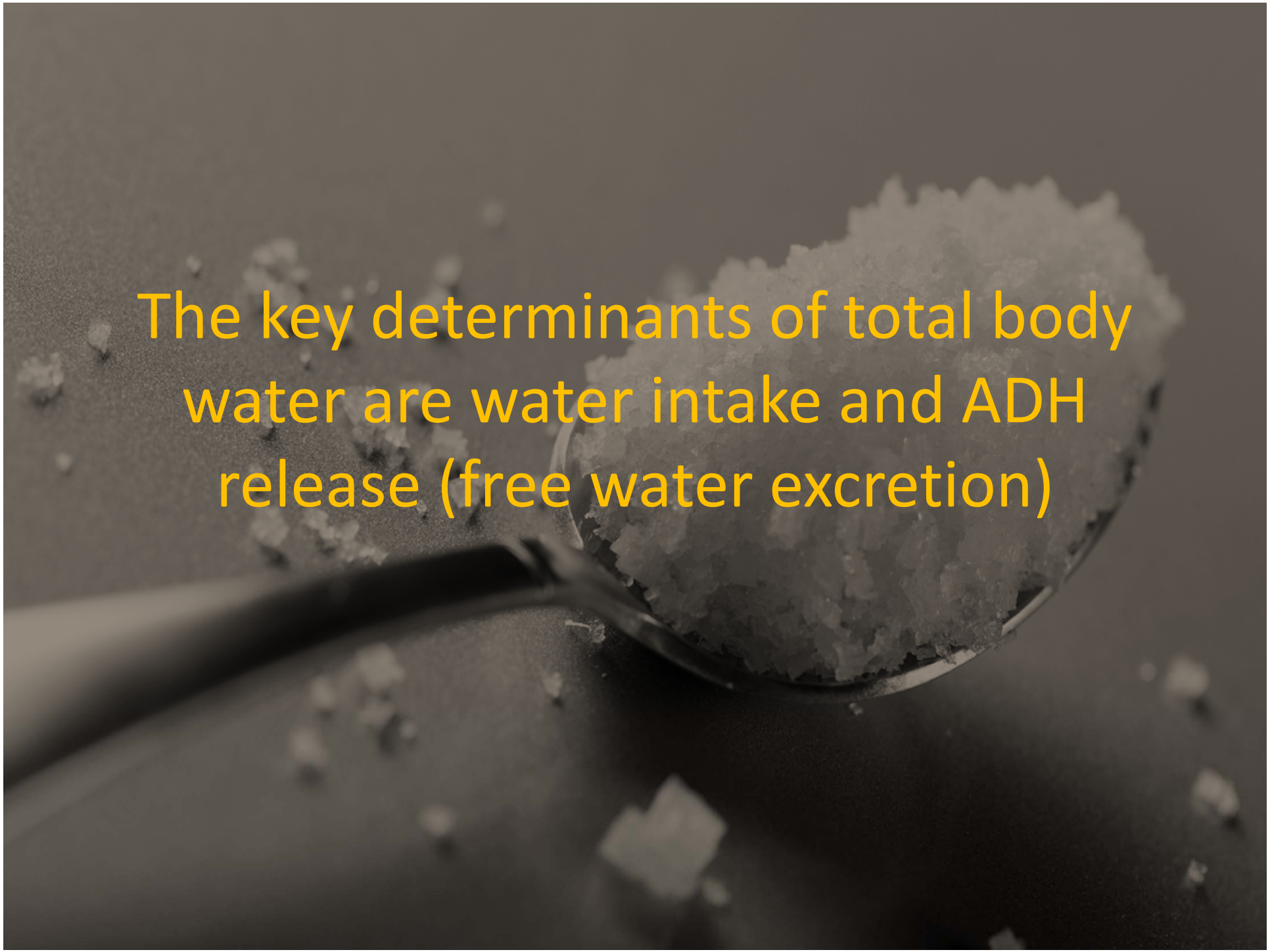
- The problem is never the salt!
- Remember the body does not see “sodium” but “osmolarity”
- The importance of medications
- The patient’s volume status is the key examination finding
- Treat the patient not the number
- Correct sodium, almost always, nice and slowly

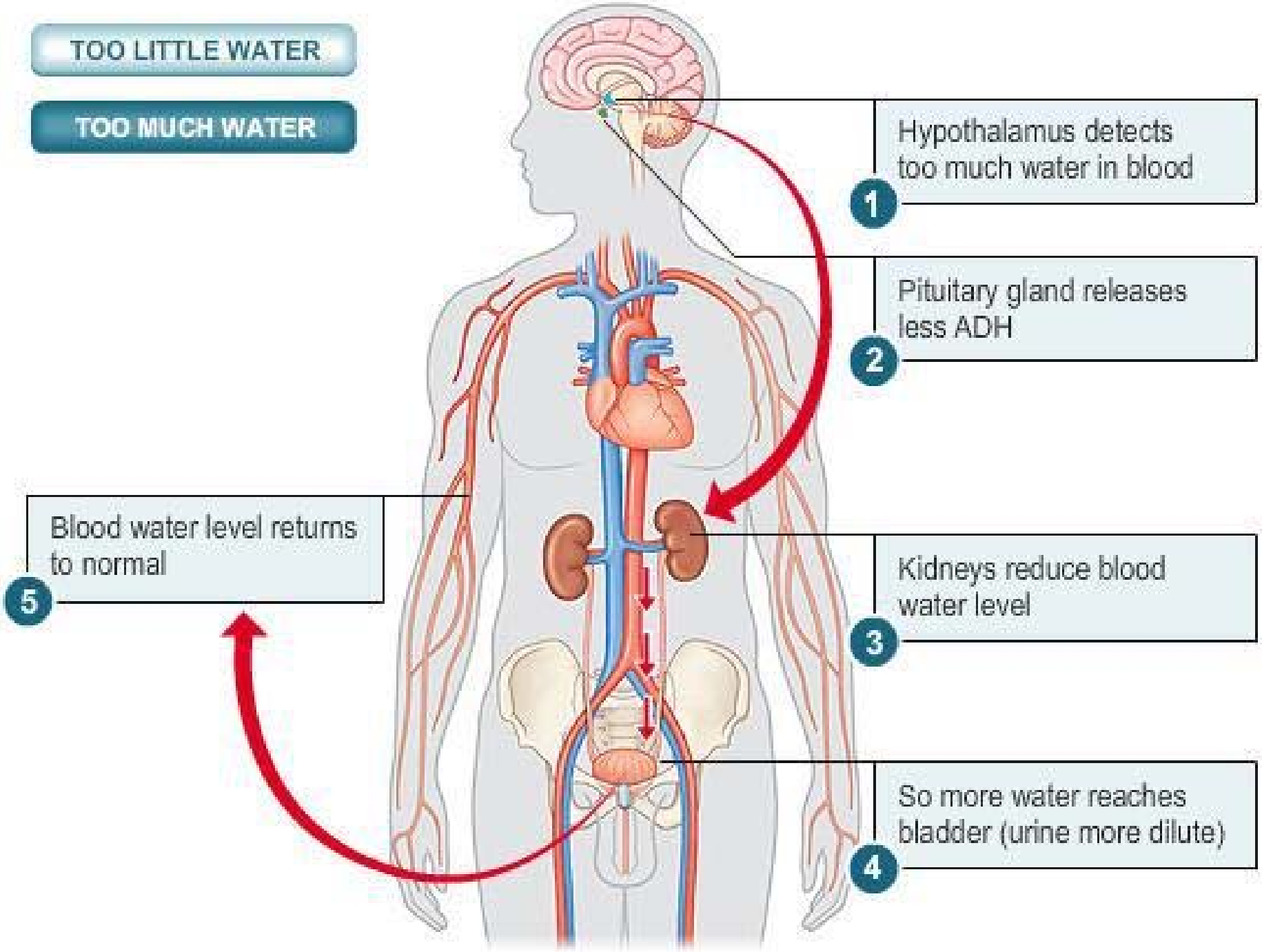

First, some physiology!

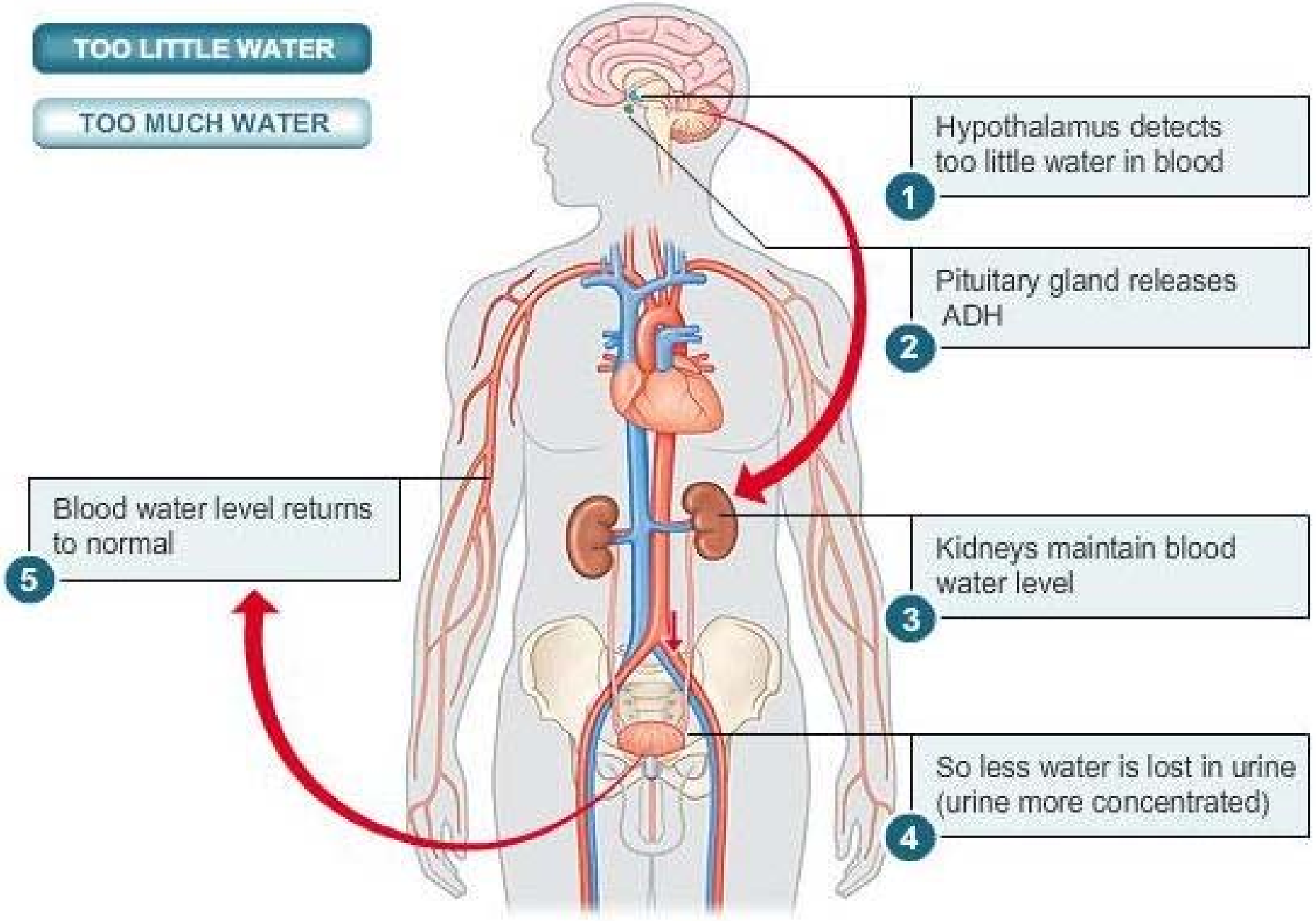

The body does not see sodium
It sees OSMOLARITY

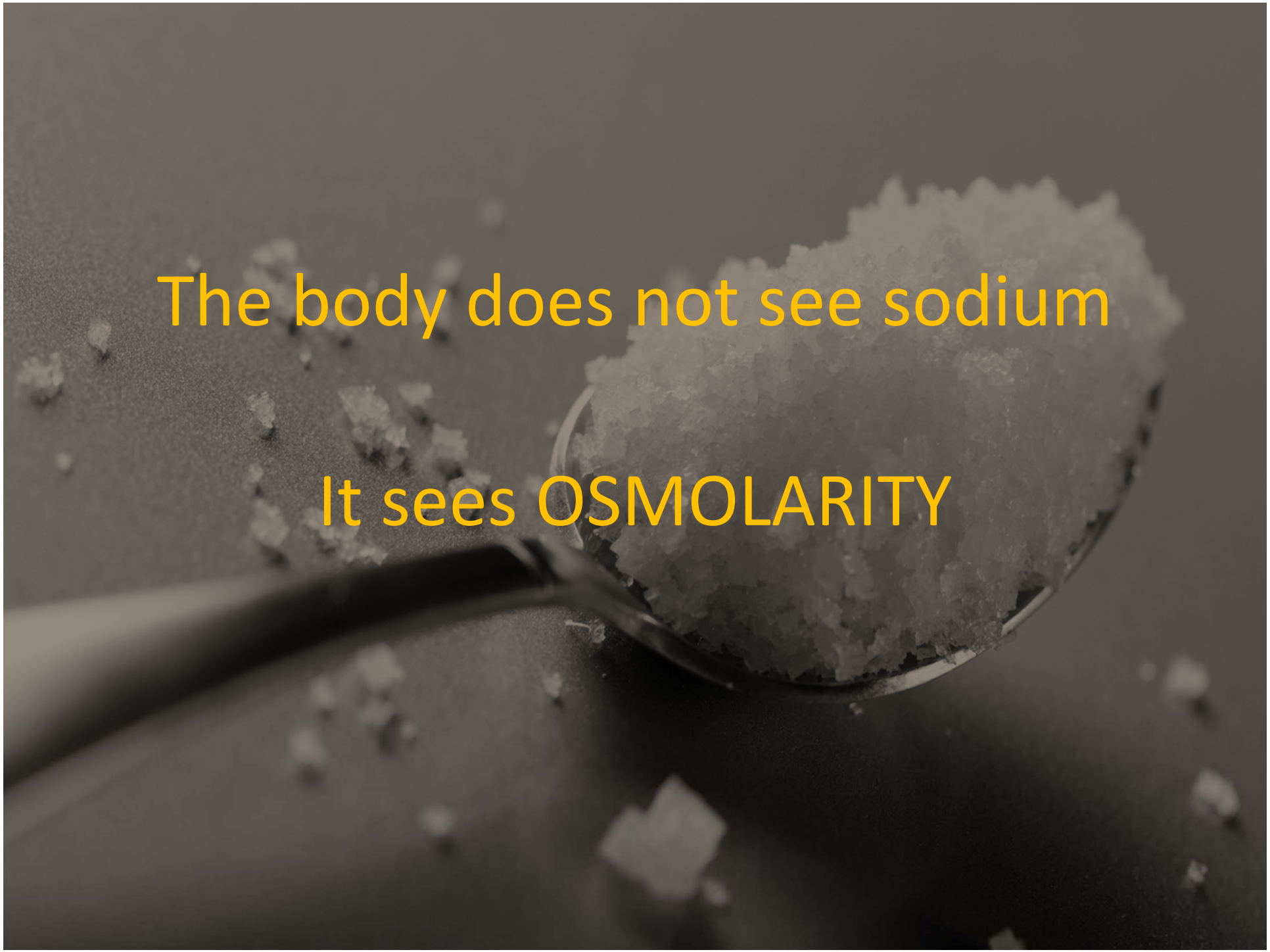



Hypertonic
Isotonic
Hypotonic
H2O
H2O
H2O
H2O


The key determinants of total body water are water intake and ADH release (free water excretion)


TOO LITTLE WATER
TOO MUCH WATER
Hypothalamus detects too much water in blood
1
Pituitary gland releases less ADH
2
Kidneys reduce blood water level
3
So more water reaches bladder (urine more dilute)
4
Blood water level returns to normal
5


TOO LITTLE WATER
TOO MUCH WATER
Hypothalamus detects too little water in blood
1
Pituitary gland releases ADH
2
Kidneys maintain blood water level
3
So less water is lost in urine (urine more concentrated)
4
Blood water level returns to normal
5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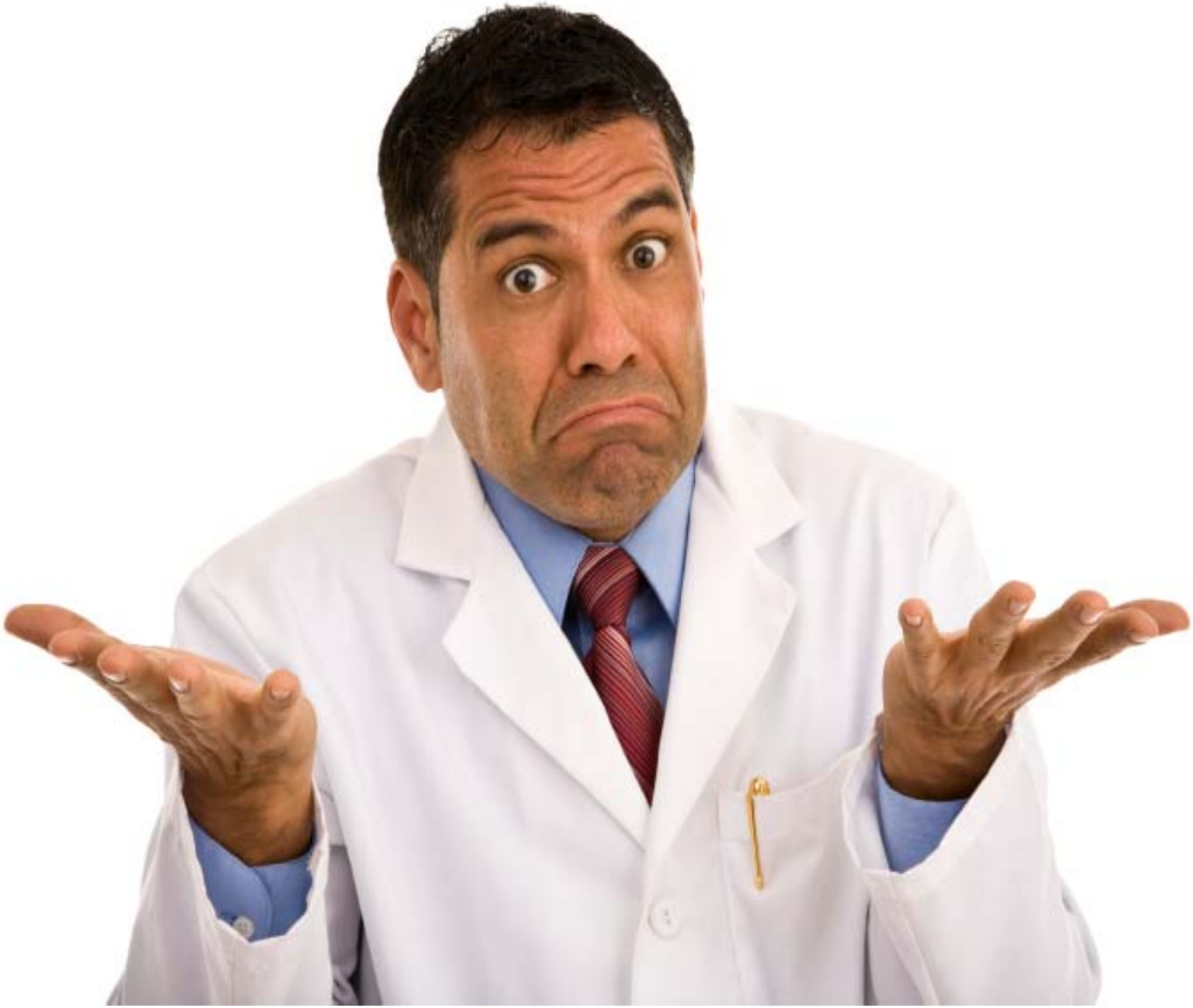
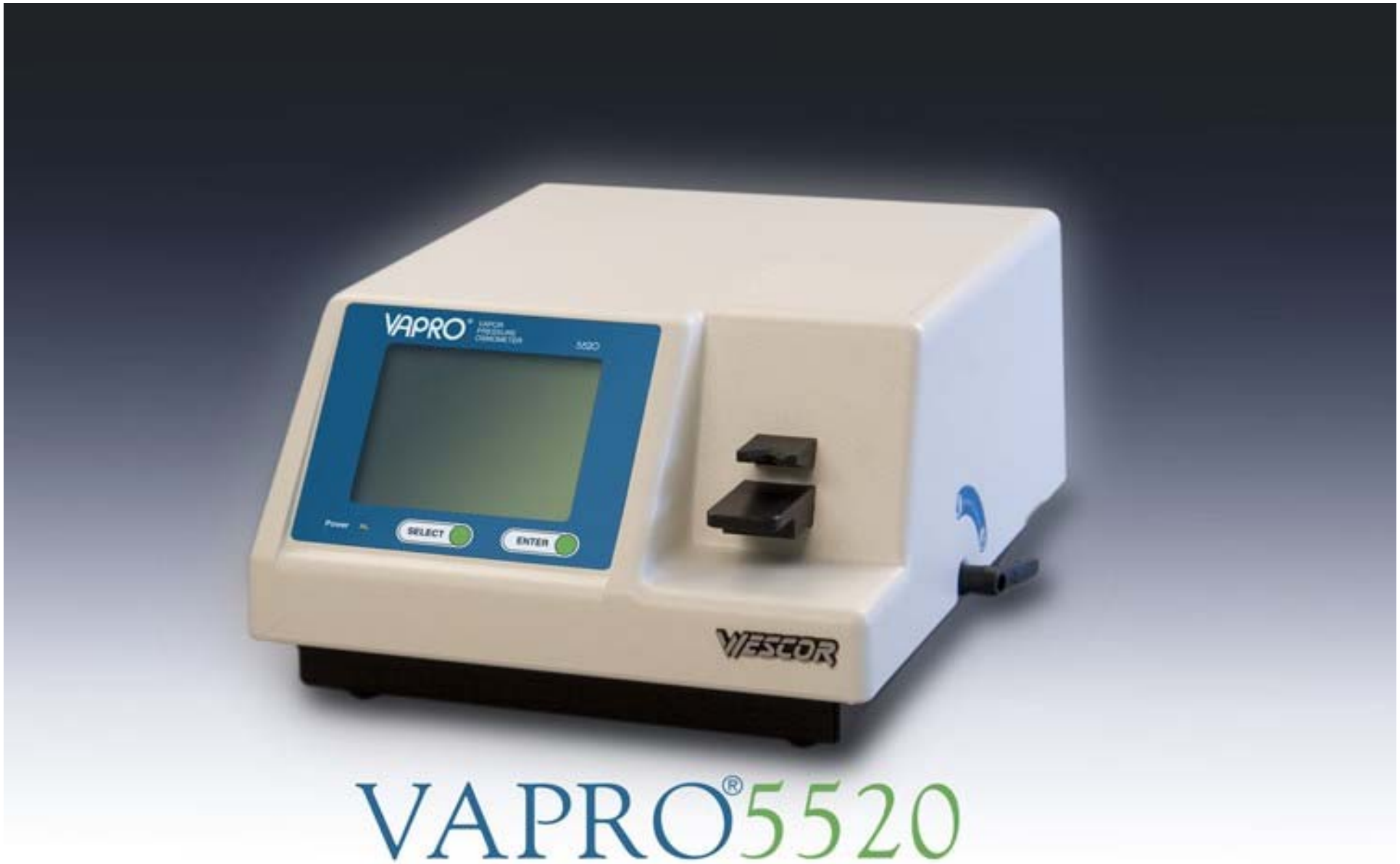
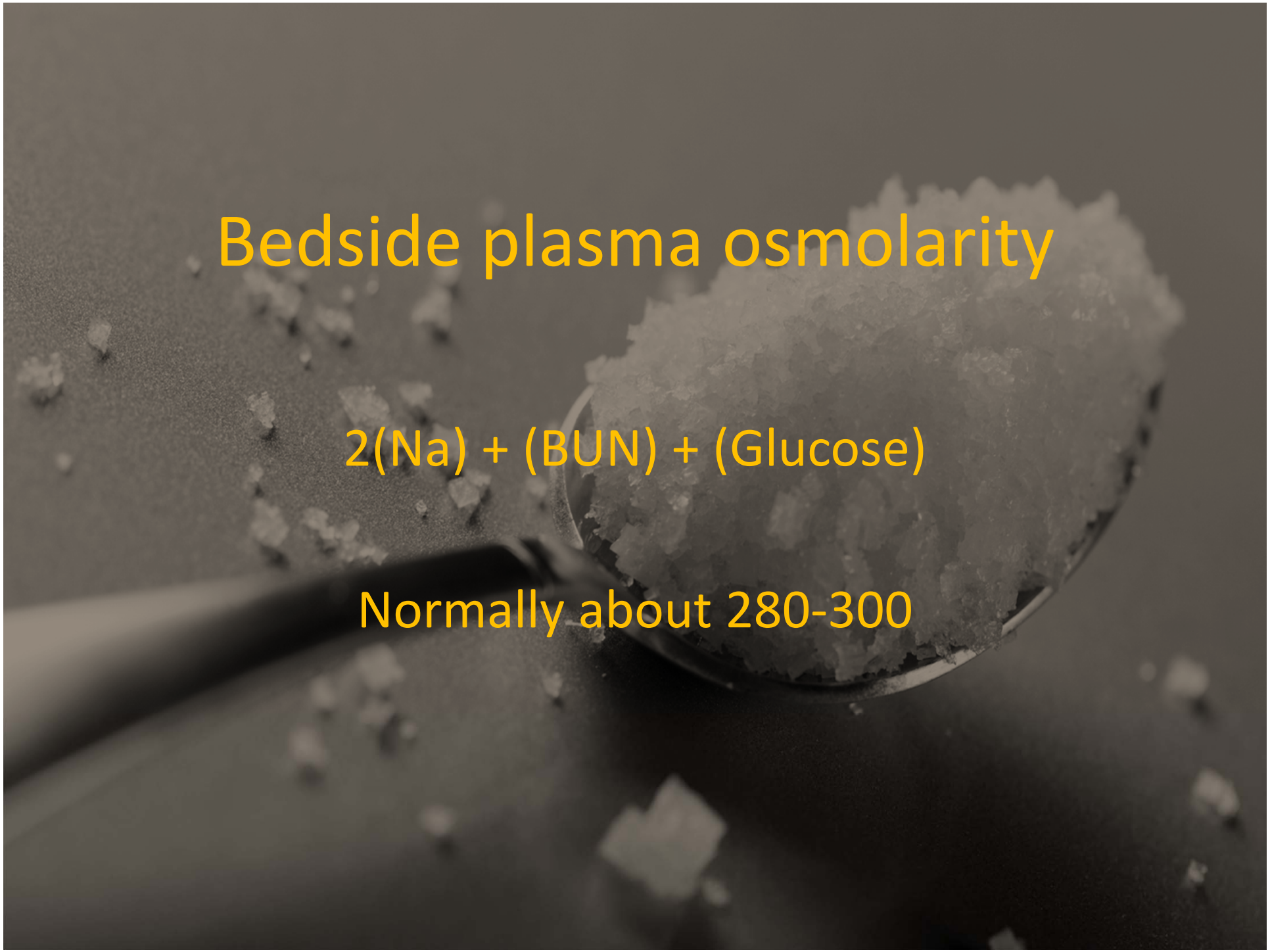
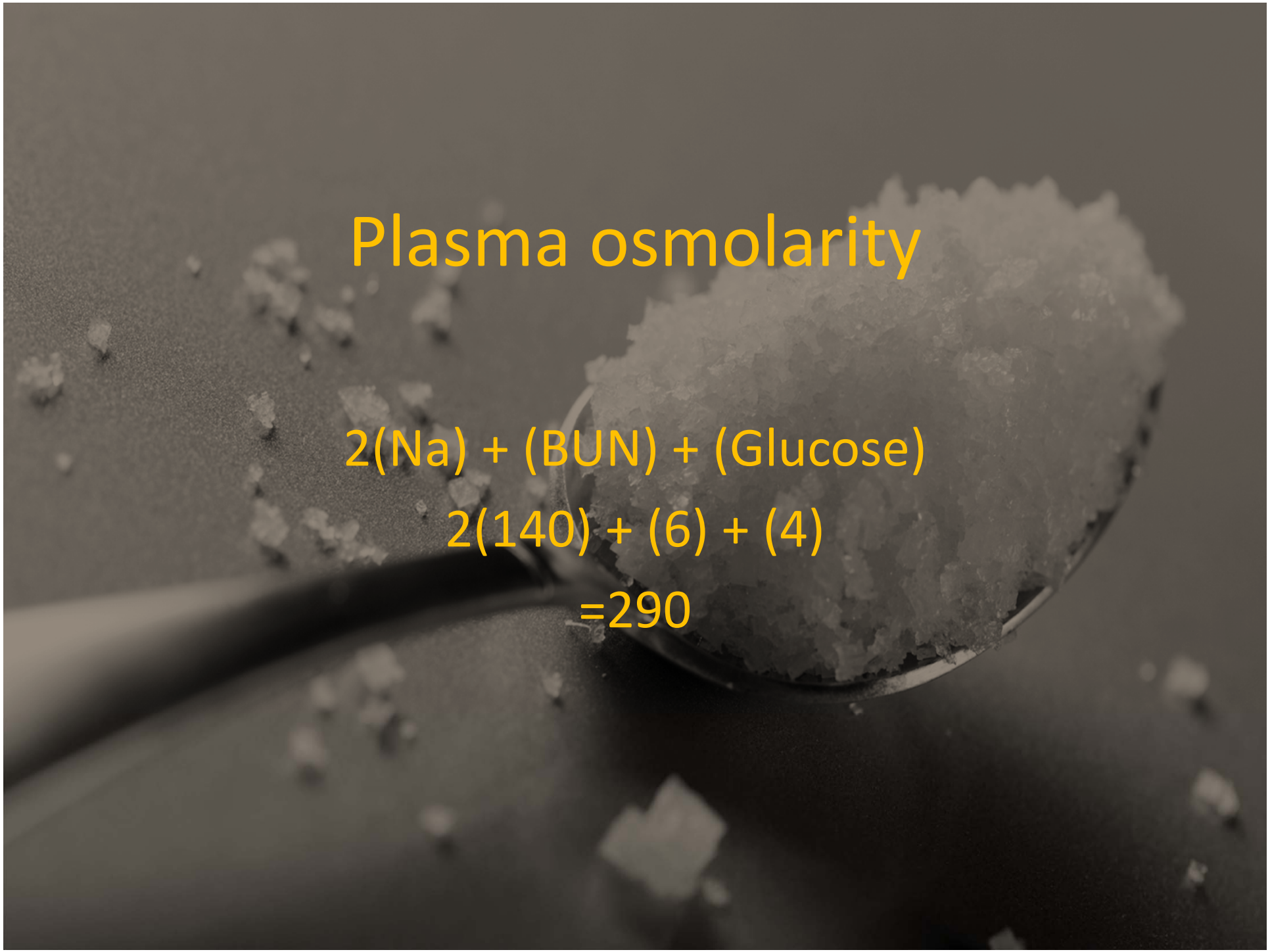




VAPRO®5520

VAPOR PRESSURE OSMOMETER


Bedside plasma osmolarity
2(Na) + (BUN) + (Glucose)
Normally about 280-300

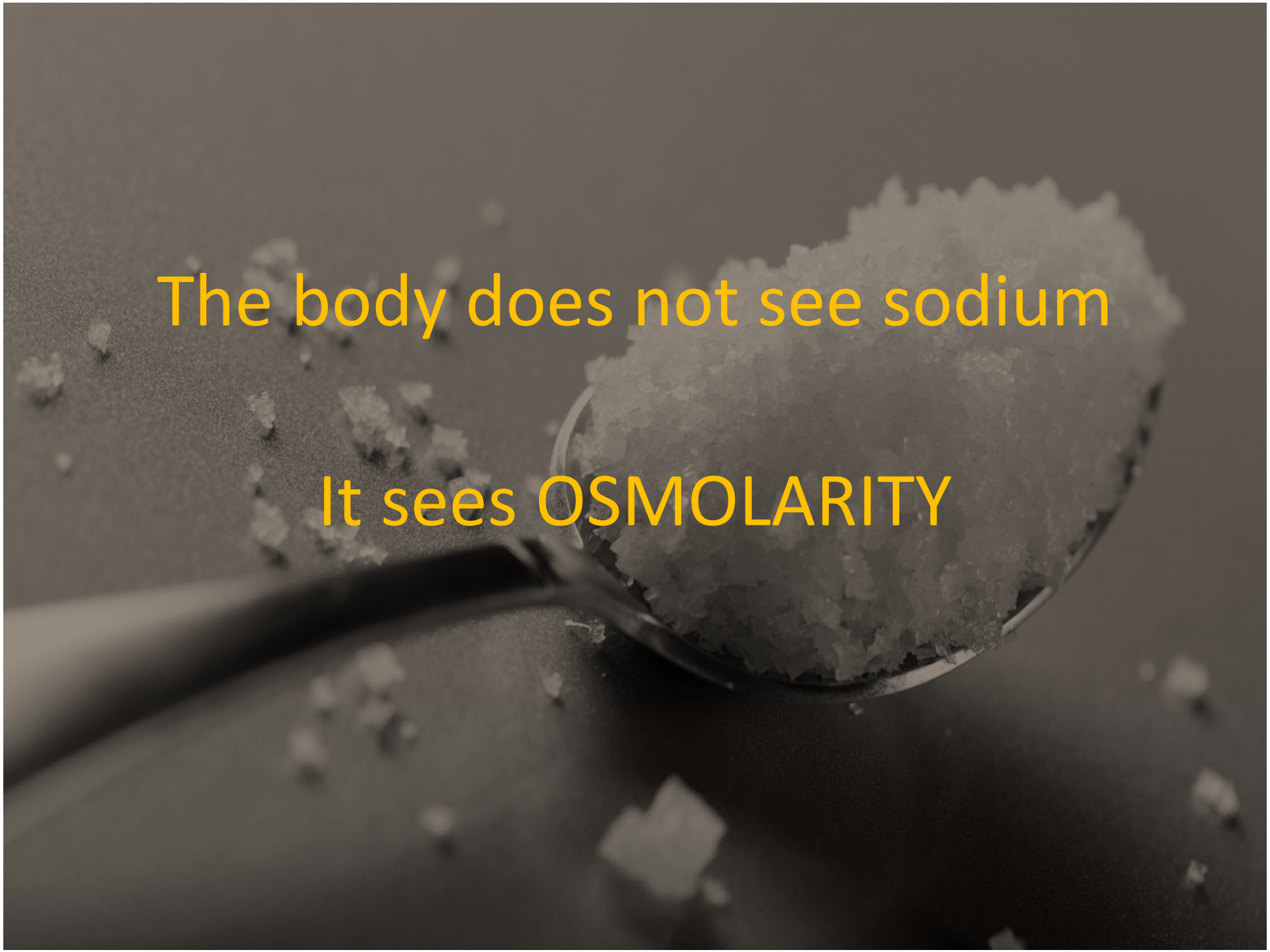


Plasma osmolarity

2(Na) + (BUN) + (Glucose)

2(140) + (6) + (4)

=290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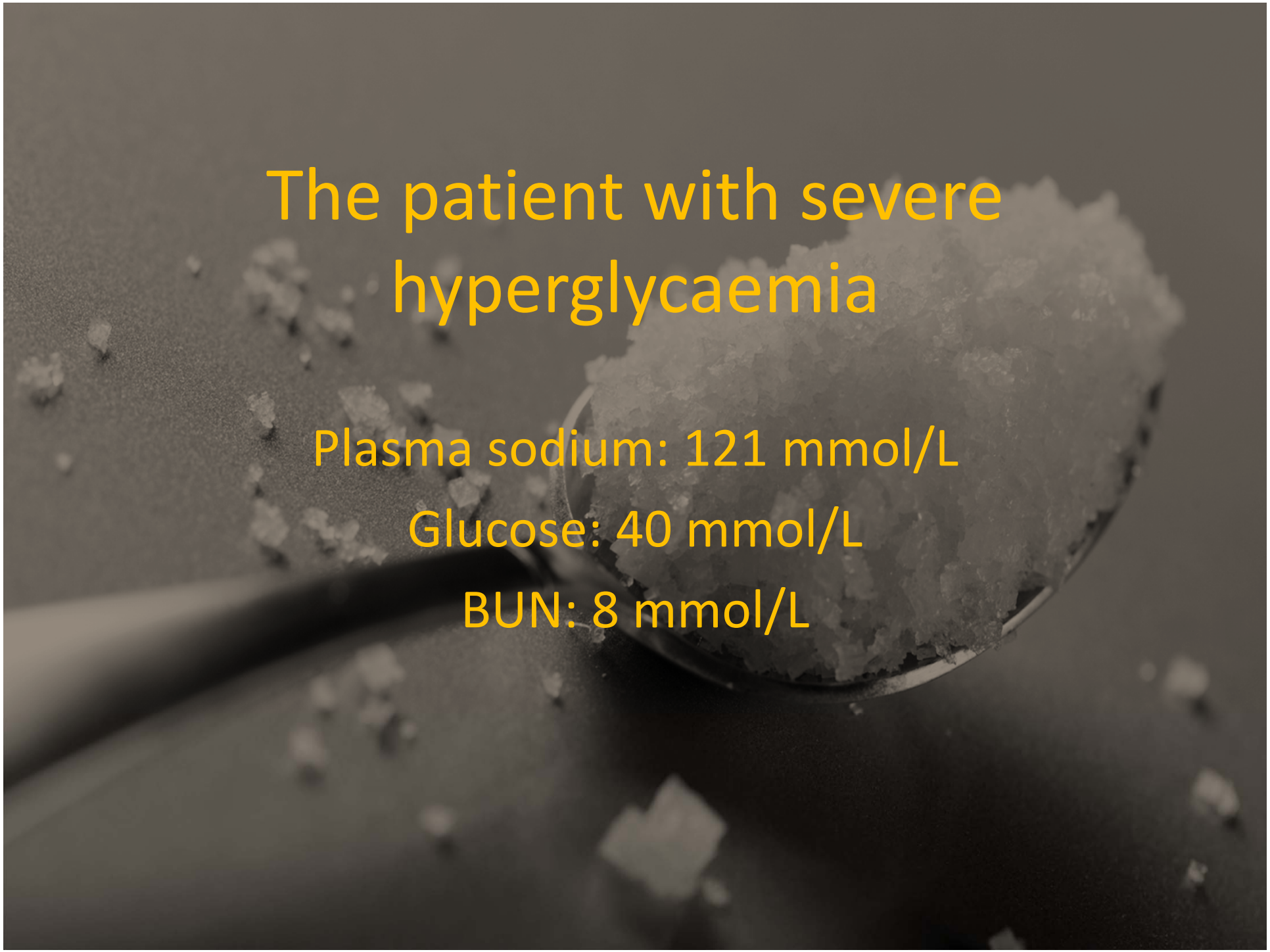
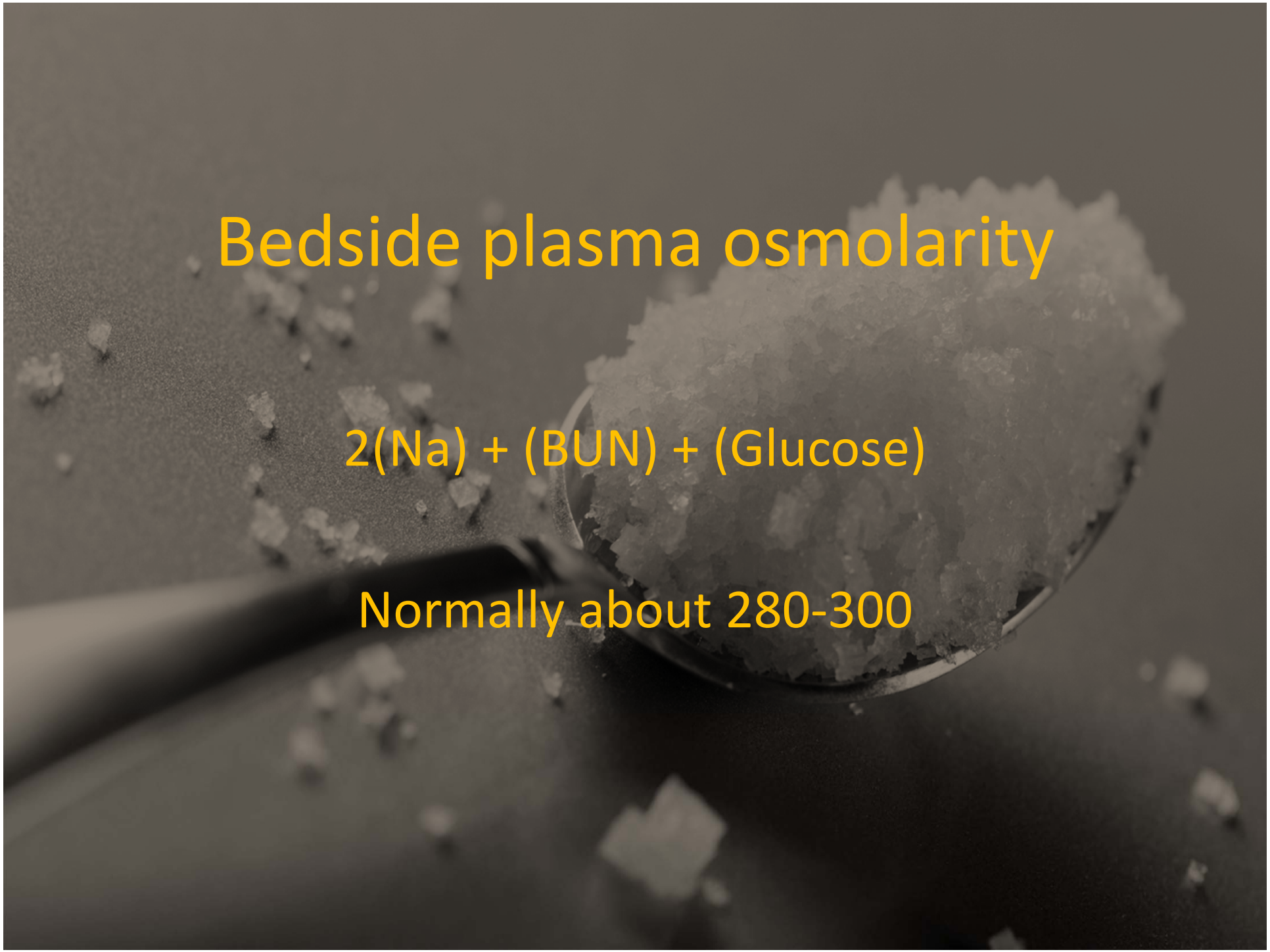

The patient with severe hyperglycaemia
Plasma sodium: 121 mmol/L
Glucose: 40 mmol/L
BUN: 8 mmol/L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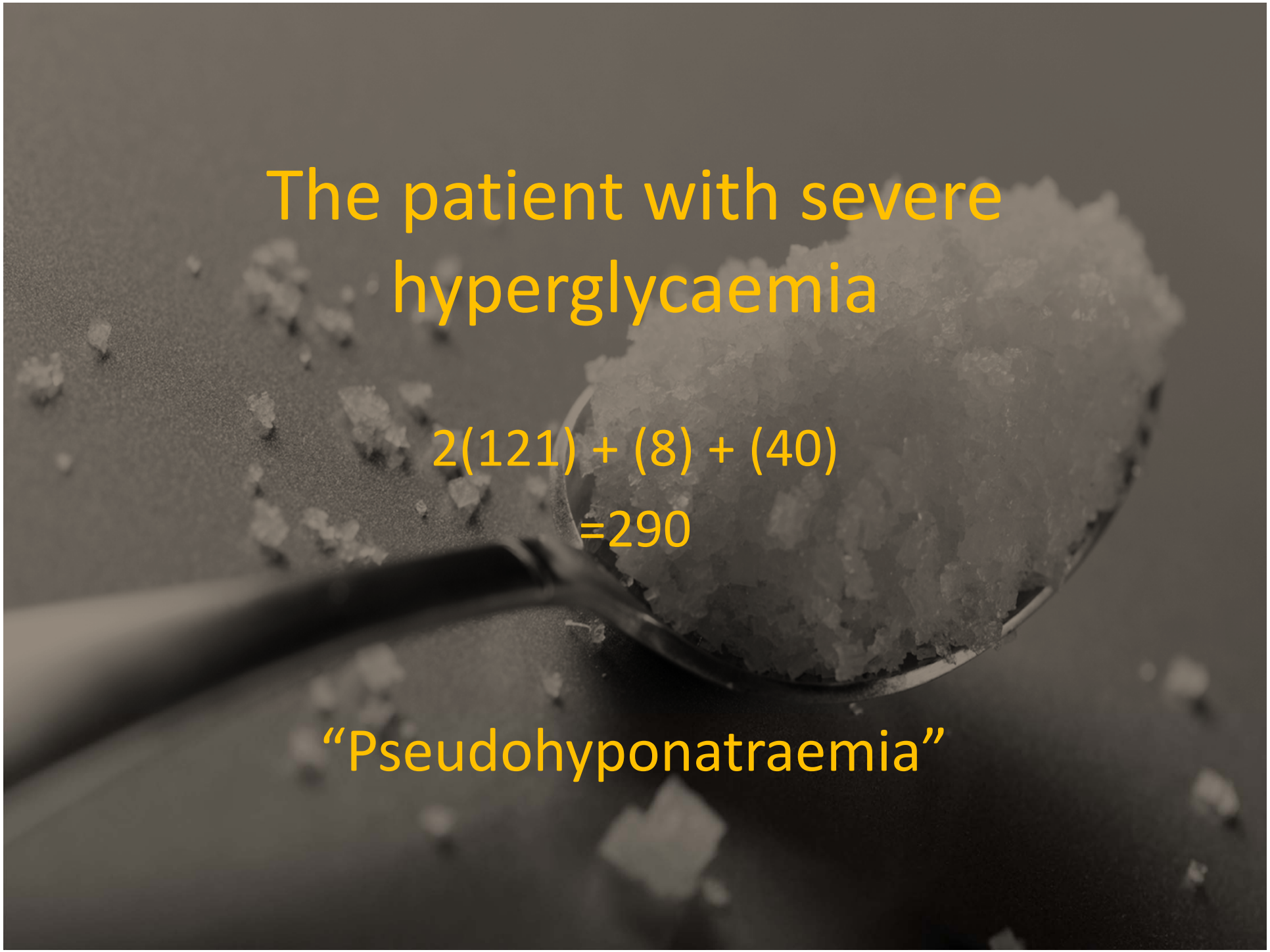
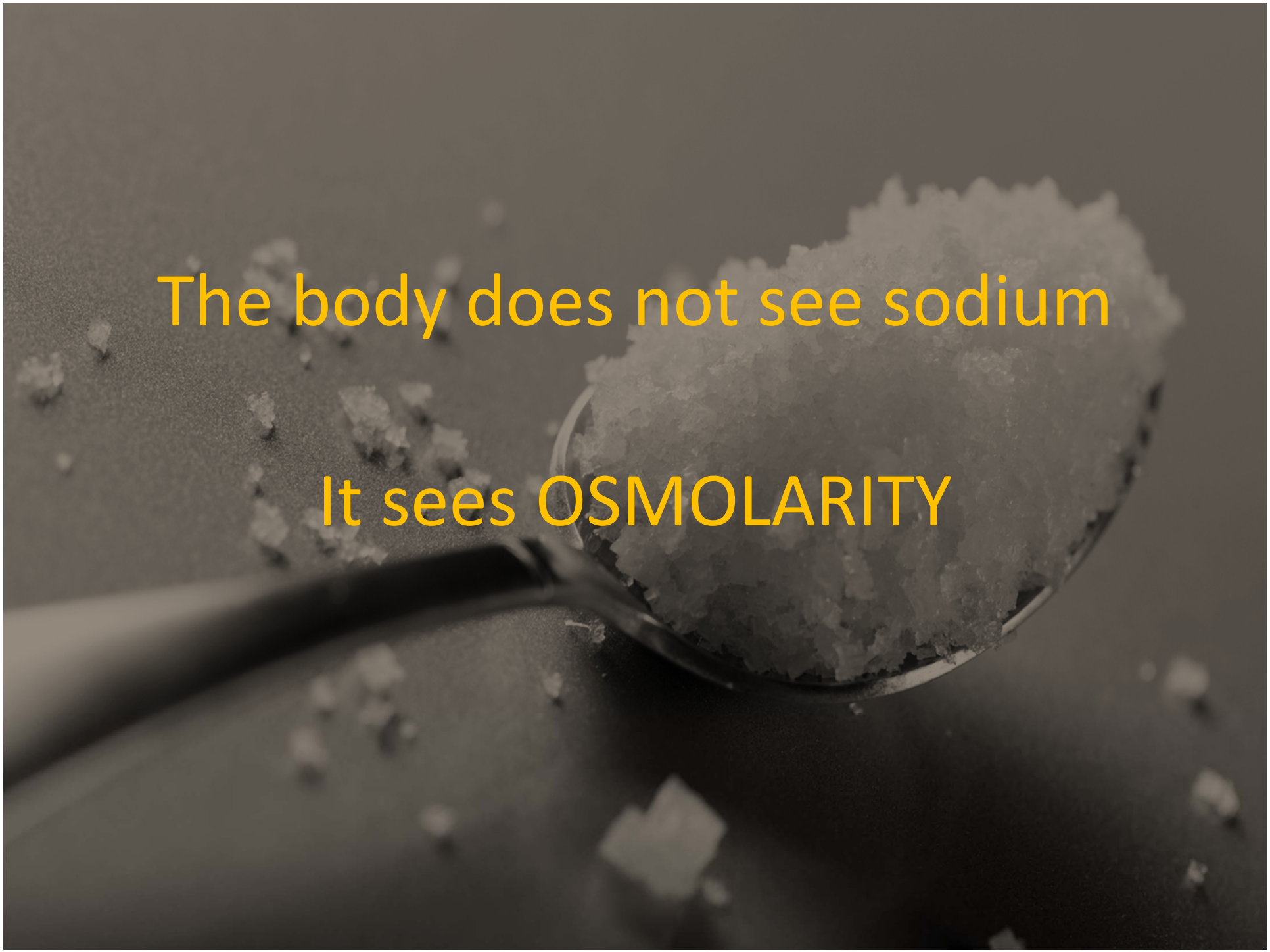
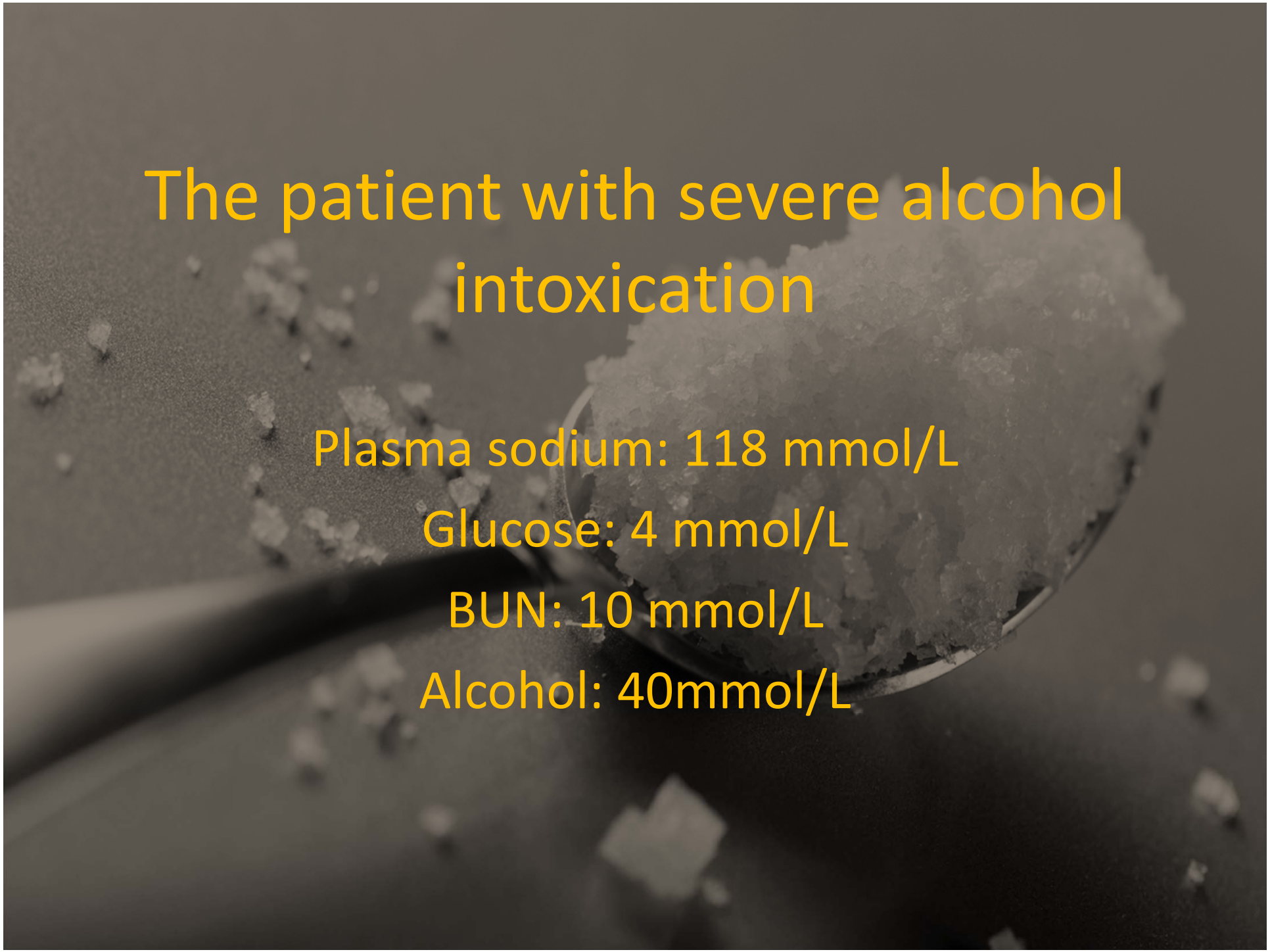

The patient with severe hyperglycaemia
2(121) + (8) + (40)
=290
“Pseudohyponatraemia”


The body does not see sodium
It sees OSMOLARITY

Unmeasured osmoles: “osmolar gap”

- Alcohols
- Lipids
- Sugars
- Proteins
- Ethanol, methanol, ethylene glycol, acetone
- Triglycerides



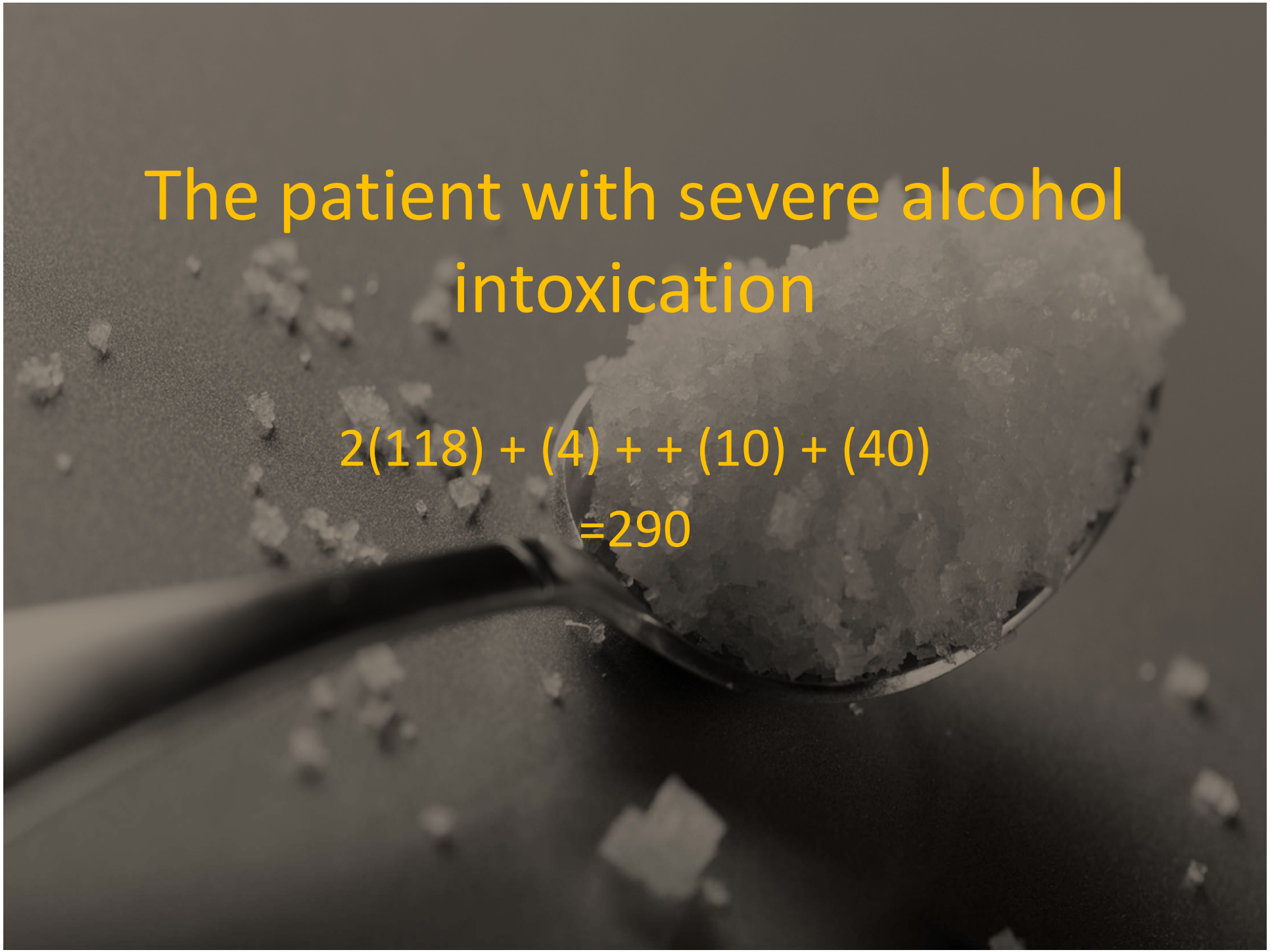
The patient with severe alcohol intoxication

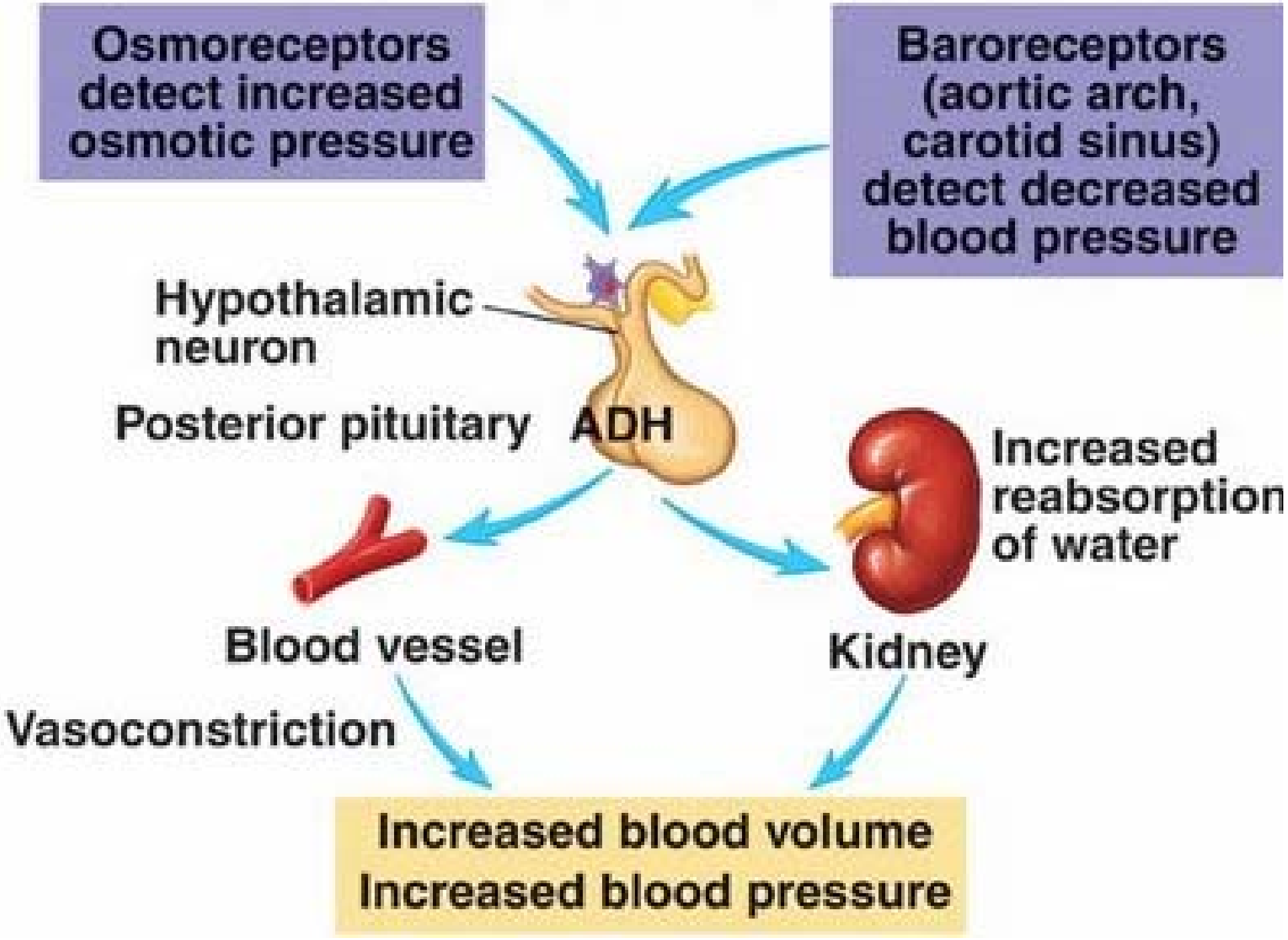
Plasma sodium: 118 mmol/L

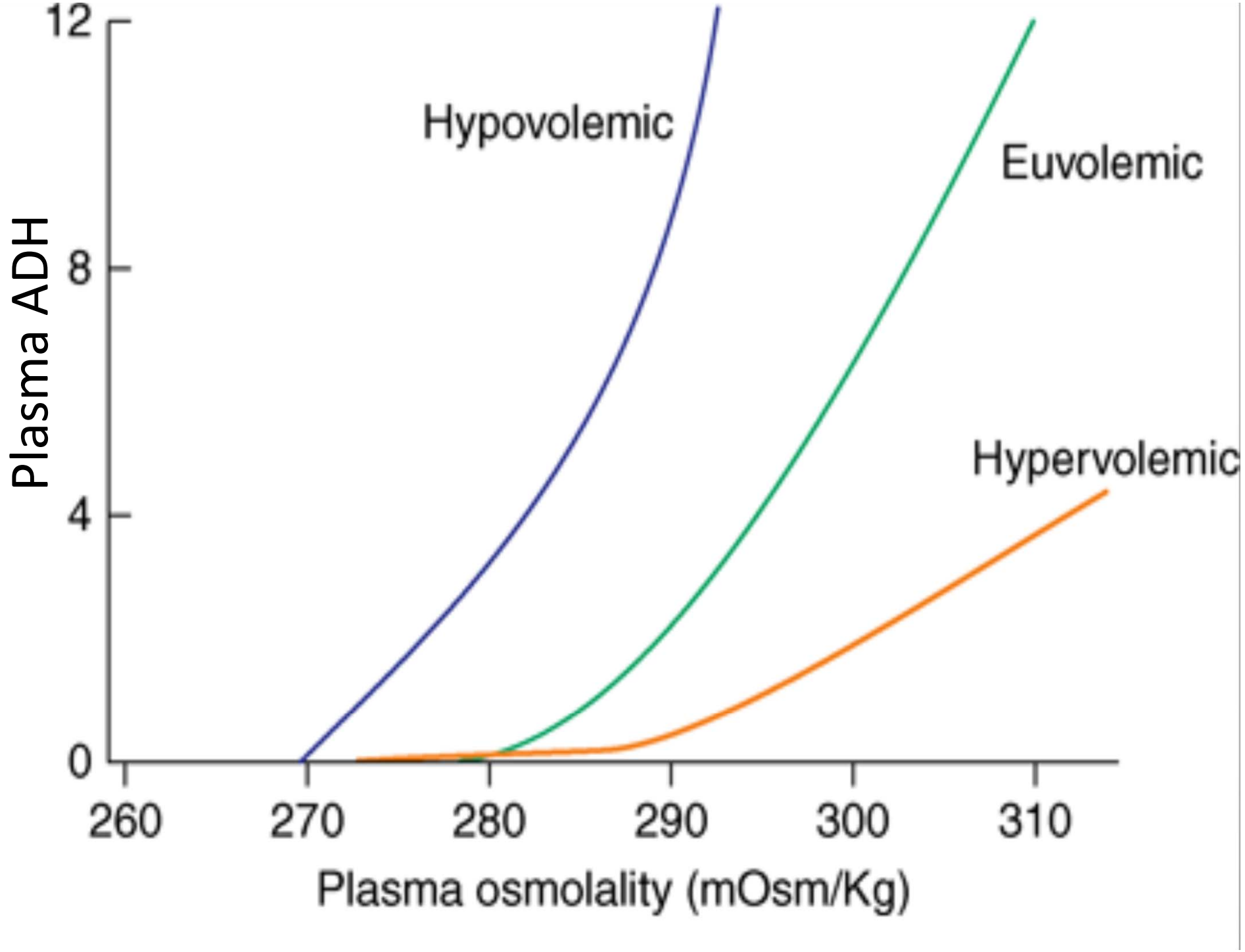
Glucose: 4 mmol/L

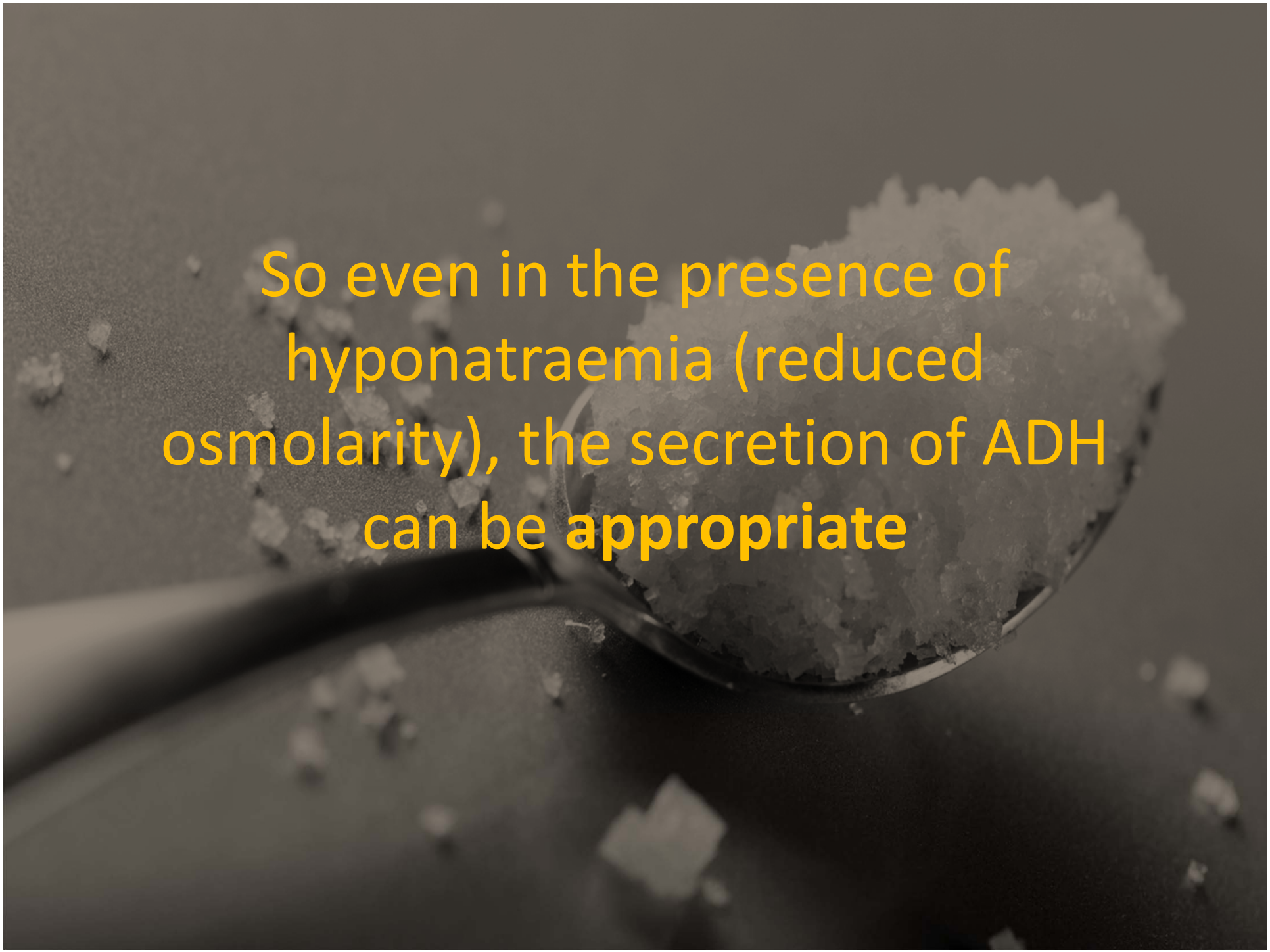
BUN: 10 mmol/L

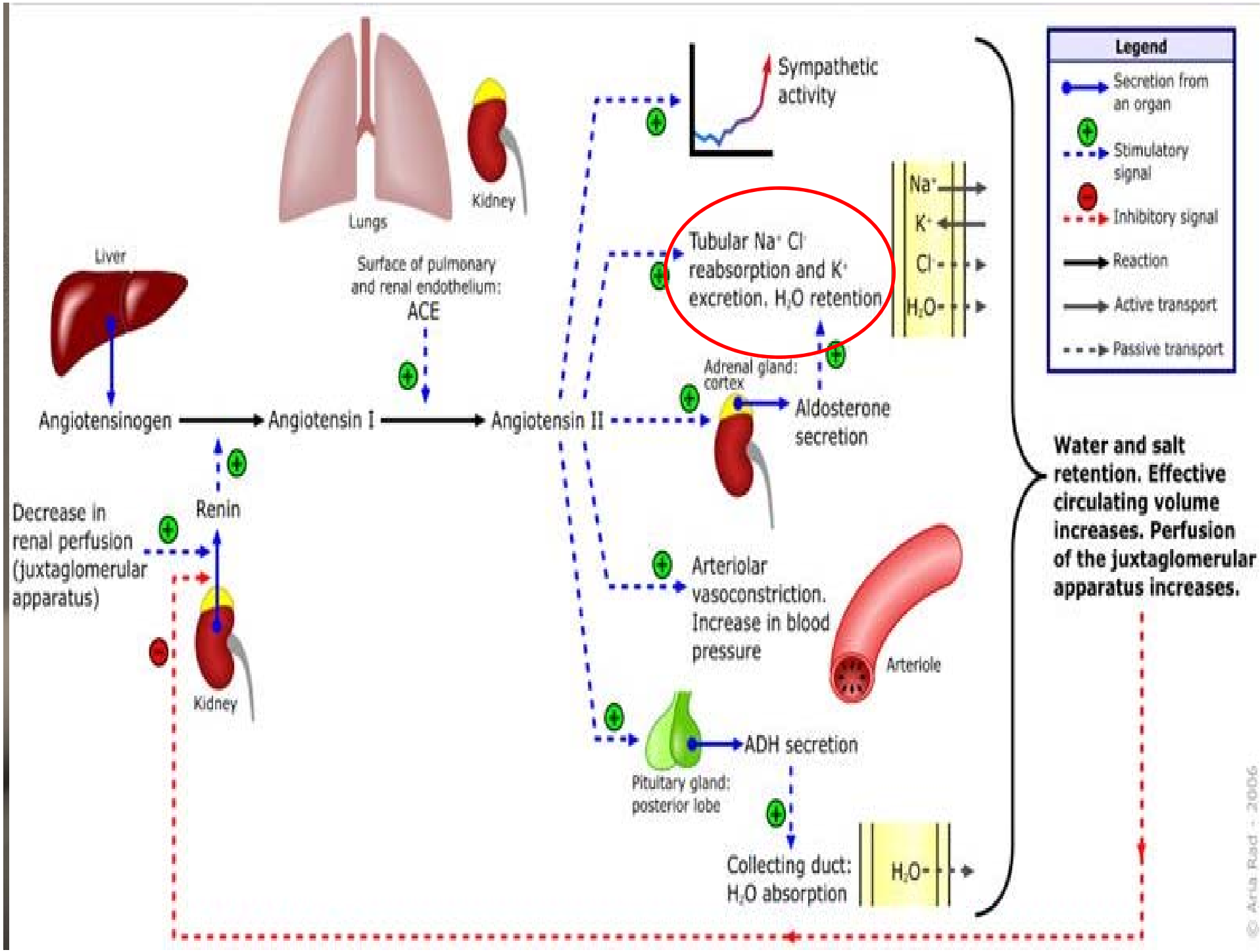
Alcohol: 40mmol/L

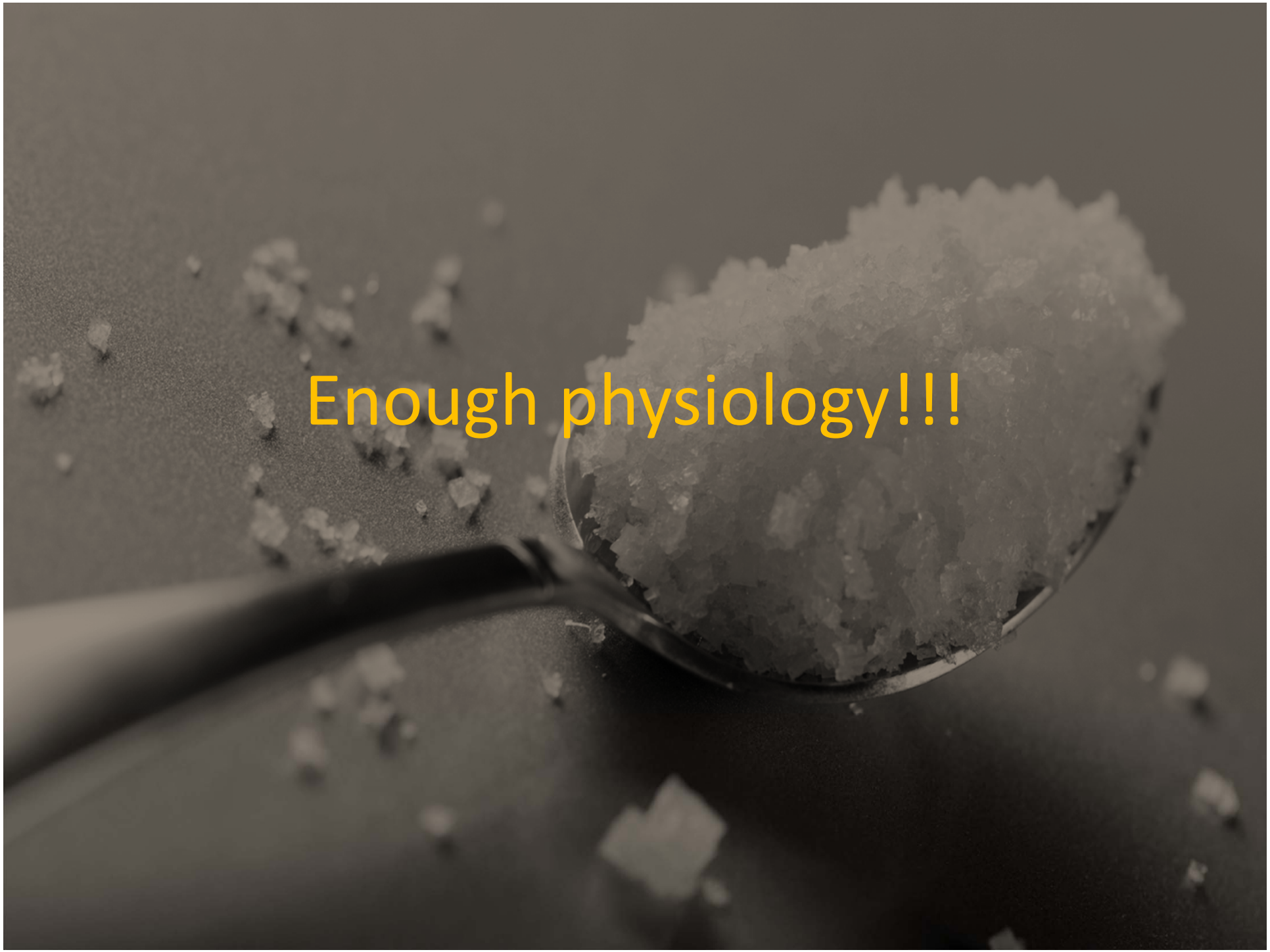

The patient with severe alcohol intoxication
2(118) + (4) + + (10) + (40)
=290




12
8
4
0
Plasma ADH
Hypovolemic
Euvolemic
Hypervolemic
260
270
280
290
300
310
Plasma osmolality (mOsm/Kg)


So even in the presence of hyponatraemia (reduced osmolarity), the secretion of ADH can be **appropriate**


Lungs
Kidney
Sympathetic activity
Liver
Surface of pulmonary and renal endothelium:
ACE
Tubular Na⁺ Cl⁻ reabsorption and K⁺ excretion, H₂O retention
Na⁺
K⁺
Cl⁻
H₂O
Adrenal gland: cortex
Aldosterone secretion
Angiotensinogen
Angiotensin I
Angiotensin II
Renin
Decrease in renal perfusion (juxtaglomerular apparatus)
Arteriolar vasoconstriction. Increase in blood pressure
Arteriole
Kidney
ADH secretion
Pituitary gland: posterior lobe
Collecting duct: H₂O absorption
H₂O
Water and salt retention. Effective circulating volume increases. Perfusion of the juxtaglomerular apparatus increases.
Legend
Secretion from an organ
Stimulatory signal
Inhibitory signal
Reaction
Active transport
Passive transport
© Arta Rad - 2006


Enough physiology!!!

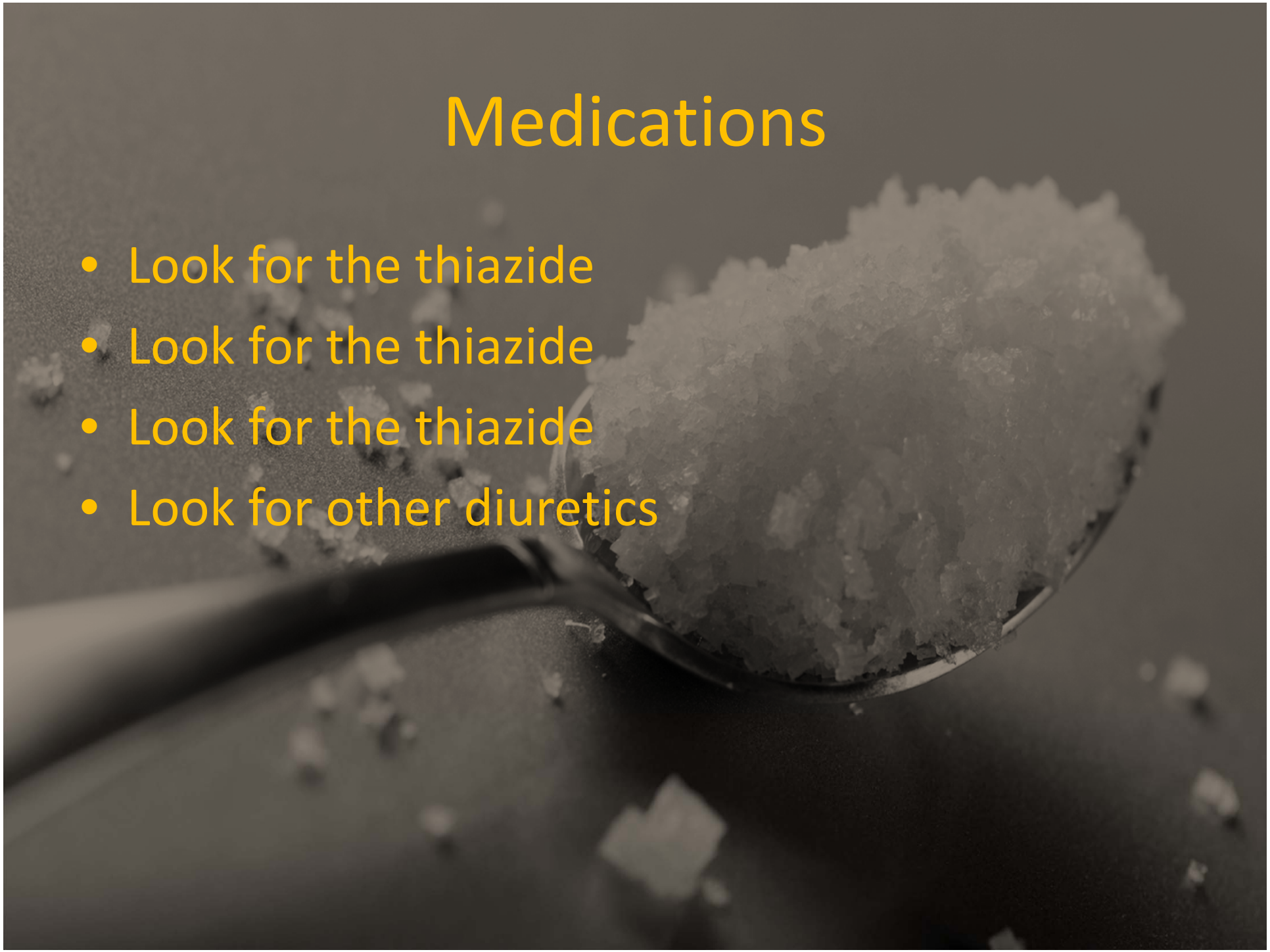
Hyponatraemia: clinical presentation

- Anorexia, nausea
- Headache
- Muscle cramps
- Confusion
- Coma
- Seizures


Proportional to severity and
speed of onset

History

- Careful medical history
- Medication list



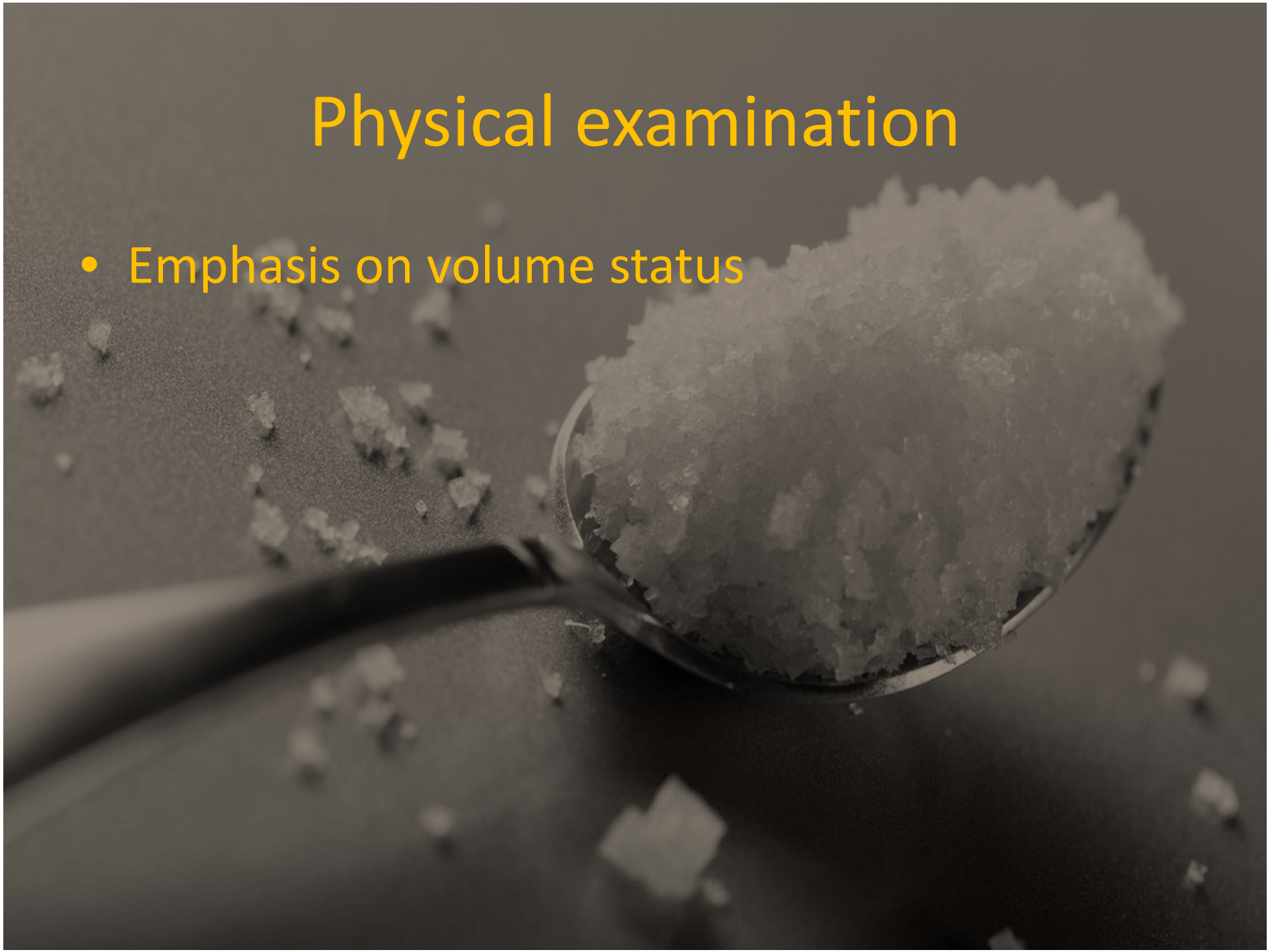
Medications

- Look for the thiazide
- Look for the thiazide
- Look for the thiazide
- Look for other diuretics

Action	Drugs
Stimulation of AVP release	Opiates Nicotine Tryciclic antidepressants Phenothiazines Haloperidol Oxytocin Dopamine agonists Methylenedioxymethamfetamine[a]
Direct renal effects, potentiation of AVP action, or both	Desmopressin NSAIDs
Mixed or uncertain action	ACE inhibitors Clofibrate Cyclophosphamide Colchicine Vincristine Carbamazepine, oxcarbazepine Clozapine Serotonin reuptake inhibitors Amiodarone

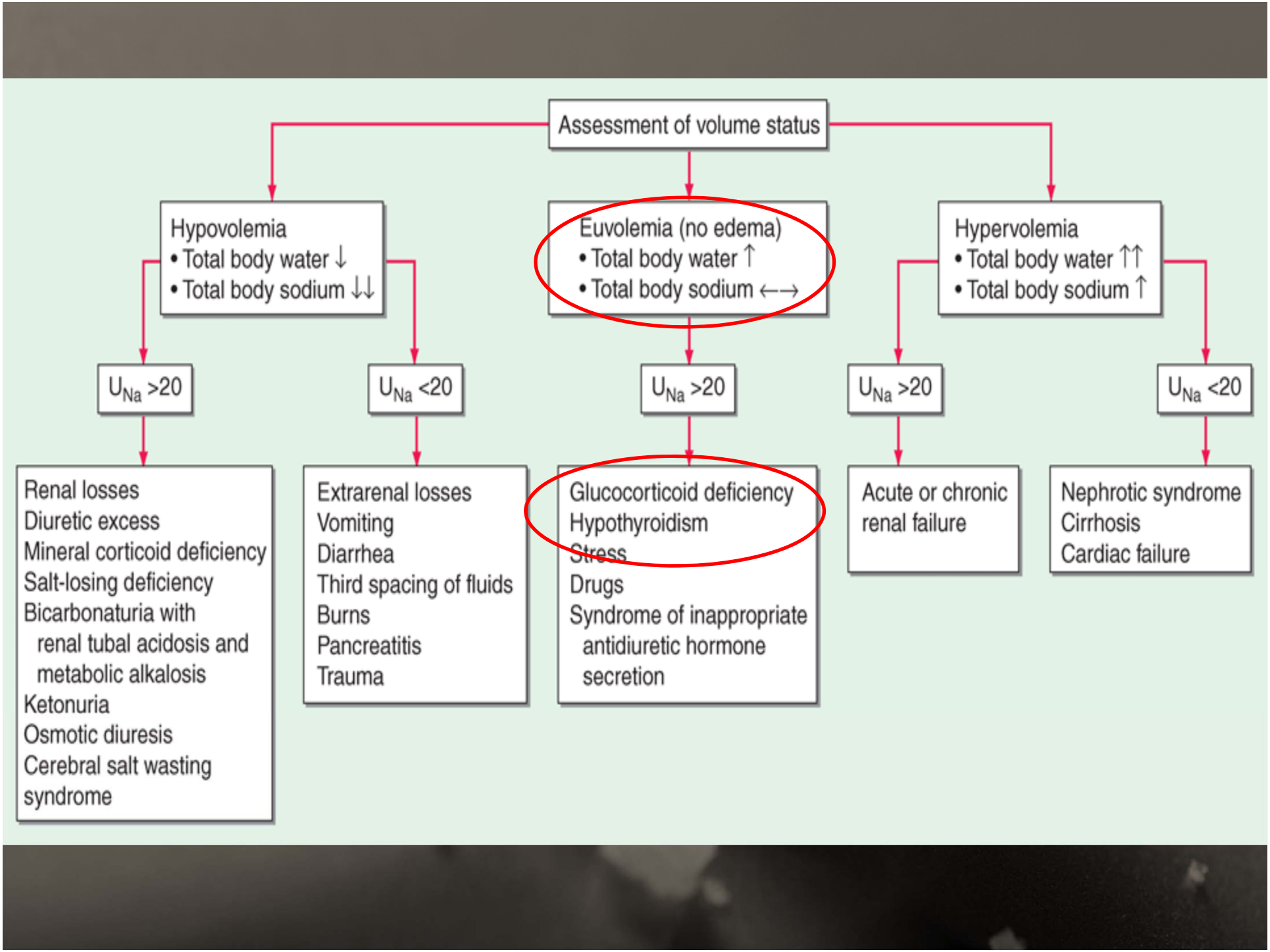
Physical examination

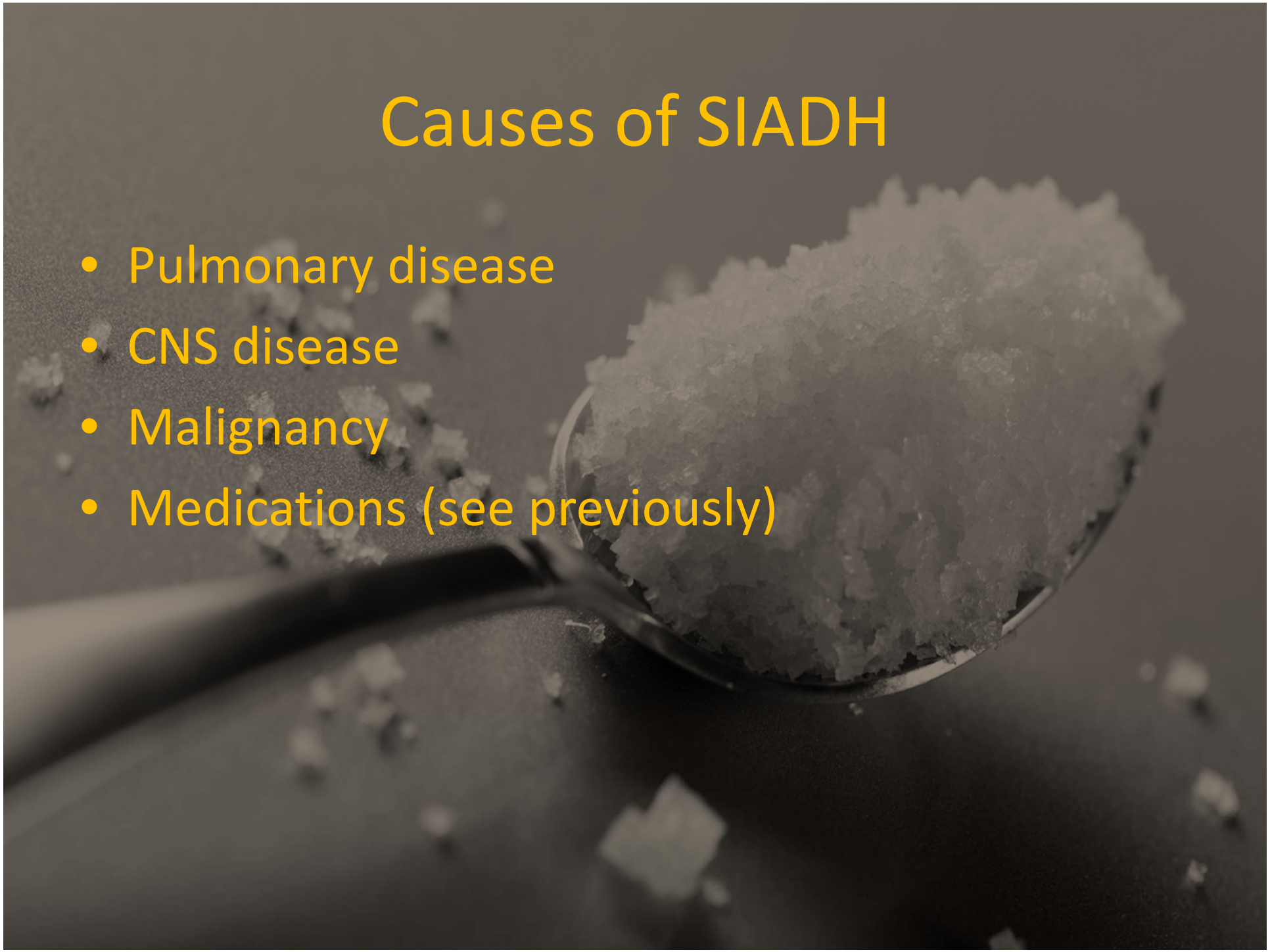
- Emphasis on volume status



3 essential laboratory tests

- Serum osmolarity
- Urine osmolarity
- Urine sodium


Assessment of volume status
Hypovolemia
• Total body water ↓
• Total body sodium ↓↓
Euvolemia (no edema)
• Total body water ↑
• Total body sodium ←→
Hypervolemia
• Total body water ↑↑
• Total body sodium ↑
U_{Na} >20
U_{Na} <20
U_{Na} >20
U_{Na} >20
U_{Na} <20
Renal losses
Diuretic excess
Mineral corticoid deficiency
Salt-losing deficiency
Bicarbonaturia with renal tubal acidosis and metabolic alkalosis
Ketonuria
Osmotic diuresis
Cerebral salt wasting syndrome
Extrarenal losses
Vomiting
Diarrhea
Third spacing of fluids
Burns
Pancreatitis
Trauma
Glucocorticoid deficiency
Hypothyroidism
Stress
Drugs
Syndrome of inappropriate antidiuretic hormone secretion
Acute or chronic renal failure
Nephrotic syndrome
Cirrhosis
Cardiac failure

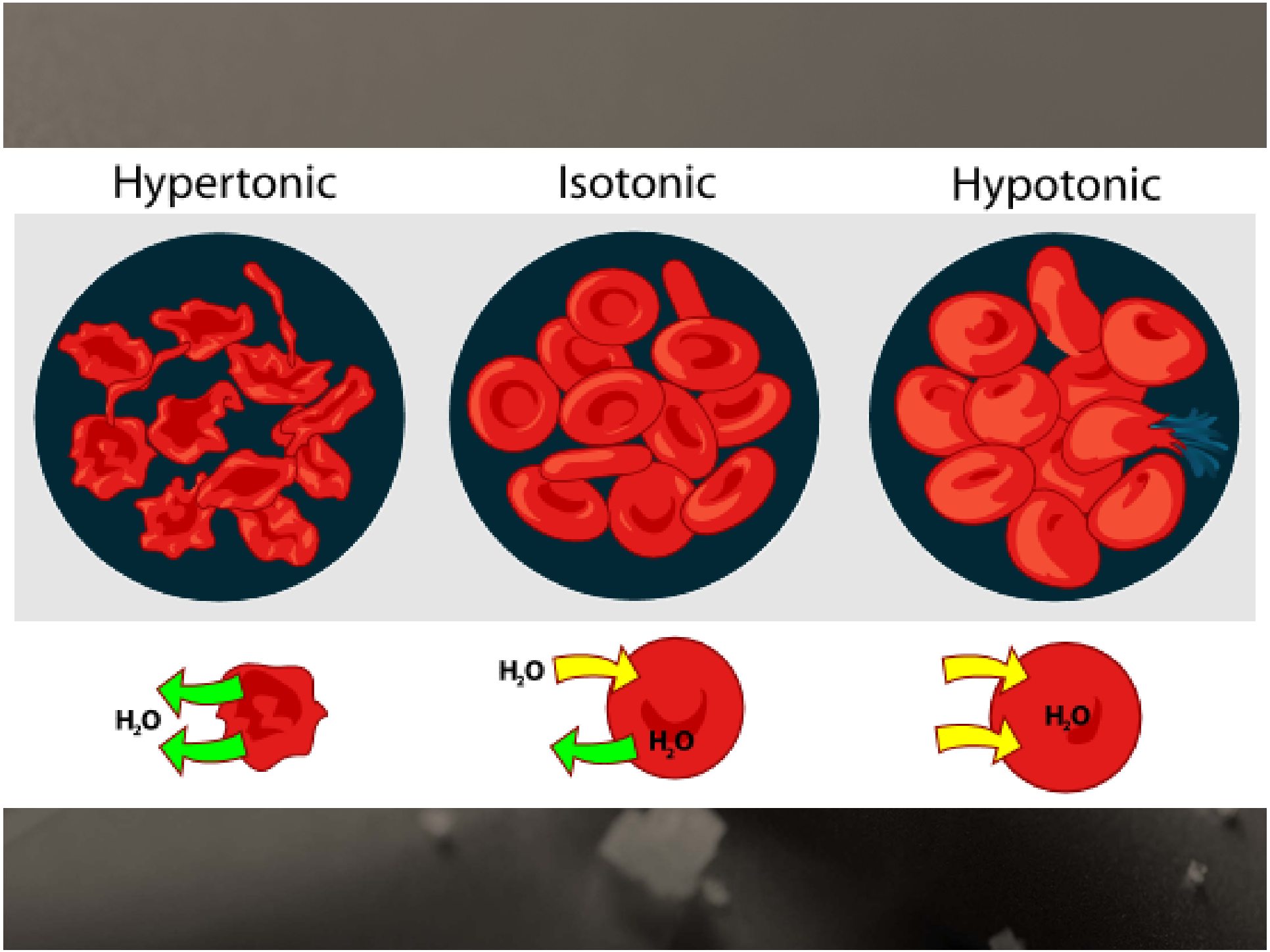


Causes of SIADH

- Pulmonary disease
- CNS disease
- Malignancy
- Medications (see previously)

Treatment of hyponatraemia

- Treat the patient not the number!
- The patient's osmoreceptors, pituitary and kidneys are much cleverer than you
- Identify and remove the cause (frequently a medication)
- Correct chronic hyponatraemia slowly


Hypertonic
Isotonic
Hypotonic
H2O
H2O
H2O
H2O

Treatment

- Role of hypertonic saline?
- Rarely required
- Chronic hyponatraemia corrected <12mmol in first 24 hours and <18mmol/L in first 48 hours


OK, it’s your turn!

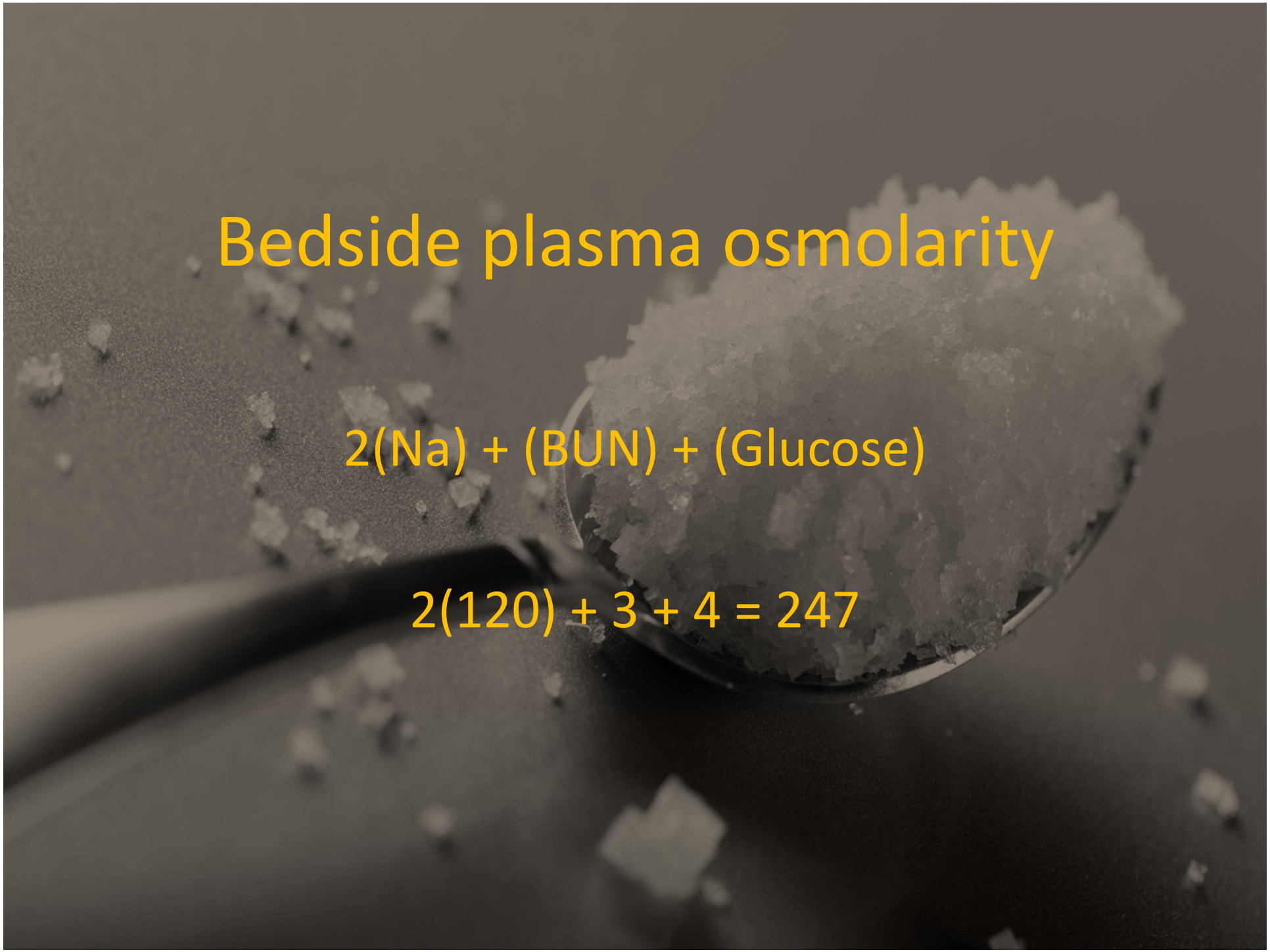
Case one

- 54M presents with a 12 hour history of nausea and confusion
- PMH: depression
- Medication: fluoxetine
- Examination: no localising signs, but patient disoriented to time and place
- Euvolaemic

Case one

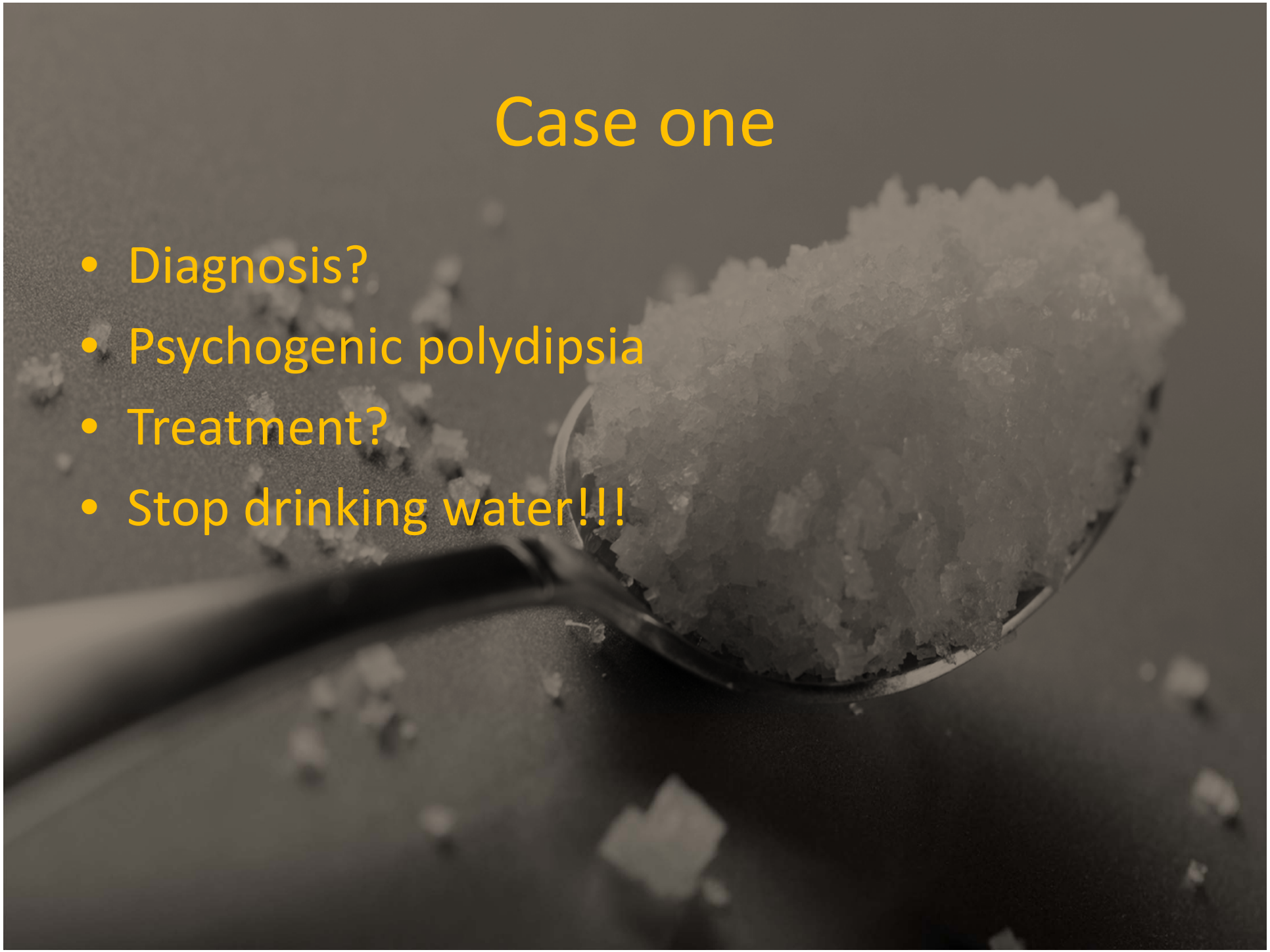
- Na 120
- K 4
- Cl 85
- HCO3 24
- Urea 3
- Creatinine 72
- Glucose 4

- FBC, LFTs are normal


Bedside plasma osmolarity
2(Na) + (BUN) + (Glucose)
2(120) + 3 + 4 = 247

Case one: other tests

- Serum osmolarity: 251mmol/L
- Urine osmolarity: 70mmol/L
- Urine sodium: 6mmol/L



Case one

- Diagnosis?
- Psychogenic polydipsia
- Treatment?
- Stop drinking water!!!

Case two

- 54M presents with a 12 hour history of nausea and confusion
- PMH: depression
- Medication: fluoxetine
- Examination: no localising signs, but patient disoriented to time and place
- Euvolaemic

Case two

- Na 120
- K 4
- Cl 85
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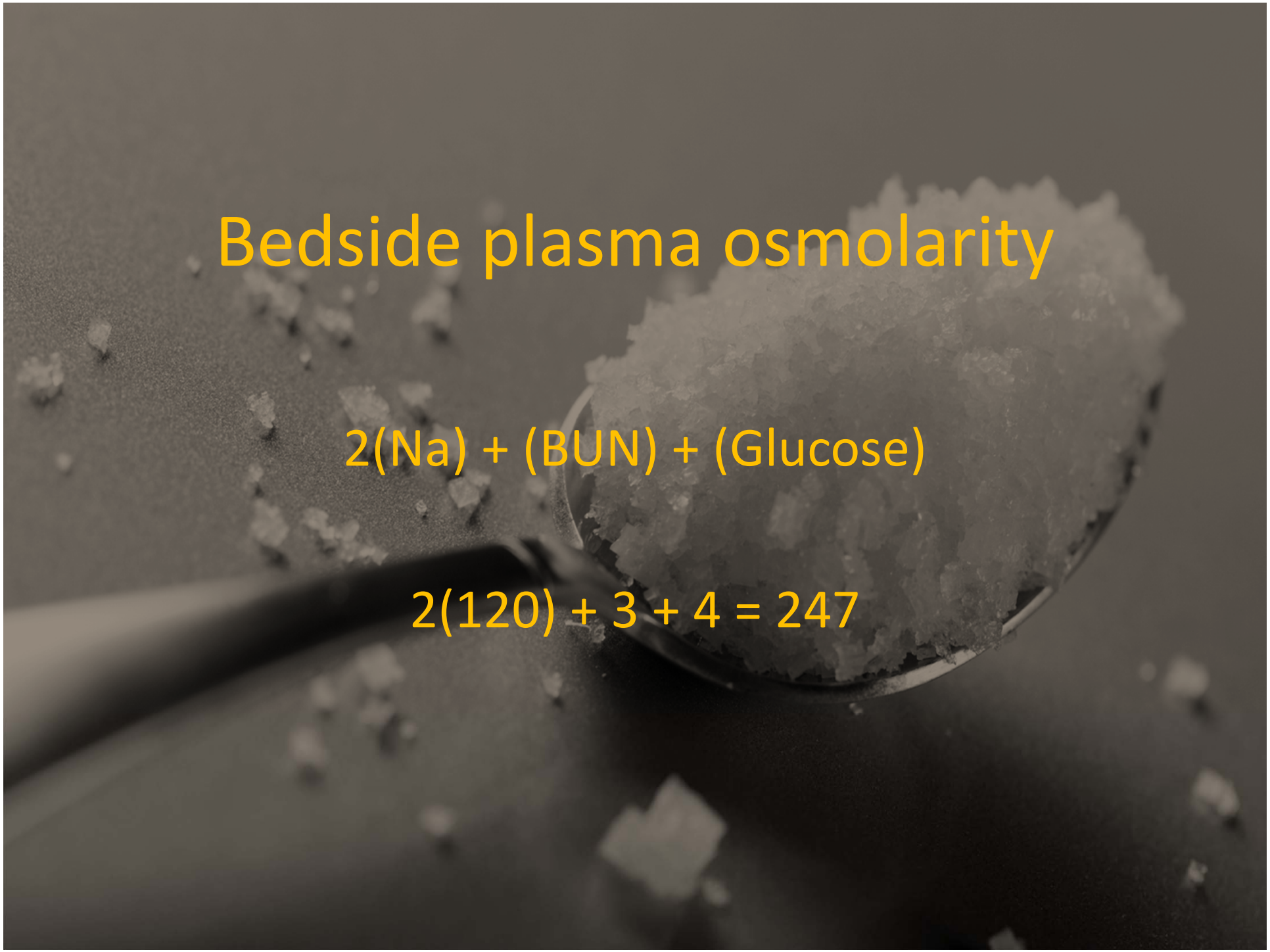
- FBC, LFTs are normal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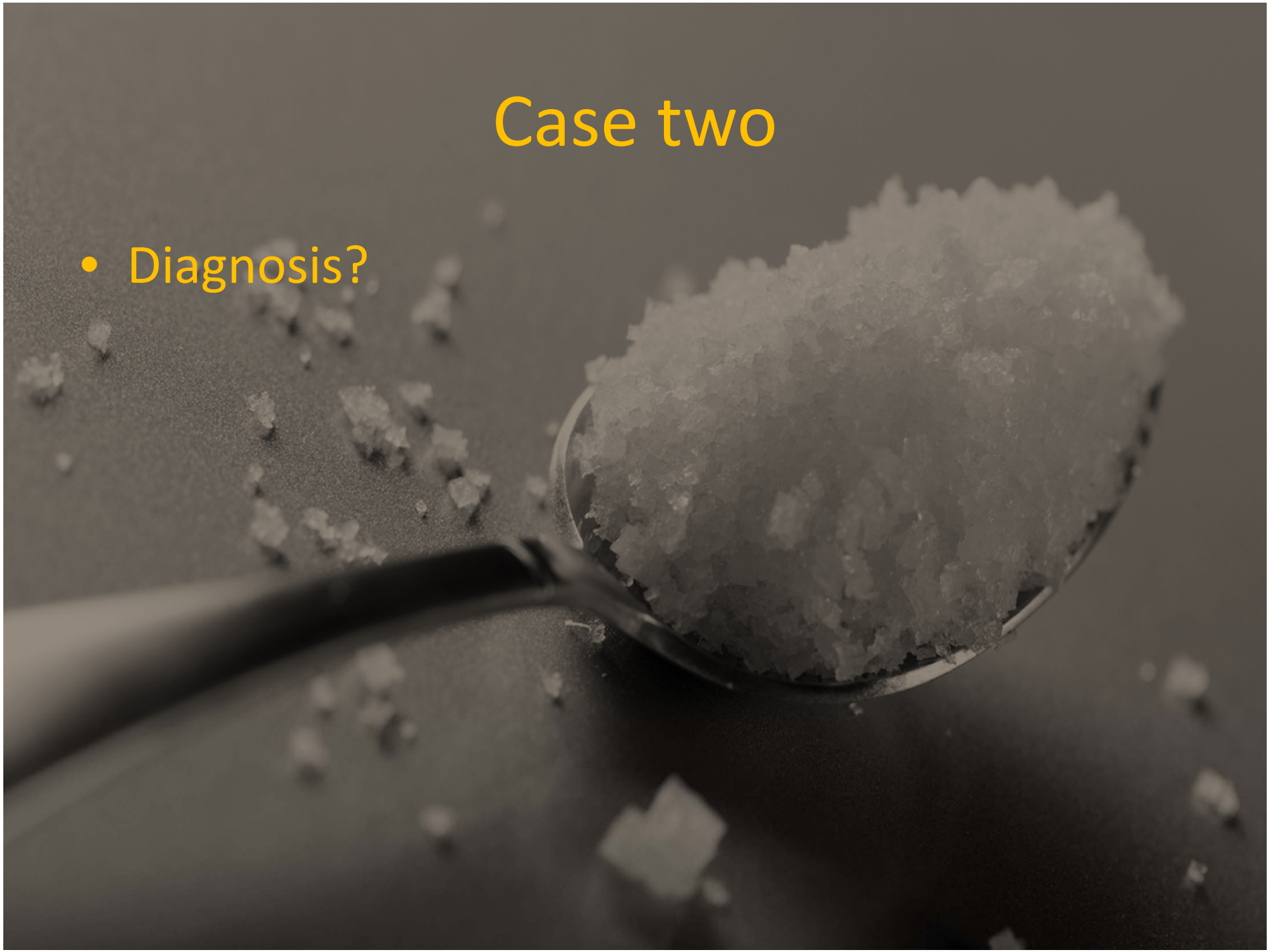
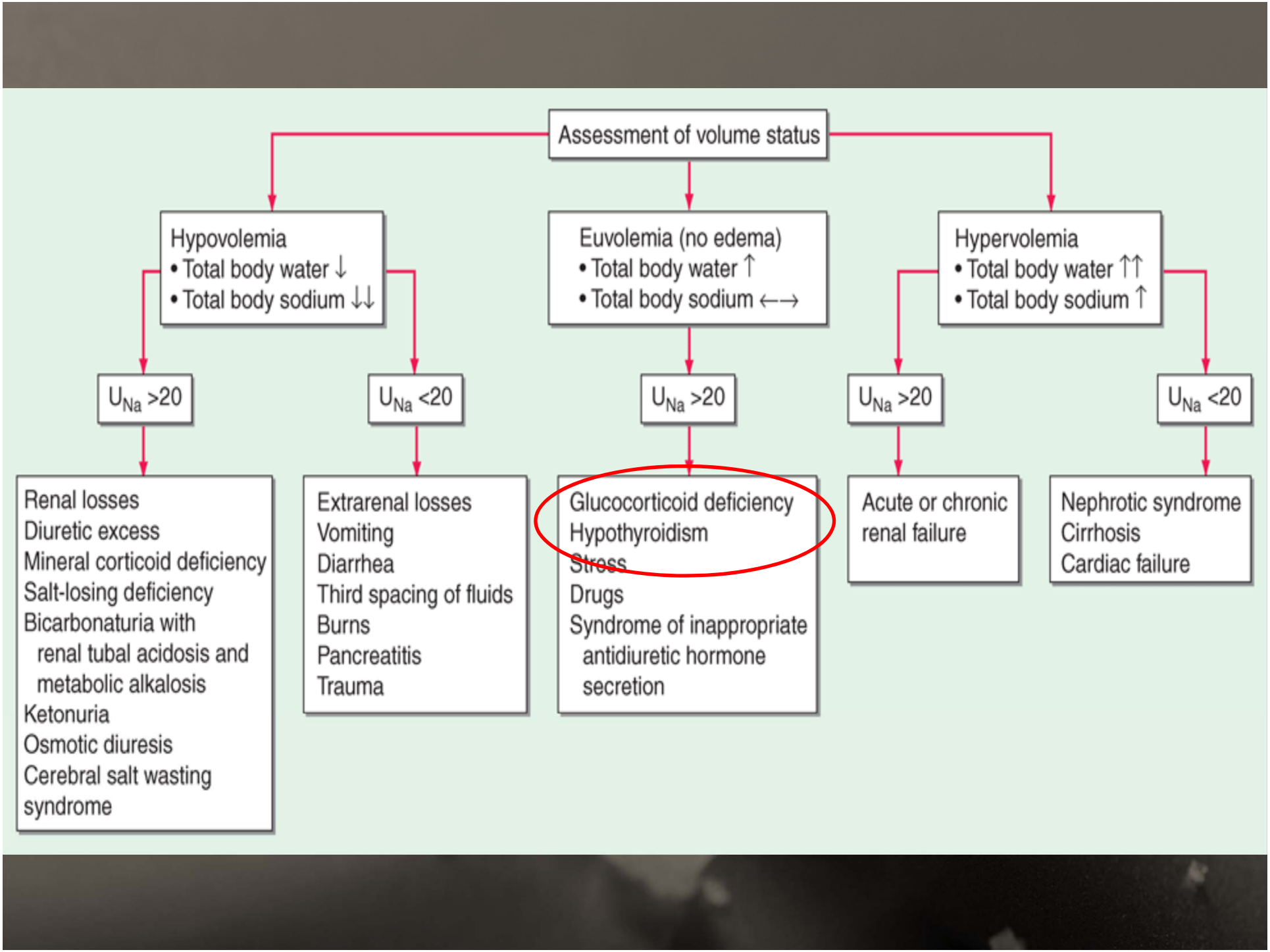
Case two: other tests

- Serum osmolarity: 250mmol/L
- Urine osmolarity: 650mmol/L
- Urine sodium: 55mmol/L

Case two

- Diagnosis?

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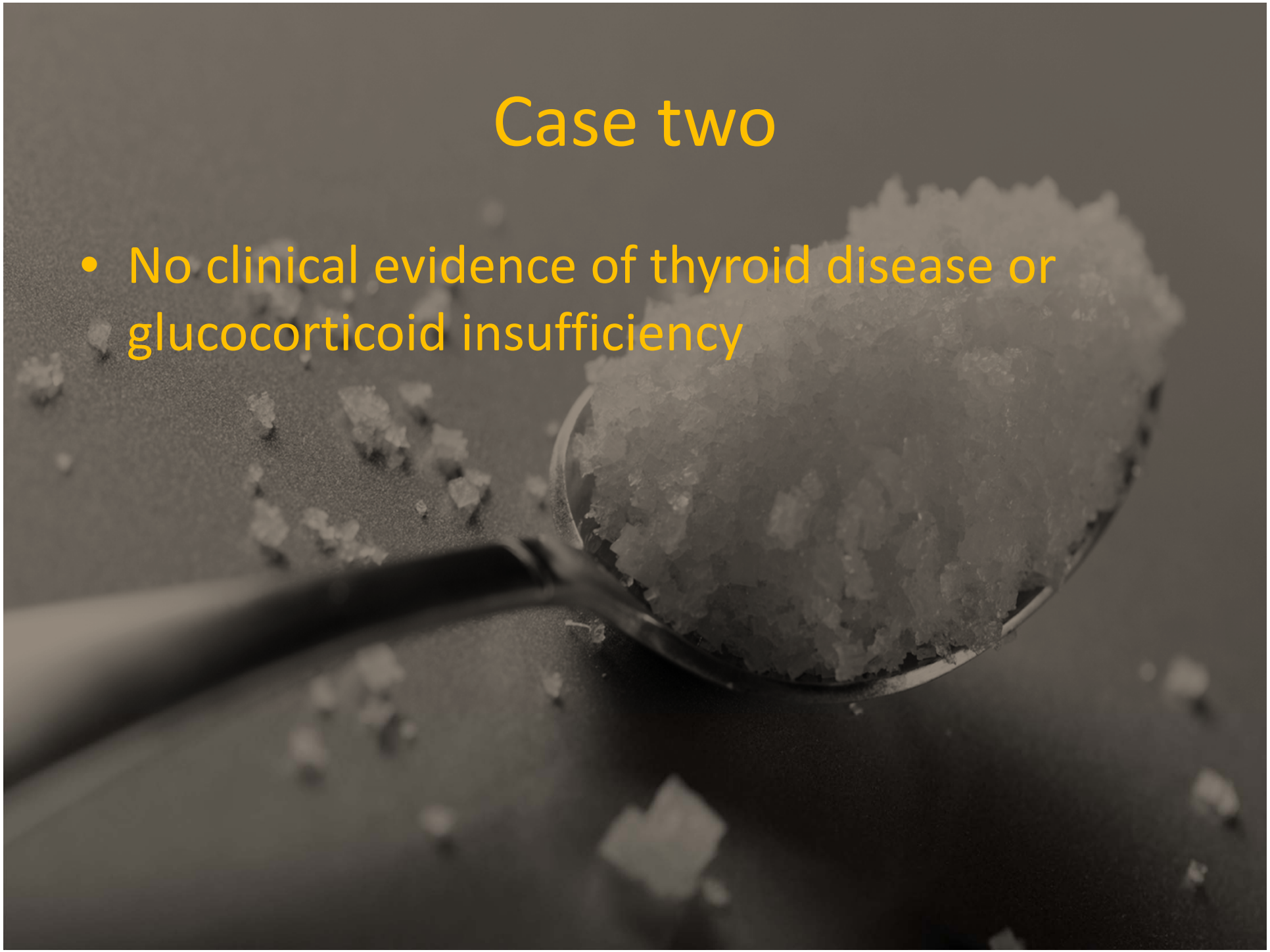
Ketonuria
Osmotic diuresis
Cerebral salt wasting syndrome
Extrarenal losses
Vomiting
Diarrhea
Third spacing of fluids
Burns
Pancreatitis
Trauma
Glucocorticoid deficiency
Hypothyroidism
Stress
Drugs
Syndrome of inappropriate antidiuretic hormone secretion
Acute or chronic renal failure
Nephrotic syndrome
Cirrhosis
Cardiac failure

Case two

- No clinical evidence of thyroid disease or glucocorticoid insufficiency



Case two

- Diagnosis?
- SIADH secondary to SSRI
- Treatment?
- Cease SSRI, fluid restriction

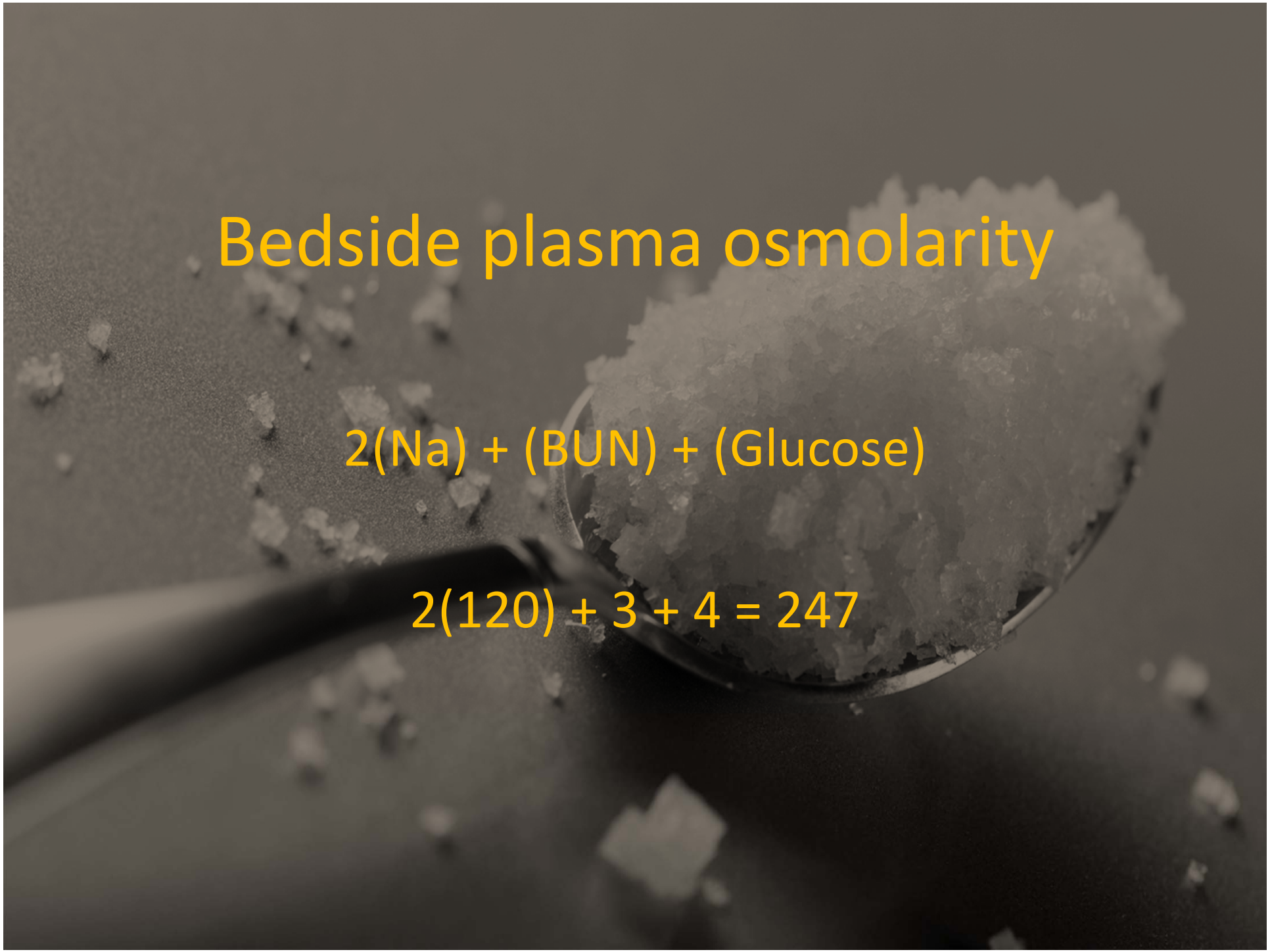
Case three

- 54M presents with a 12 hour history of nausea and confusion
- PMH: depression
- Medication: fluoxetine
- Examination: no localising signs , but patient disoriented to time and place
- Euvolaemic

Case three

- Na 120
- K 4
- Cl 85
- HCO3 24
- Urea 3
- Creatinine 72
- Glucose 4

- FBC, LFTs are normal


Bedside plasma osmolarity
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2(120) + 3 + 4 = 247

Case three: other tests

- Serum osmolarity: 290mmol/L
- Urine osmolarity: 350mmol/L
- Urine sodium: 20mmol/L

Case three

- Diagnosis???

Case three

- Diagnosis?
- Pseudohyponatraemia secondary to osmolar gap (alcohol commonest)
- Blood alcohol level: 40mmol/L
- Treatment?
- Observation

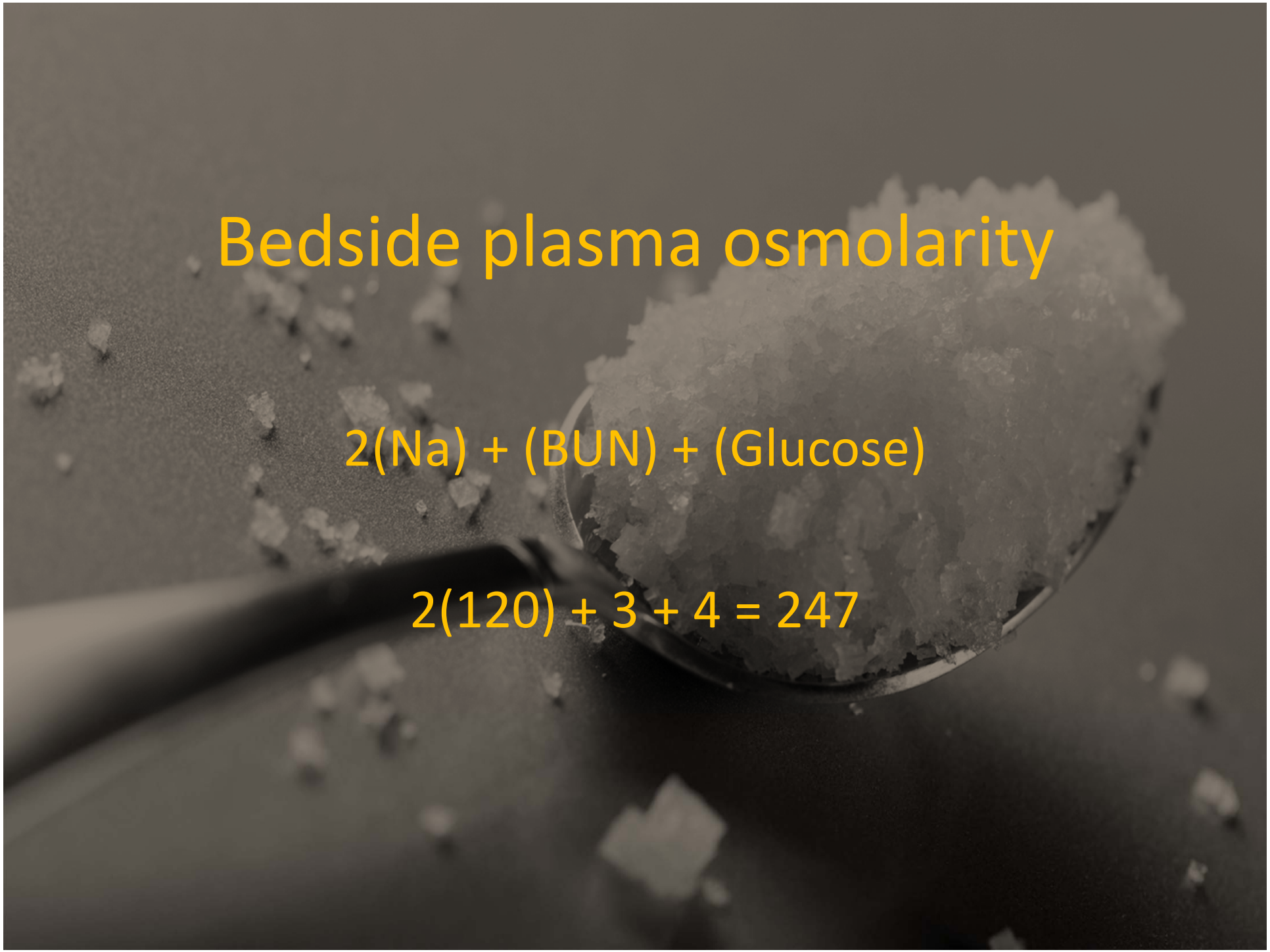
Case four

- 54M presents with a 12 hour history of nausea and confusion
- PMH: depression
- Medication: fluoxetine, another medicine given by his GP for his blood pressure?
- Examination: no localising signs , but patient disoriented to time and place
- Euvolaemic, blood pressure: 150/100

Case four

- Na 120
- K 4
- Cl 85
- HCO3 24
- Urea 3
- Creatinine 110
- Glucose 4

- FBC normal
- LFTs normal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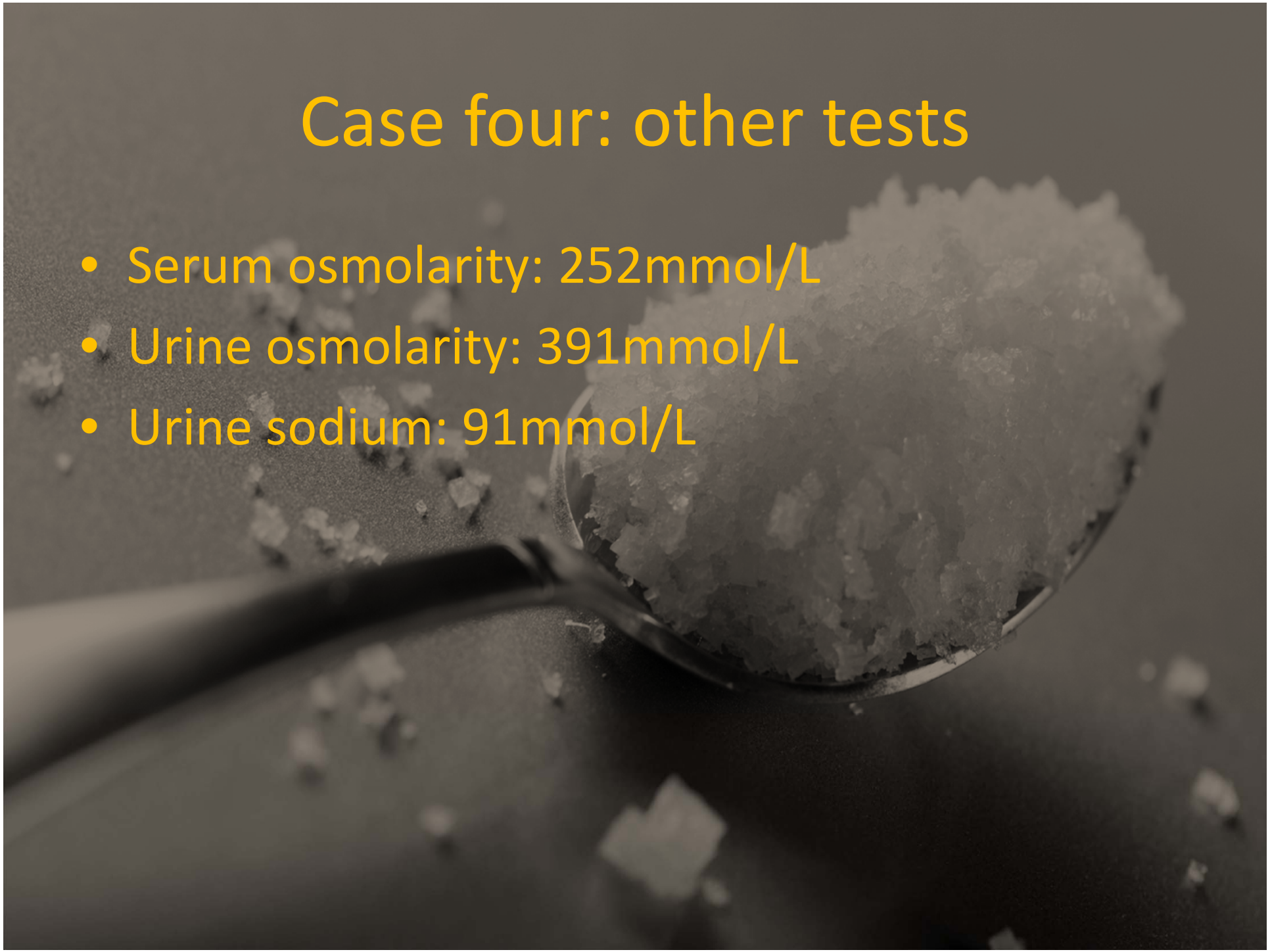
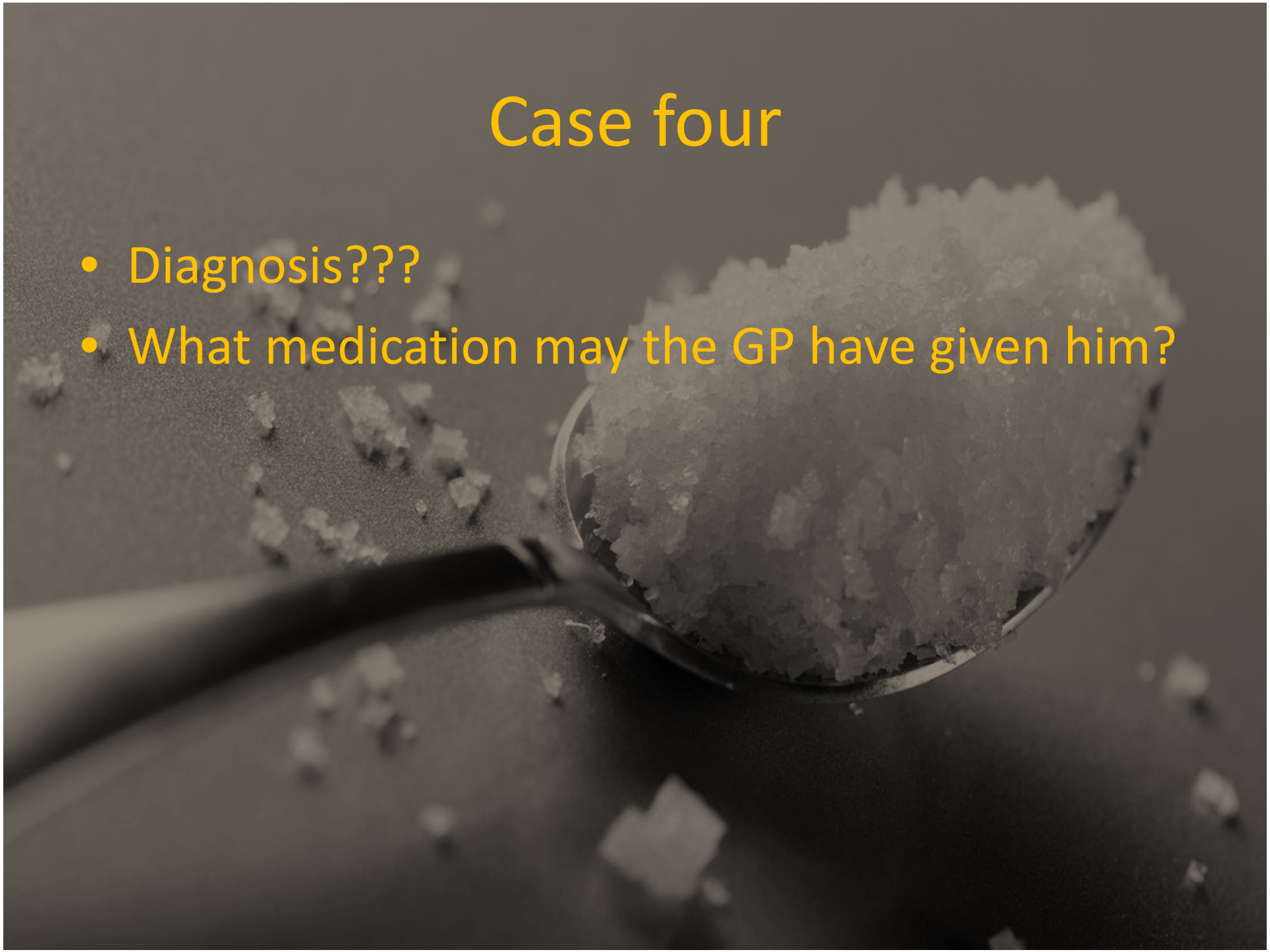


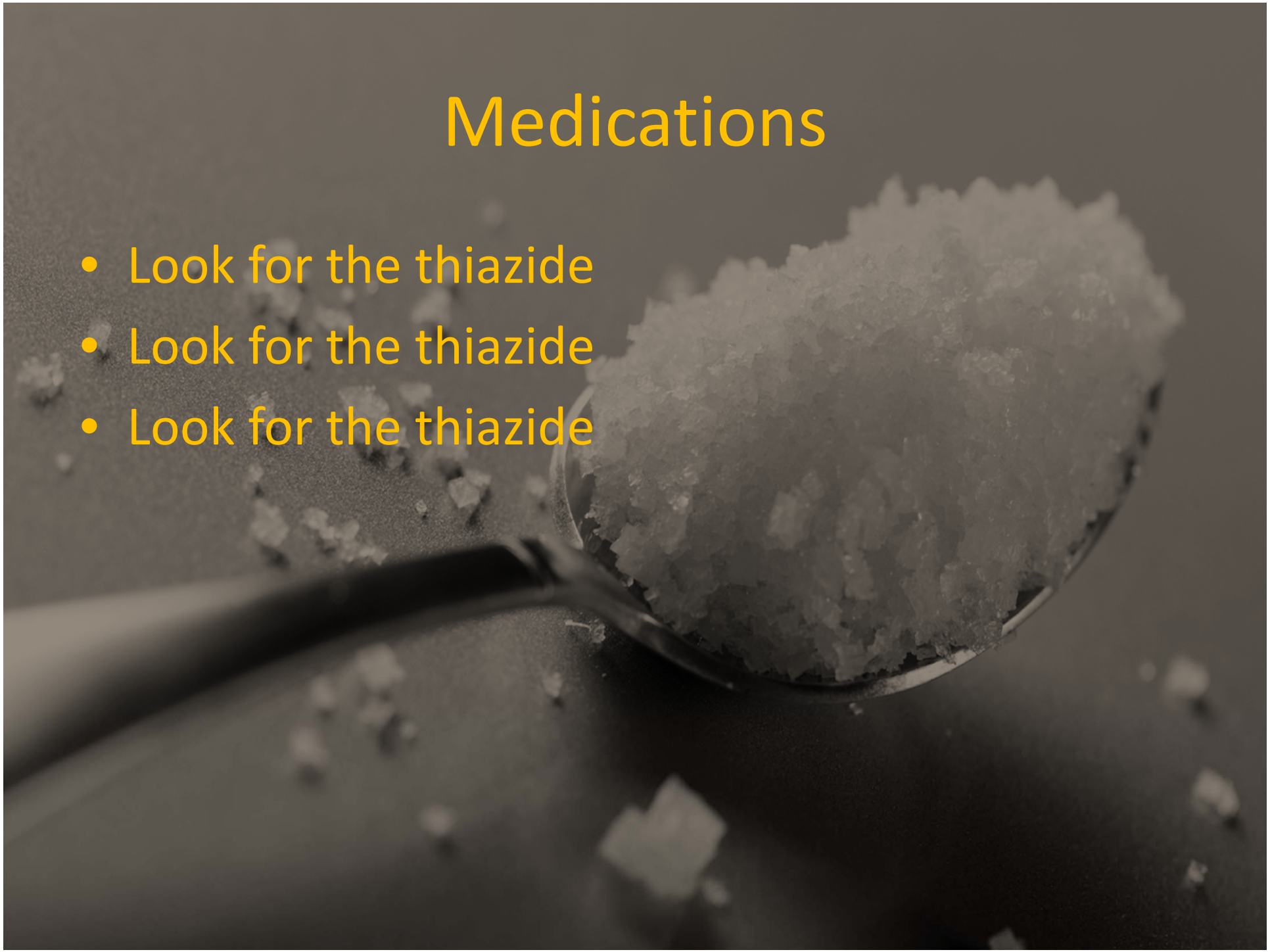
Case four: other tests

- Serum osmolarity: 252mmol/L
- Urine osmolarity: 391mmol/L
- Urine sodium: 91mmol/L



Case four

- Diagnosis???
- What medication may the GP have given him?



Medications

- Look for the thiazide
- Look for the thiazide
- Look for the thiazide

Case four

- Diagnosis?
- Hyponatraemia secondary to thiazide
- Treatment?
- Cease thiazide
- Consider secondary cause of his hypertension

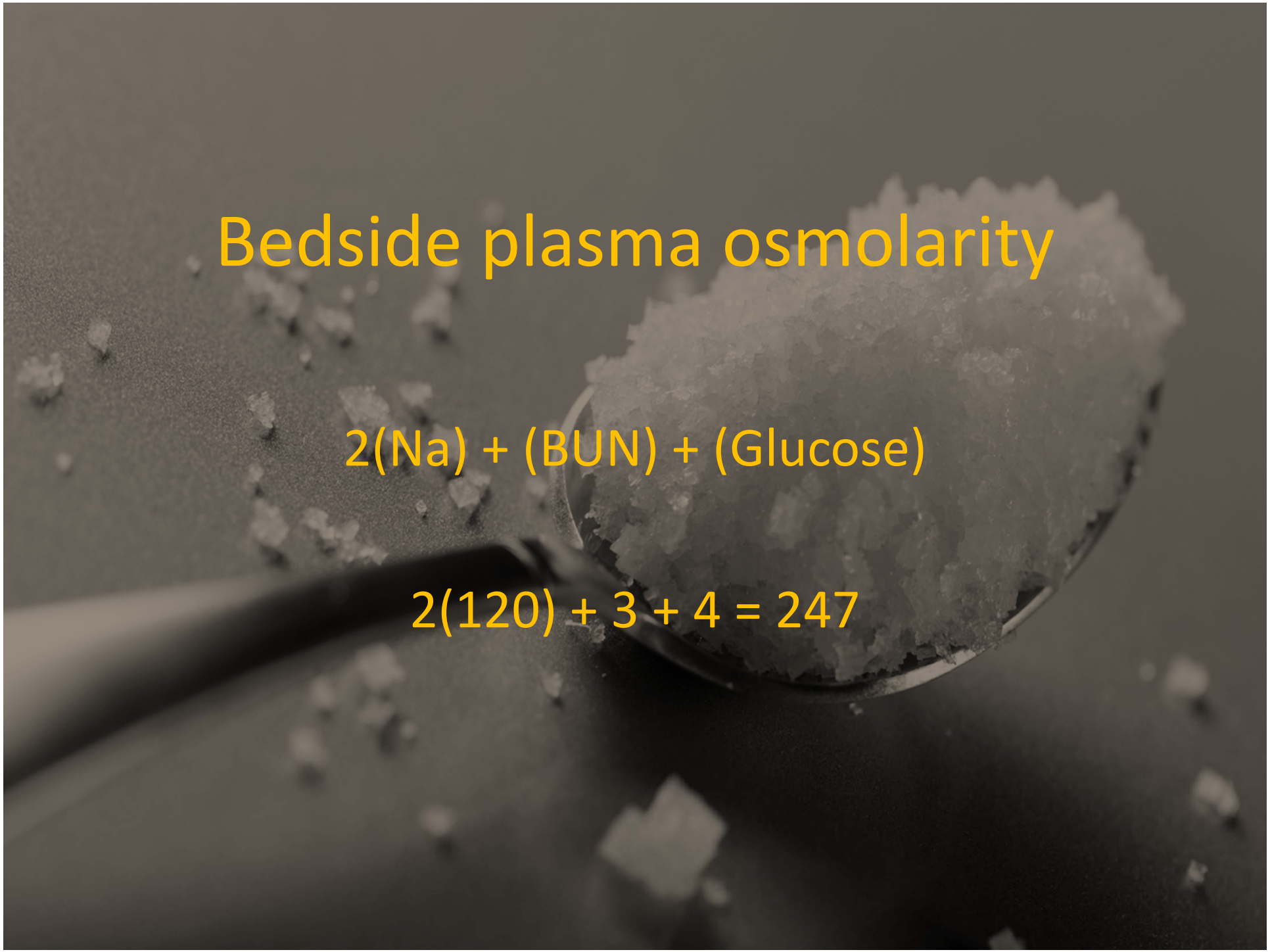
Case five

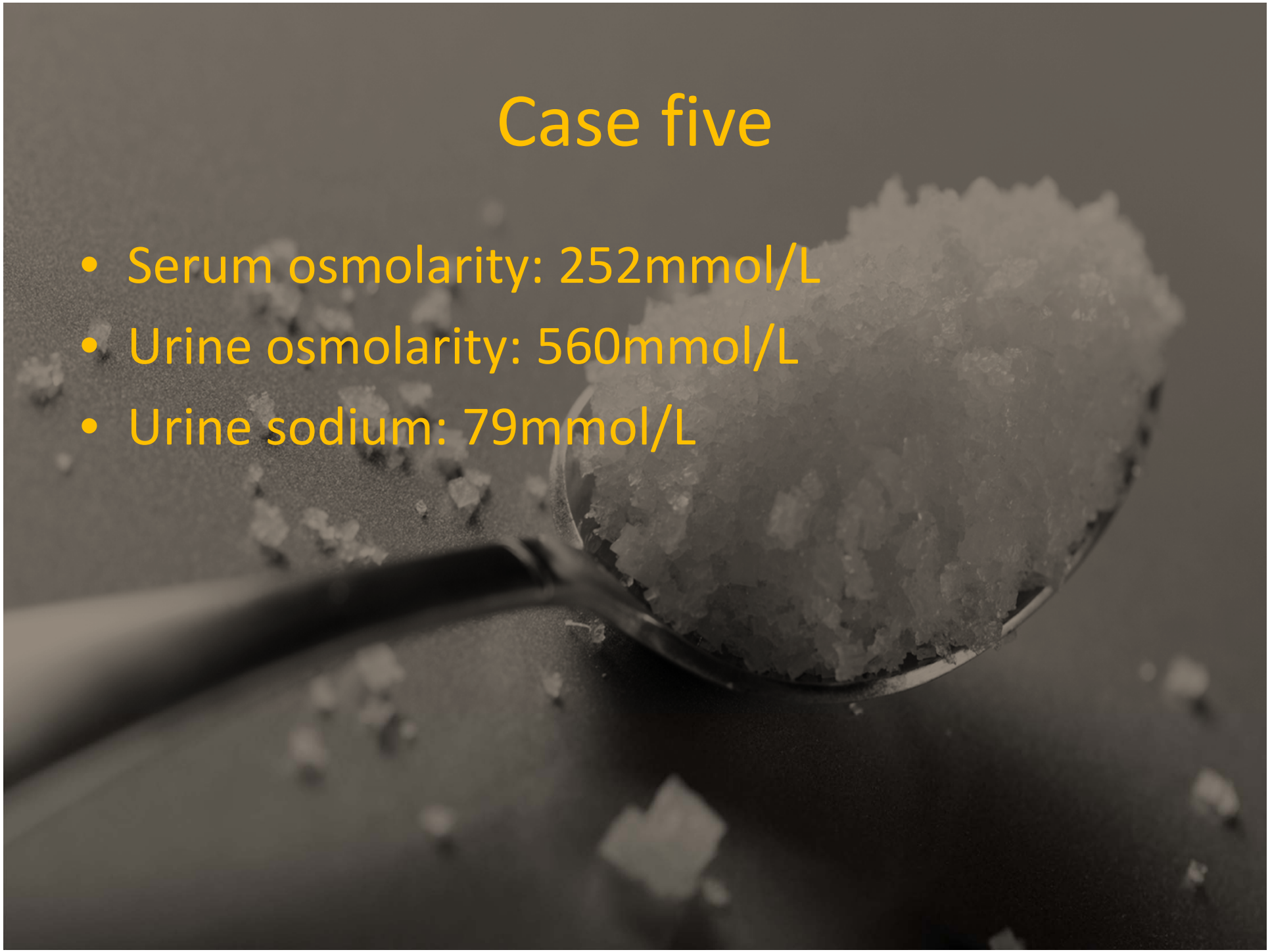
- 54M presents with a 12 hour history of nausea and confusion
- PMH: depression
- Medication: fluoxetine, another medicine given by his GP?
- Examination: no localising signs , but patient disoriented to time and place
- Elevated JVP
- Third heart sound
- Bibasal crepitations
- Pitting oedema to mid thighs
- Hepatomegaly

Case five

- Na 120
- K 4
- Cl 85
- HCO3 24
- Urea 3
- Creatinine 110
- Glucose 4

- FBC normal
- Bilirubin 56
- SAP 250
- GGT 400
- ALT 70
- AST 69


Bedside plasma osmolarity
2(Na) + (BUN) + (Glucose)
2(120) + 3 + 4 = 247

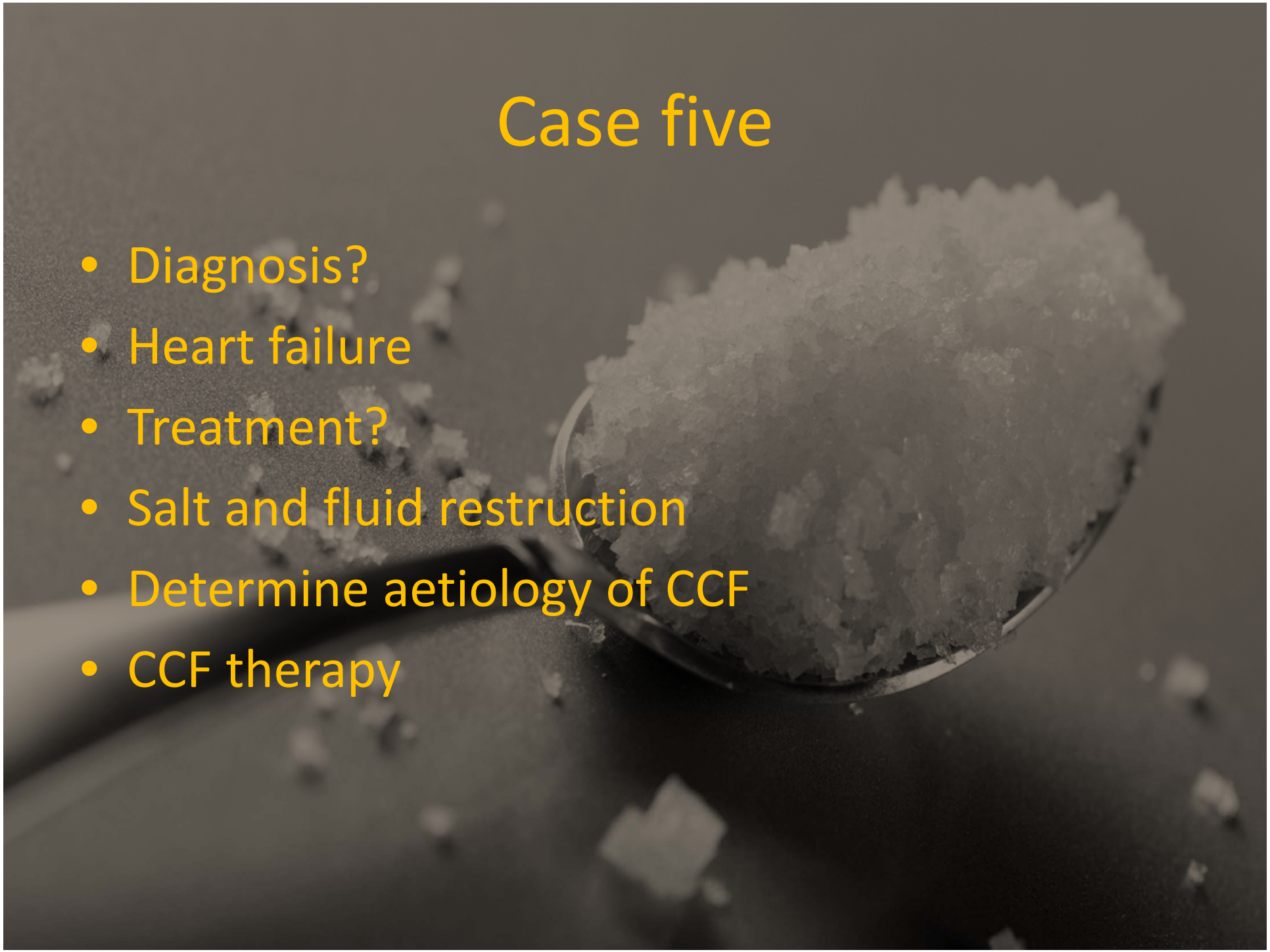


Case five

- Serum osmolarity: 252mmol/L
- Urine osmolarity: 560mmol/L
- Urine sodium: 79mmol/L

Case five

- Diagnosis???



Case five

- Diagnosis?
- Heart failure
- Treatment?
- Salt and fluid restruction
- Determine aetiology of CCF
- CCF therapy

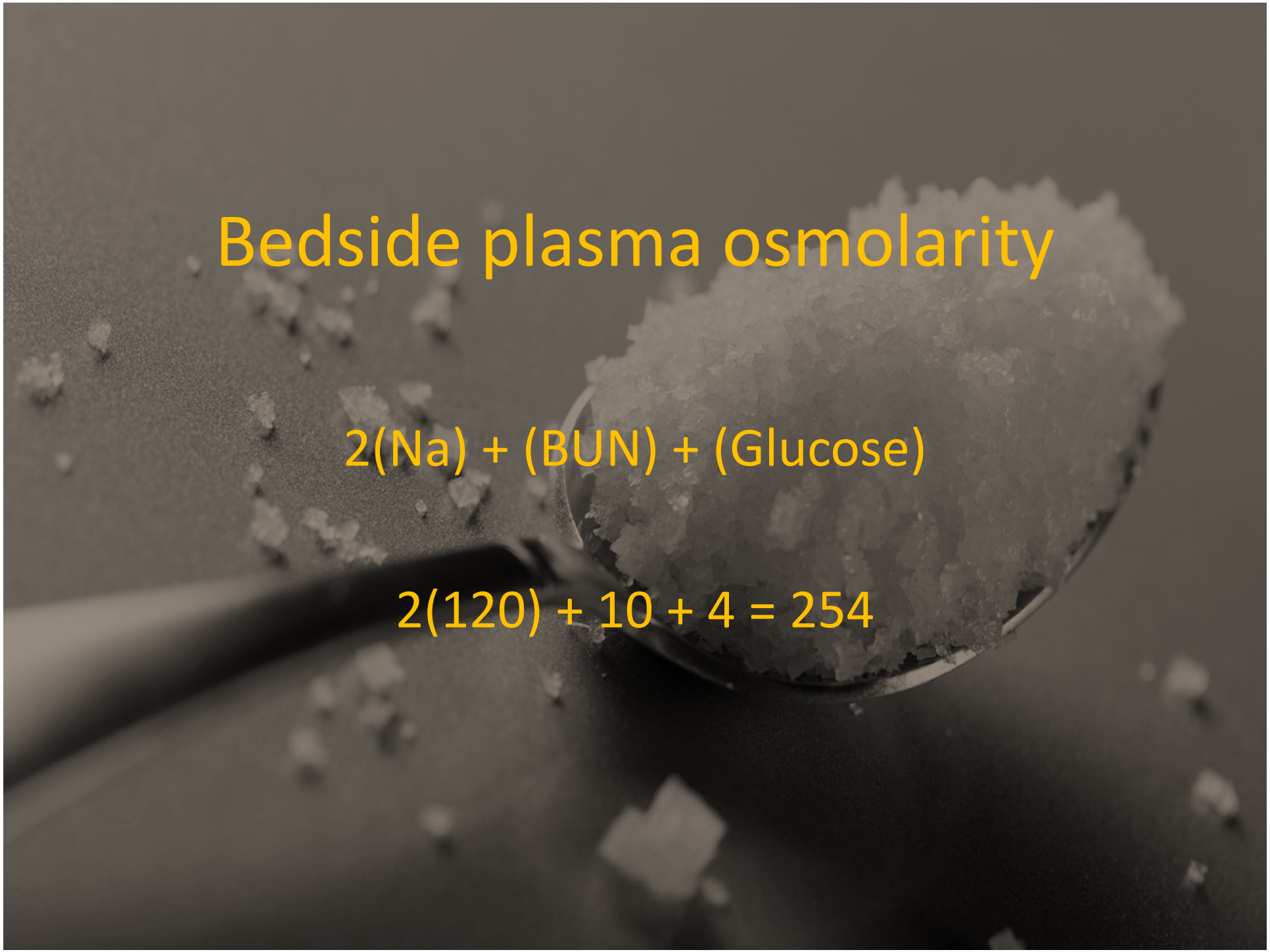
Case six

- 54M presents with a 24 hour history of nausea, vomiting and confusion
- PMH: depression
- Medication: fluoxetine
- Examination: no localising signs , but patient disoriented to time and place
- Febrile to 38.5
- Scleral icterus, JVP not visible, dry mucous membranes

Case five

- Na 120
- K 4
- Cl 85
- HCO3 20
- Urea 10
- Creatinine 130
- Glucose 4

- FBC normal
- Bilirubin 56
- SAP 150
- GGT 97
- ALT 70
- AST 69


Bedside plasma osmolarity
2(Na) + (BUN) + (Glucose)
2(120) + 10 + 4 = 254

Case five: other tests

- Serum osmolarity: 268mmol/L
- Urine osmolarity: 560mmol/L
- Urine sodium: 5mmol/L

Case five

- Diagnosis?
- Hypovolaemia leading to APPROPRIATE ADH secretion
- Treatment?
- IV normal saline
- Determine the cause of his febrile illness
- Any suggestions?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Hyponatremia in Severe Malaria: Evidence for an Appropriate Anti-diuretic Hormone Response to Hypovolemia

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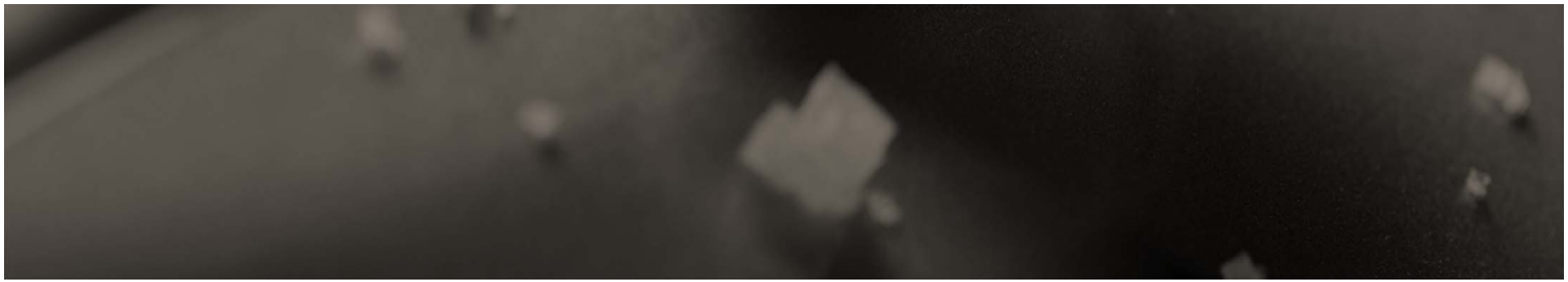


Any questions?