



水电平衡紊乱

第一节 正常水、电解质代谢平衡

* 钾平衡及紊乱

* 水钠平衡及紊乱

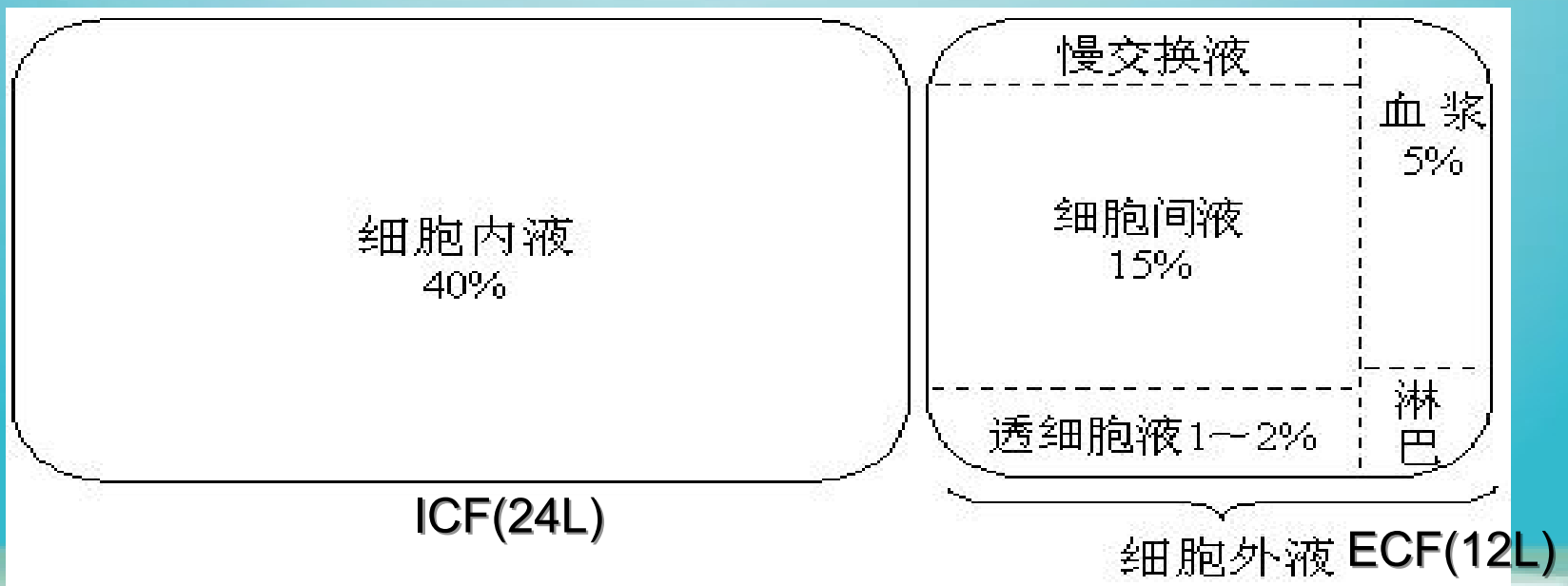
静水压和渗透压

体液的电解质组成

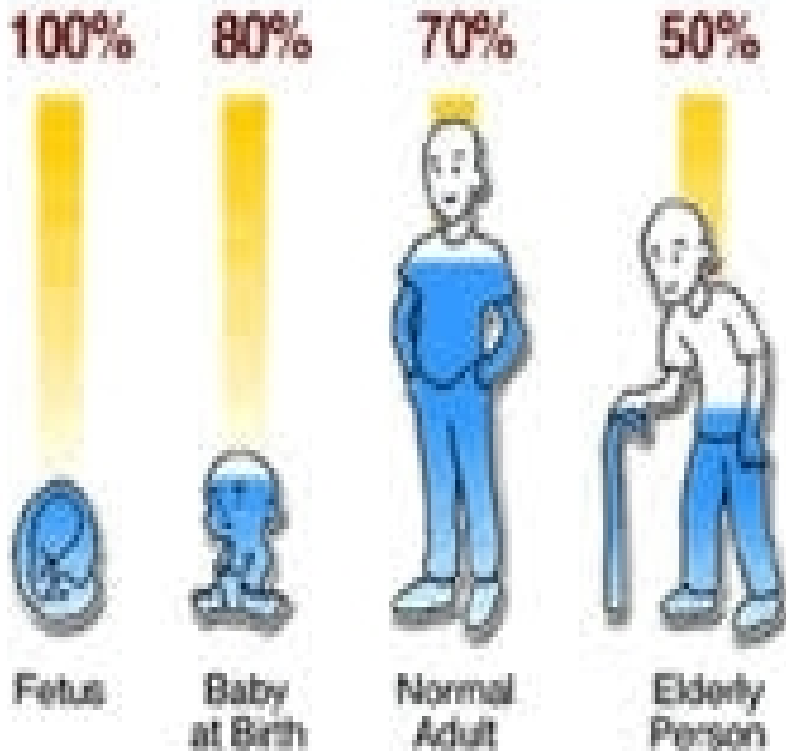
体液的分布

一、体液的分布 (Distribution of body fluid: water, crystalloids、colloids) (占体重%)

	成人 (男)	儿童	新生儿	老年人
TBF(total body fluid)	60	65	80	52
Intracellular fluid	40	40	35	27
Extracellular fluid	20	25	45	25
Interstitial fluid	15	20	40	20
Plasma	5	5	5	5



Percent of Water in the Human Body



- **Male(60%) > Female(55%)**
- **Most concentrated in skeletal muscle**
- **TBF=0.6×BW**
- **ICF=0.4×BW**
- **ECF=0.2×BW**

影响体液量的因素：年龄、性别、胖瘦

organ (tissue)	water content
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fat	25%~30%
muscle	76%
bone	14%~46%
liver	70%
skin	72%



Quiz:

1. Who is having higher proportion of body weight as fluid (water)? And Why?

- **1. Males or Females**
- **2. Lean or Obese**
- **3. Young or Elderly**

2. A fatty person and a thin person with the same body weight lost the same volume of body fluid, whose condition is worse?

3. For a fatty person and a thin person with the same body weight, who is more sensitive when water is shortage?

二、体液的电解质组成 (Composition of electrolyte in body fluids)

		Compartmental concentration (mEq/L)		
		Plasma	Interstitial fluid	Intracellular fluid
Positive ion (Cations)	Na ⁺	142	140	10
	K ⁺	5	5	150
	Ca ²⁺	5	5	0.0001
	Mg ²⁺	3	3	40
Total		155	153	200
Negative ion (Anions)	Cl ⁻	103	112	3
	HCO ₃ ⁻	27	28	10
	HPO ₄ ²⁻	2	4	142
	SO ₄ ²⁻	1	2	5
	Protein(Pr ⁻)	16	1	40
	Others	6	6	—
Total		155	153	200

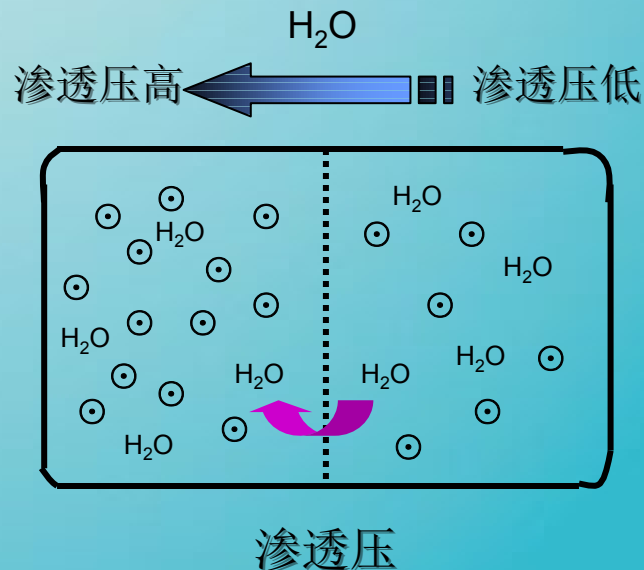
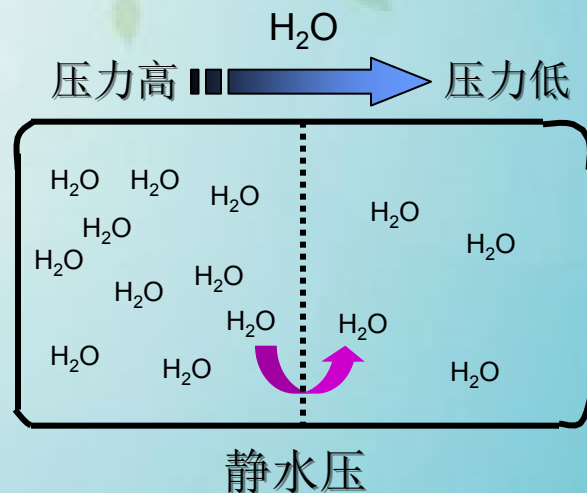
三、静水压和渗透压

(Hydrostatic & Osmotic pressure)

1. 静水压 (Hydrostatic pressure)

相邻的两个体液腔隙，由于压力不同，水必然从压力高的腔隙向压力低的腔隙转移，这种促使水转移的压力叫做静水压。渗透压 (Osmotic pressure)

如果相邻两个体液腔隙的静水压相等，而体液中溶质的浓度不同，那么水将由溶质浓度低（渗透压低）的腔隙向溶质浓度高（渗透压高）的腔隙转移，这种现象称为渗透。推动渗透的力称为渗透压。



Osmotic pressure in the body fluid:

- **Osmotic pressure of a solution depends on the amount of osmotic effective particles.**

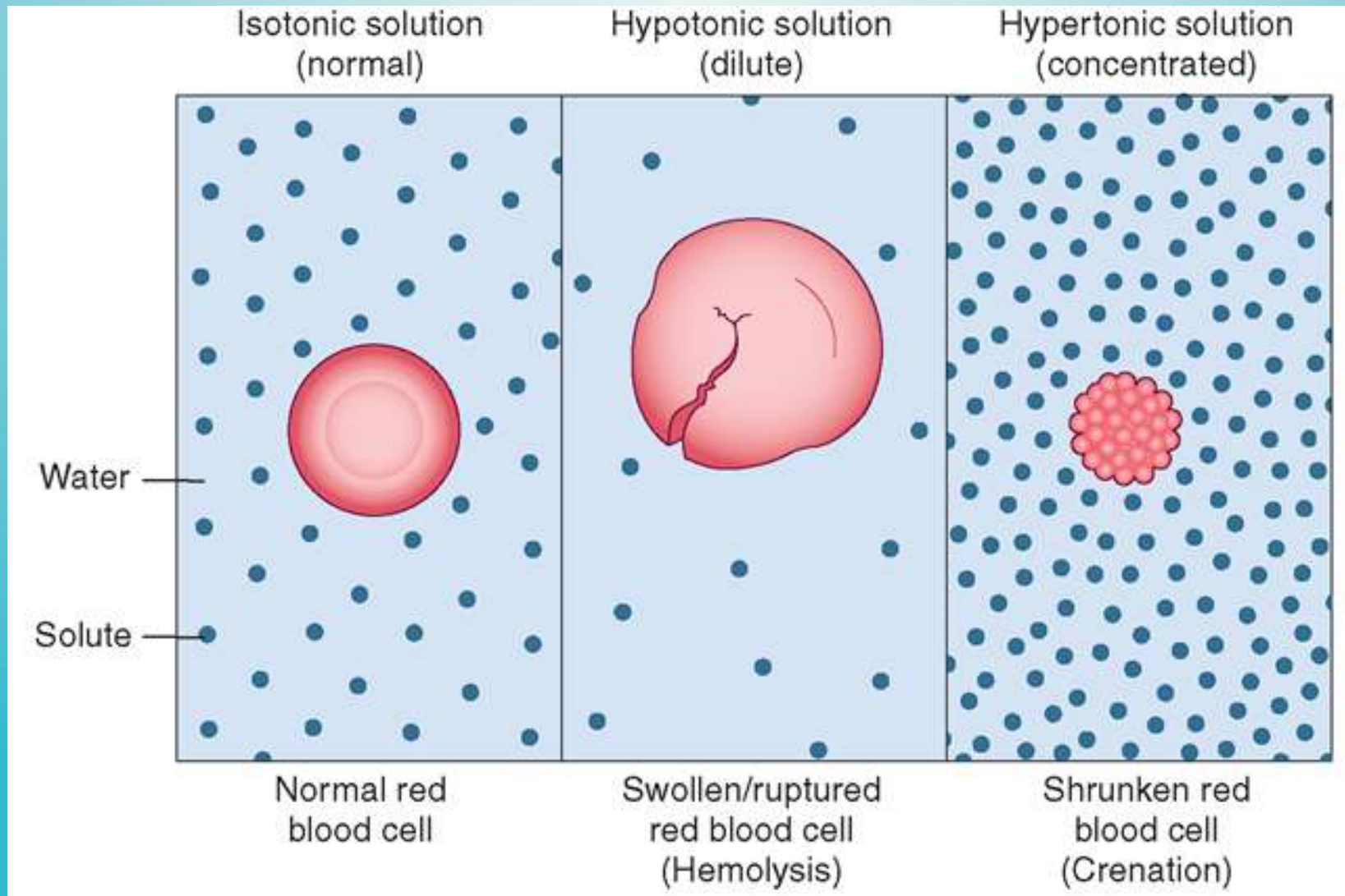
Water moves from areas of low osmolality to areas of high osmolality.

Osmotic pressure of ECF is roughly equivalent to ICF.

- **Normal plasma osmotic pressure is 280
~ 310 mOsm/L or mmol/L.**

Plasma osmotic pressure contains colloid osmotic pressure and crystal osmotic pressure.

Tonicity



四、人体水、钠的生理功能及其代谢调节 (**function and balance of water and sodium**)

1. Water daily balance

Normal water gains and losses (60Kg Man)

<u>Intake (ml)</u>		<u>Output (ml)</u>	
Drinking	1000~1300	Urine	1000~1500
Water in food	700~900	Respiration	350
Oxidative water	300	Skin	500
		Stool	150
Total	2000~2500	Total	2000~2500

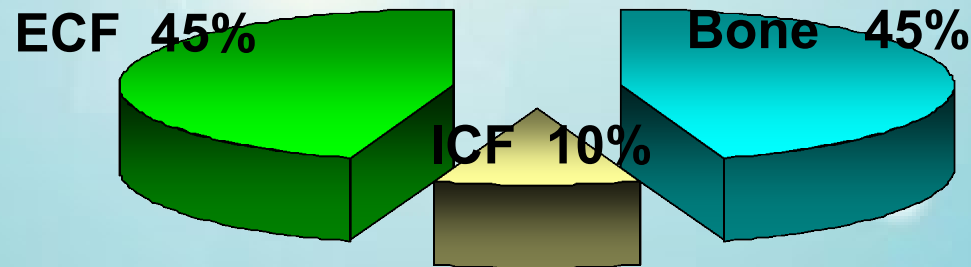
2、水的生理功能 (**function** of water):

- water is a good solvent for many body chemicals;
- water is essential to metabolism;
- water is necessary for body temperature regulation and body fluid osmotic pressure regulation, etc.

3、钠的含量与分布 (Content & distribution of body sodium)

■ Content of sodium : 58mmol/kg, Total body sodium: 60~80g/60kg.

■ Distribution of body sodium :



Serum Na⁺ concentration: 130~150mmol/L

(汗液是低渗溶液, 含钠量约10~70mmol/L; 肠道消化液富含NaHCO₃)

■ Metabolism : 食物提供: Na 2~4g/ 24h, 肾排出量: 3g/24h, 粪便排出 >10mg/24h。

肾排钠特点: “多吃多排, 少吃少排, 不吃不排”。

4、钠的生理功能 (Functions of sodium in body):

维持细胞的兴奋性和传导性;

维持细胞外液渗透压, 并影响水在细胞内、外的分布;

参与酸碱平衡的调节。

5、水、钠平衡的调节 (Regulation of water-salt metabolism)

(1) 刺激因素

血浆容量的改变：心房、大静脉

循环压力的改变：颈动脉、心房、肾脏

血浆晶体渗透压的改变：下丘脑视上核

(2) 机体反应

口渴中枢兴奋

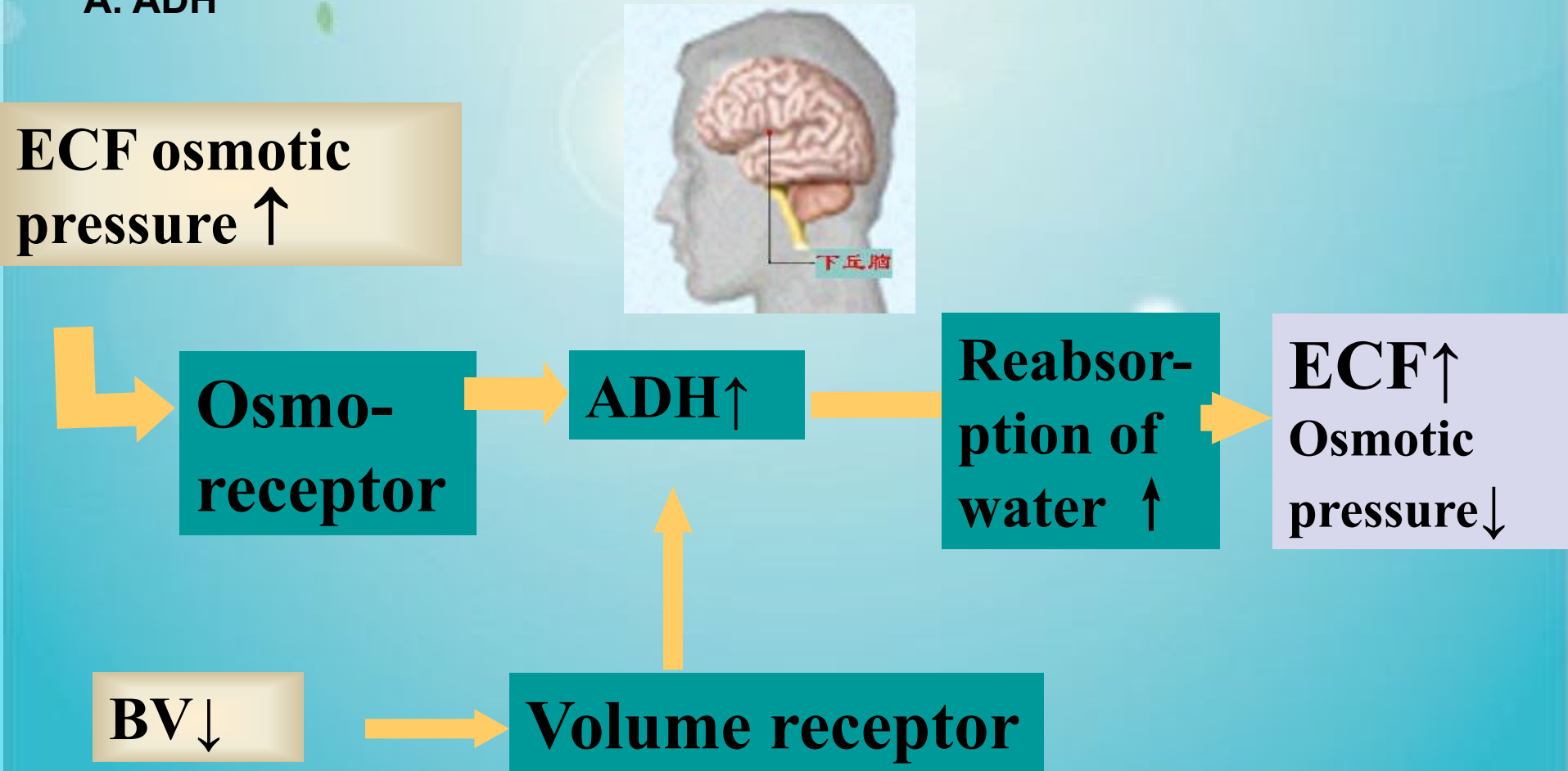
抗利尿激素

醛固酮

心房肽

1) Water balance is regulated by antidiuretic hormone (ADH) and the perception of thirst.

A. ADH



B. Thirst center

ECF osmotic pressure \uparrow



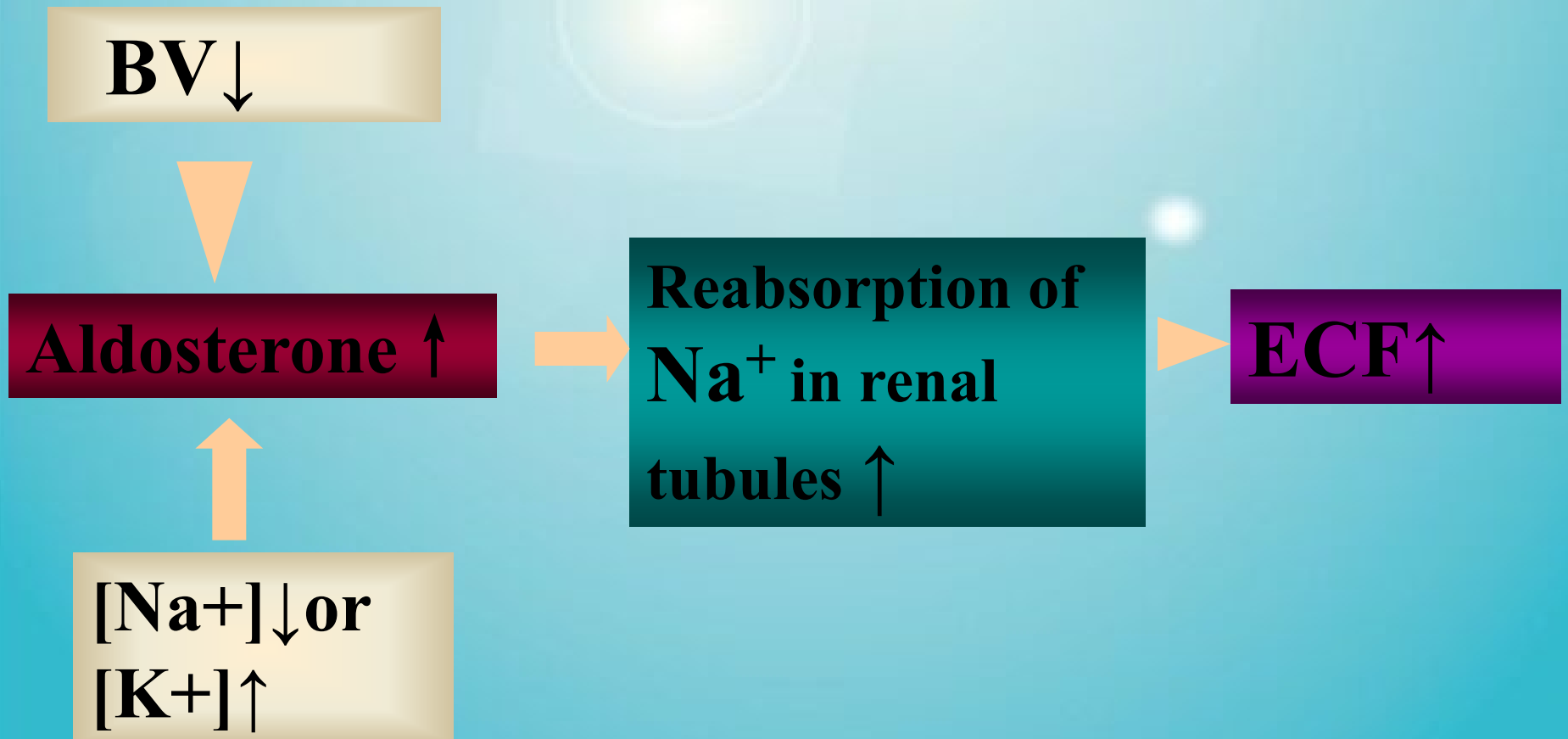
Hypothalamus

\downarrow
Thirst



Blood volume \downarrow

2) Sodium balance is regulated by aldosterone.



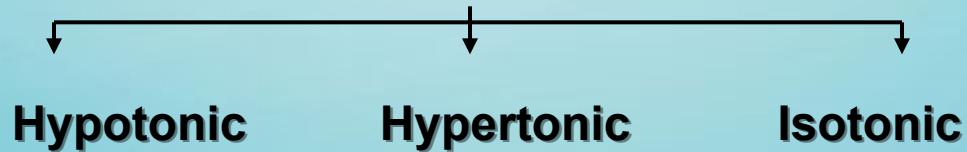
第二节 水、钠代谢紊乱

(unbalance of water and sodium)

一、分类

(一) 根据体液的渗透压变化 将脱水分为:

Dehydration



(二) 根据血钠浓度和体液容量来分

1、低钠血症 (Hyponatremia)

血清钠浓度低于**130mmol/L**。

根据体液容量分

{ 低容量性低钠血症——低渗性脱水
等容量性低钠血症
高容量性低钠血症

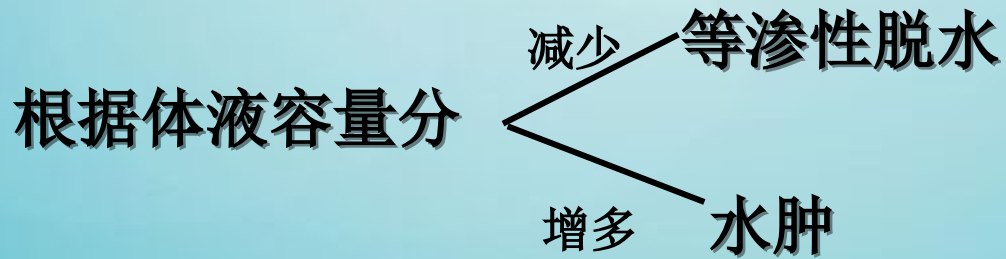
2、高钠血症 (Hypernatremia)

血清钠浓度高于**150mmol/L**。

根据体液容量分

{ 低容量性高钠血症——高渗性脱水
等容量性高钠血症
高容量性高钠血症

3、正常血钠性水紊乱：血清钠浓度130—150mmol/L



分类表:

	body fluid↓	body fluid↑
hypertonic	Dehydration	Salt intoxication
isotonic	Dehydration	Edema
hypotonic	Dehydration	Water intoxication

二、低容量性低钠血症--低渗性脱水 (Hypotonic dehydration)

1. Concept

失钠多于失水，血清钠浓度 $<130\text{mmol/L}$ ，血浆渗透压 $<280\text{mmol/L}$ ，伴有ECF的减少。

The salt loss is in excess of water loss, serum Na^+ is less than 130 mmol/L , and plasma osmotic pressure is less than 280 mmol/L .

2. Causes and mechanism

主要是等渗性或高渗性体液的丢失。

(1) 肾外性原因

- 消化液大量丢失 (Water and sodium loss through GI tract)
- 体液大量在体腔内积聚 (Collection of the fluid in peritoneal cavity)
- 大量出汗 (而只补充水) (Water and sodium loss through the skin)

(2) 肾性原因

■ 限制钠盐摄入或长期大量用排钠利尿药（氯噻嗪、速尿和利尿酸等）

■ 慢性肾疾病 → 肾小管功能障碍 → 肾排Na、H₂O ↑

■ 急性肾衰多尿期 → GFR ↑、小管功能未恢复

■ 失盐性肾炎 → 小管上皮细胞对Ald反应性 ↓ Hypotonic dehydration

■ Addison病 → Ald ↓ → 小管对Na重吸收 ↓

■ 过度渗透性利尿 → 肾排Na、H₂O ↑

血容量减少后肾脏重吸收水增多

肾外性原因 → 丢失等渗或高渗性体液

肾性原因 → 经肾失钠或同时失水

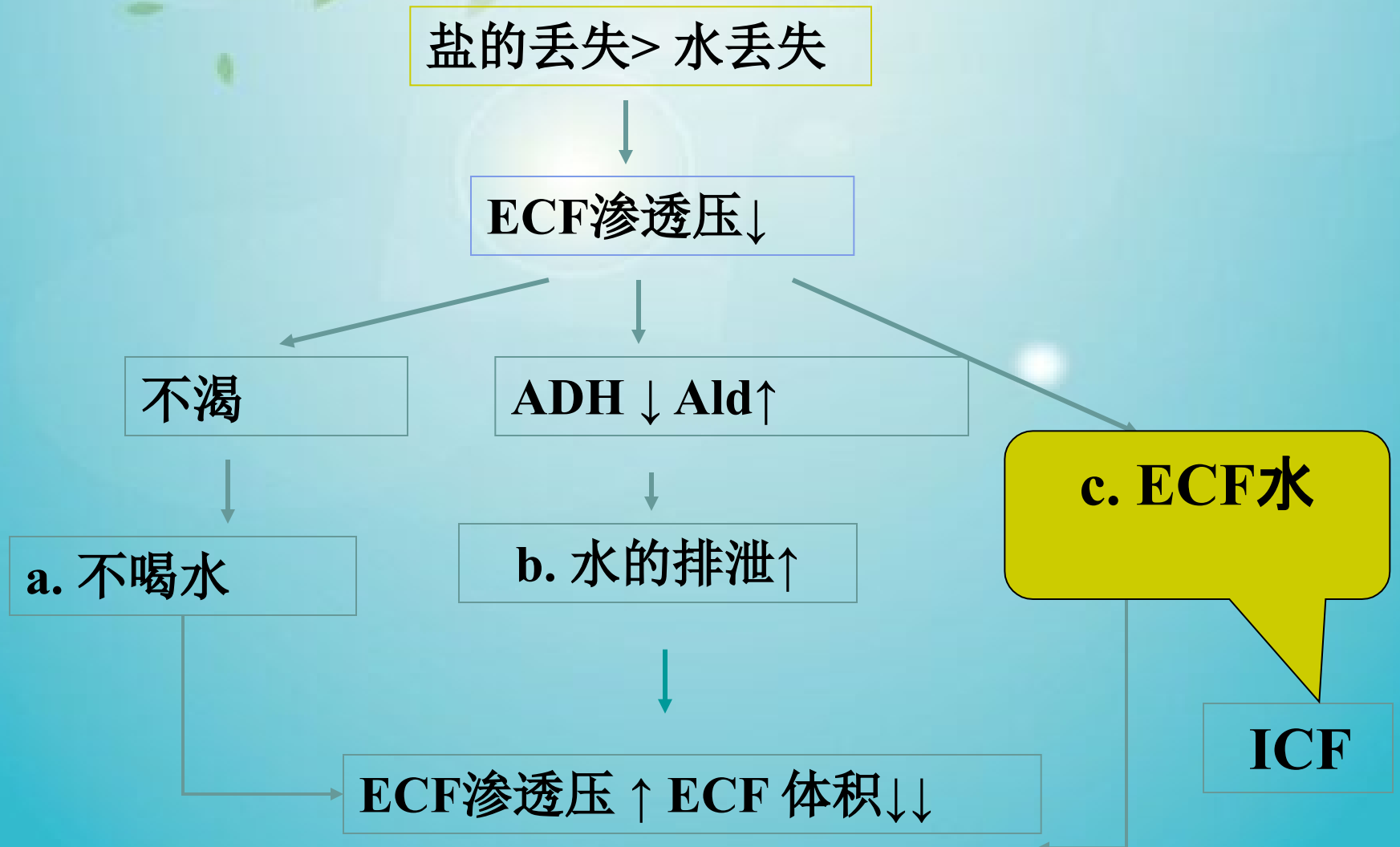
低渗性脱水

治疗上只补不足量水未注意补钠

3. 病理生理变化（对机体影响）（**Effects** on body）

代偿调节变化： 体液分布异常： 其他：

A. 代偿调节:



B. 临床表现

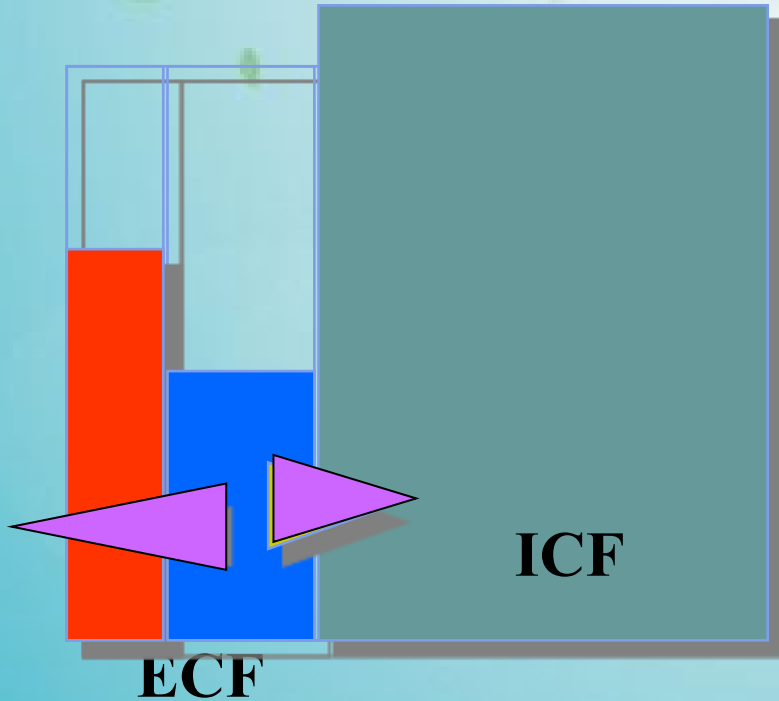


脱水征（signs of dehydration）：

皮肤弹性下降，眼窝下陷；婴幼儿出现“三凹”体征。

manifested by decreased skin turgor, sunken eye socket and fontanel-- because of obvious decrease of ECF.

病生要点:



**Mainly ECF↓;
signs of dehydration;
circulatory failure
easily occur at early
stage.**

失钠 > 失水 → 细胞外液渗透压 ↓ → 细胞外水分向细胞内转移
细胞水肿 ← 细胞内水分 ↑ ←
细胞外液 ↓ 更加明显**

4. 治疗原则:

(1) 治疗原发病, 去除病因;

(2) 补液: 补含钠液为主!!

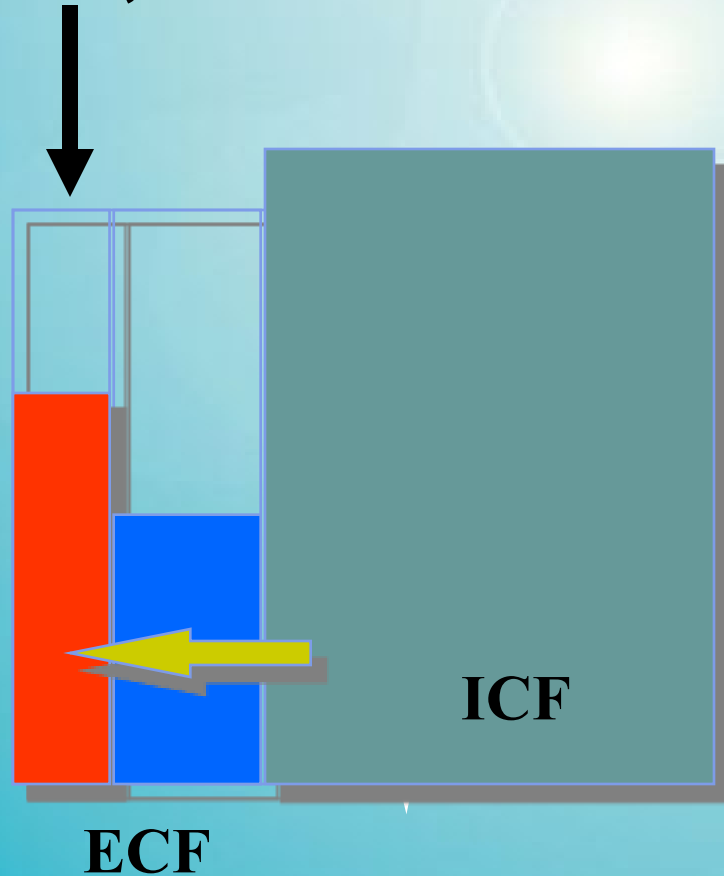
0.9%NaCl:

- **Na=154**
- **CL=154**
- **Osm=308**
- **pH=6.5**

Treatment of hypotonic dehydration :

3% , 0.9% sodium solution

What happens ?



三、高渗性脱水——低容量性高钠血症

(**Hypertonic dehydration**)

1. Concept

失水多于失钠，血清钠浓度 $> 150\text{mmol/L}$ ，血浆渗透压 $> 310\text{mmol/L}$ ，伴有ECF的减少。

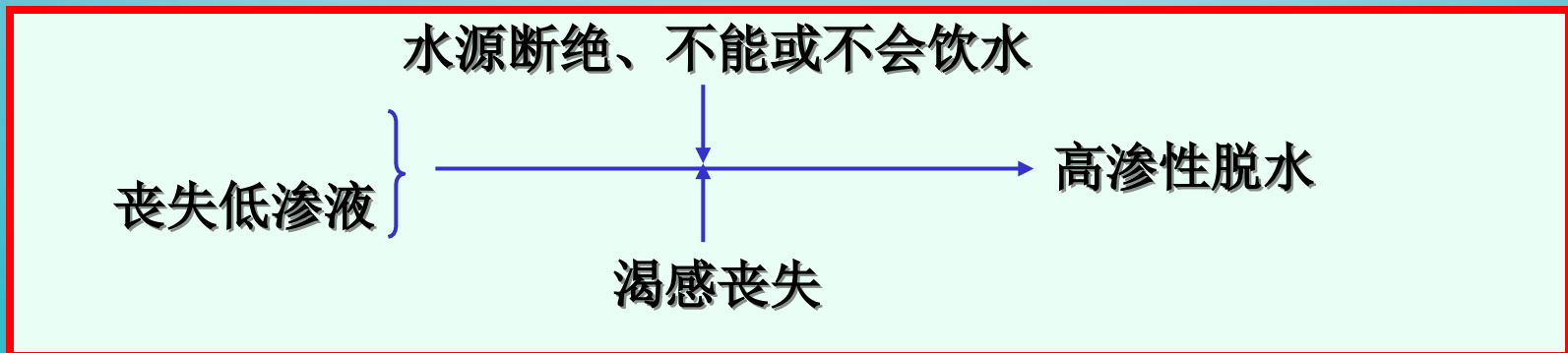
The water loss is in excess of salt loss, serum Na^+ is more than 150 mmol/L , and plasma osmotic pressure is more than 310 mmol/L .

2. Causes and mechanism

机体失水或丢失低渗体液是引起高渗性脱水的主要原因。

丧失低渗体液：

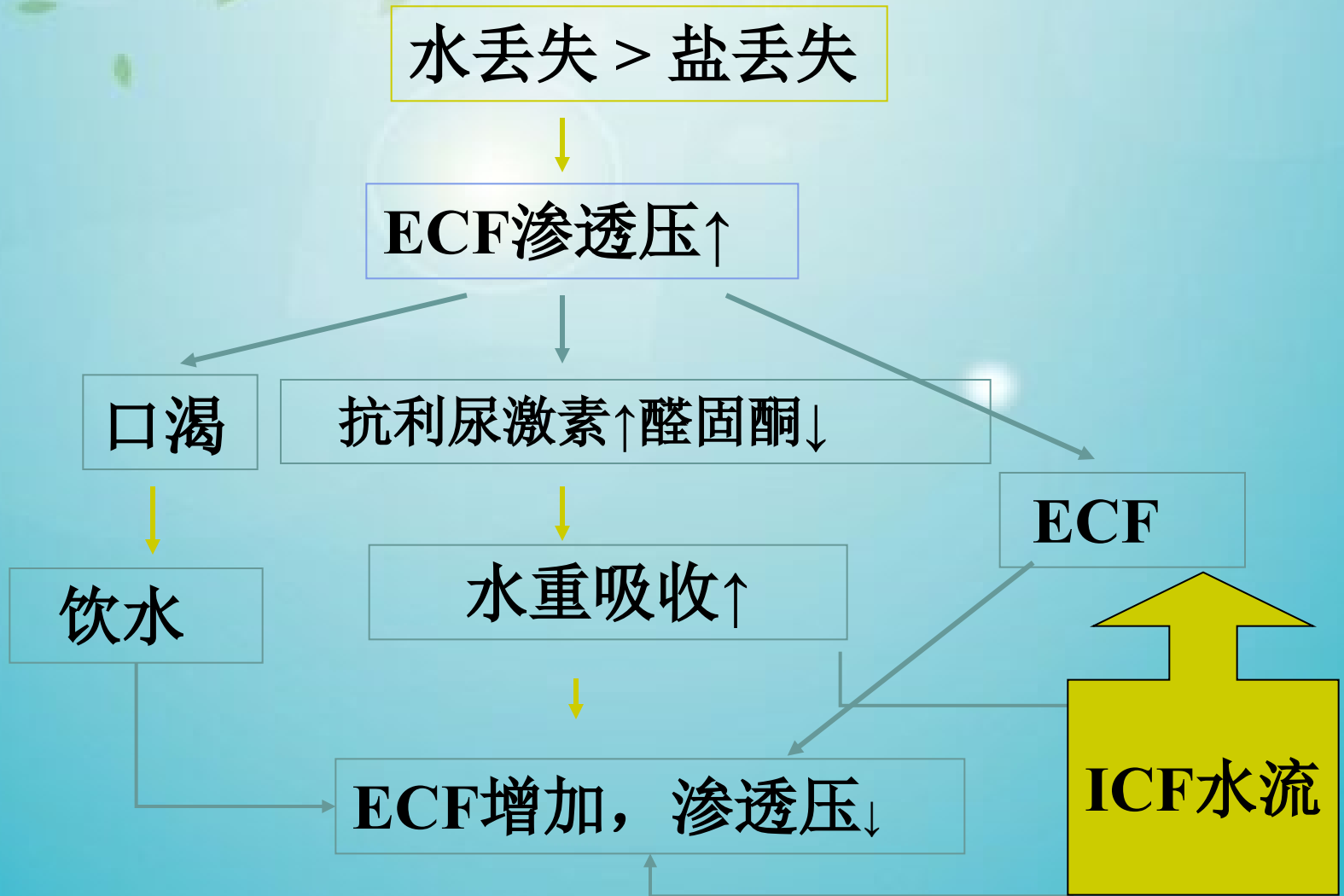
- 肺失水； ■ 皮肤失水；
- 肾失水（中枢性、肾性尿崩症）。
- 渗透性利尿；
- 胃肠道丧失等渗或低渗液；



3. 病理生理变化（对机体影响）（**Effects** on body）

代偿调节变化： 体液分布异常： 其他：

A. 代偿过程：



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