



Institute of Veterinary Clinical Sciences,  
School of Veterinary Medicine,  
National Taiwan University

# 輸液治療面面觀

## 1. 電解質與水和

## 2. 如何選擇及監控輸液治療

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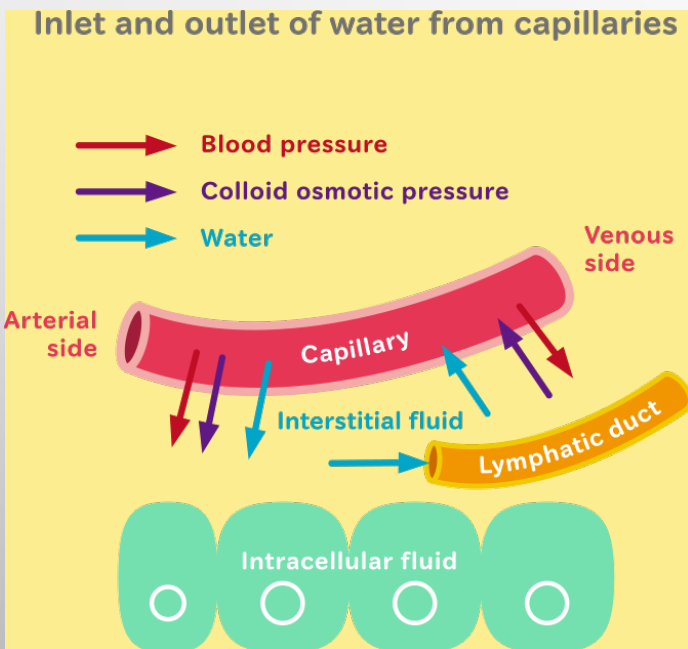


The slide features a light gray background with a gradient. In the top-left and bottom-right corners, there are several realistic water droplets of various sizes, rendered with soft shadows and highlights to give them a three-dimensional appearance. The main title is centered in the middle of the slide.

# 1. 電解質與水和 ELECTROLYTE & HYDRATION

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# 體液分布 水之平衡



細胞內

細胞外 (間質 血管內)

血管內

血管外 (間質 細胞內)

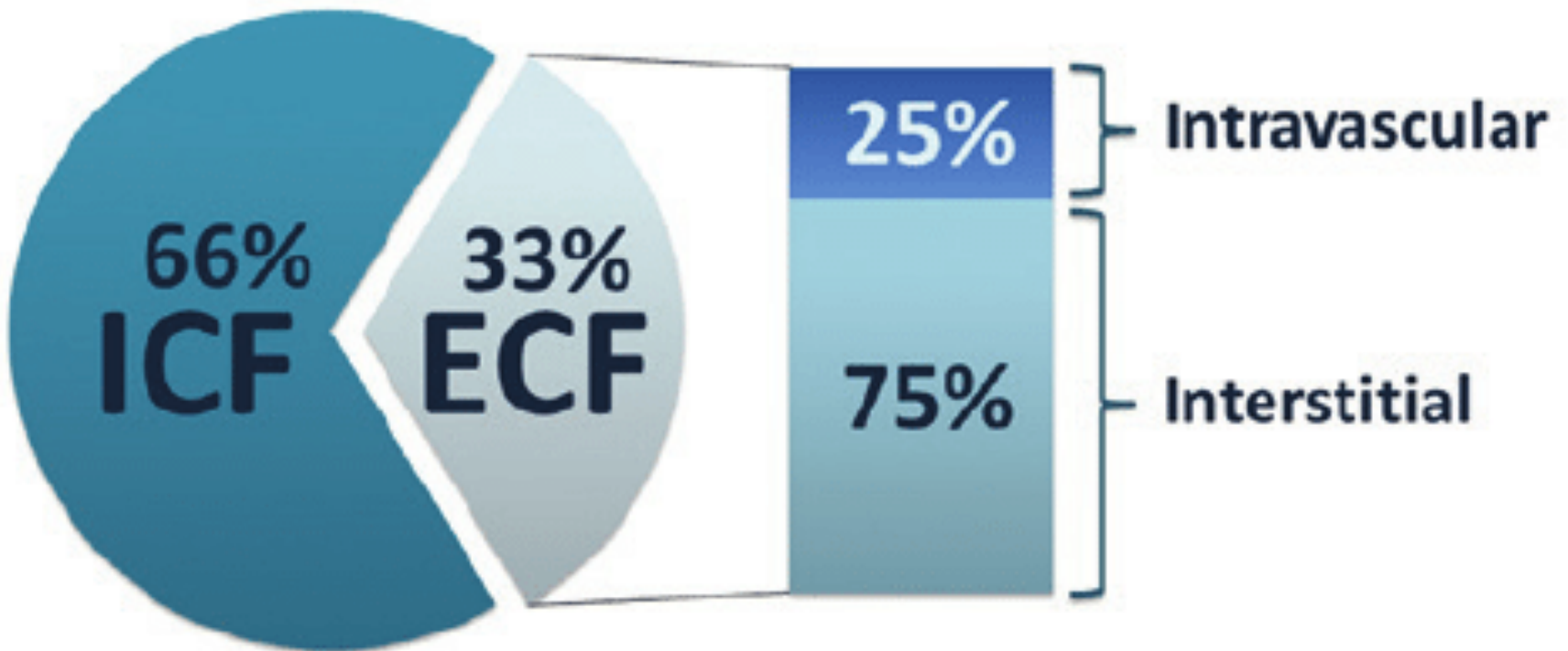
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# 水及電解質的平衡

- 成人的體重大約60%由水組成
- 40% 在細胞內, 20% 在細胞外 (5% 血漿PLASMA + 15% 間質INTERSTITIAL).
- 越年輕的動物水佔體重的比例越高 (60-80%). 年紀大則水量減少至45%左右
- 嘔吐、下痢及多尿是改變身體的水及電解質平衡的最主要原因
- 不平衡時會影響很多器官，包含神經，心臟及肌肉系統。

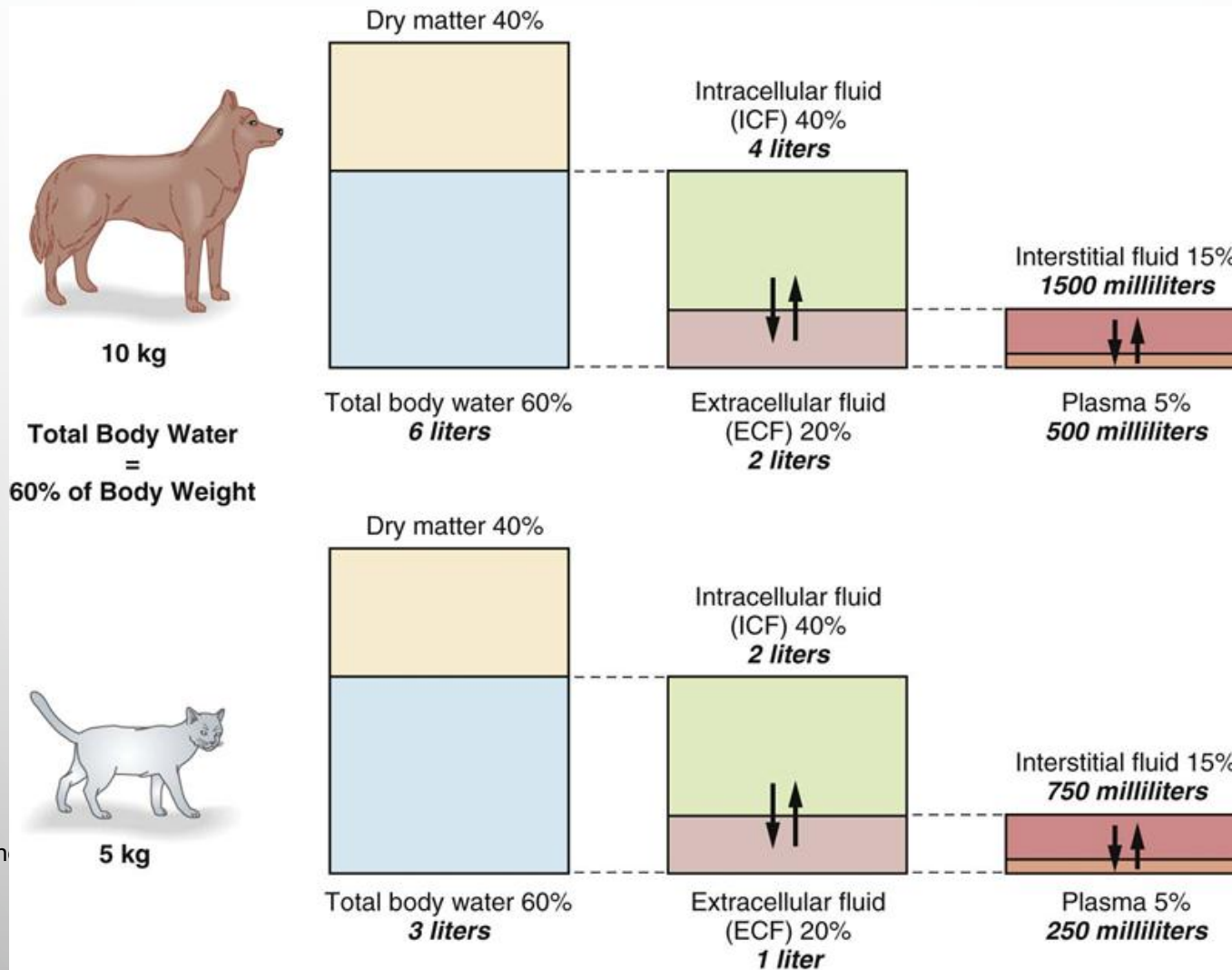
# 身體水的分佈

Total Body water = 60 % Body weight



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# 狗貓身體水的分佈



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# 需要列入考量

- AGE, SEX, AND BODY COMPOSITION 都會影響身體的水量
- 人類含水量會隨著年齡降低，女性也比男性低
- 新生的小狗及小貓含較高的水分（大約體重的80%），成年動物就只含約60%，隨著年齡就會再降低
- 因為脂肪含水量較低，所以在計算身體含水量時須考量脂肪含量

Normal body weight  $\times 0.8 =$  Lean body mass

Obese body weight  $\times 0.7 =$  Lean body mass

Thin body weight  $\times 1.0 =$  Lean body mass

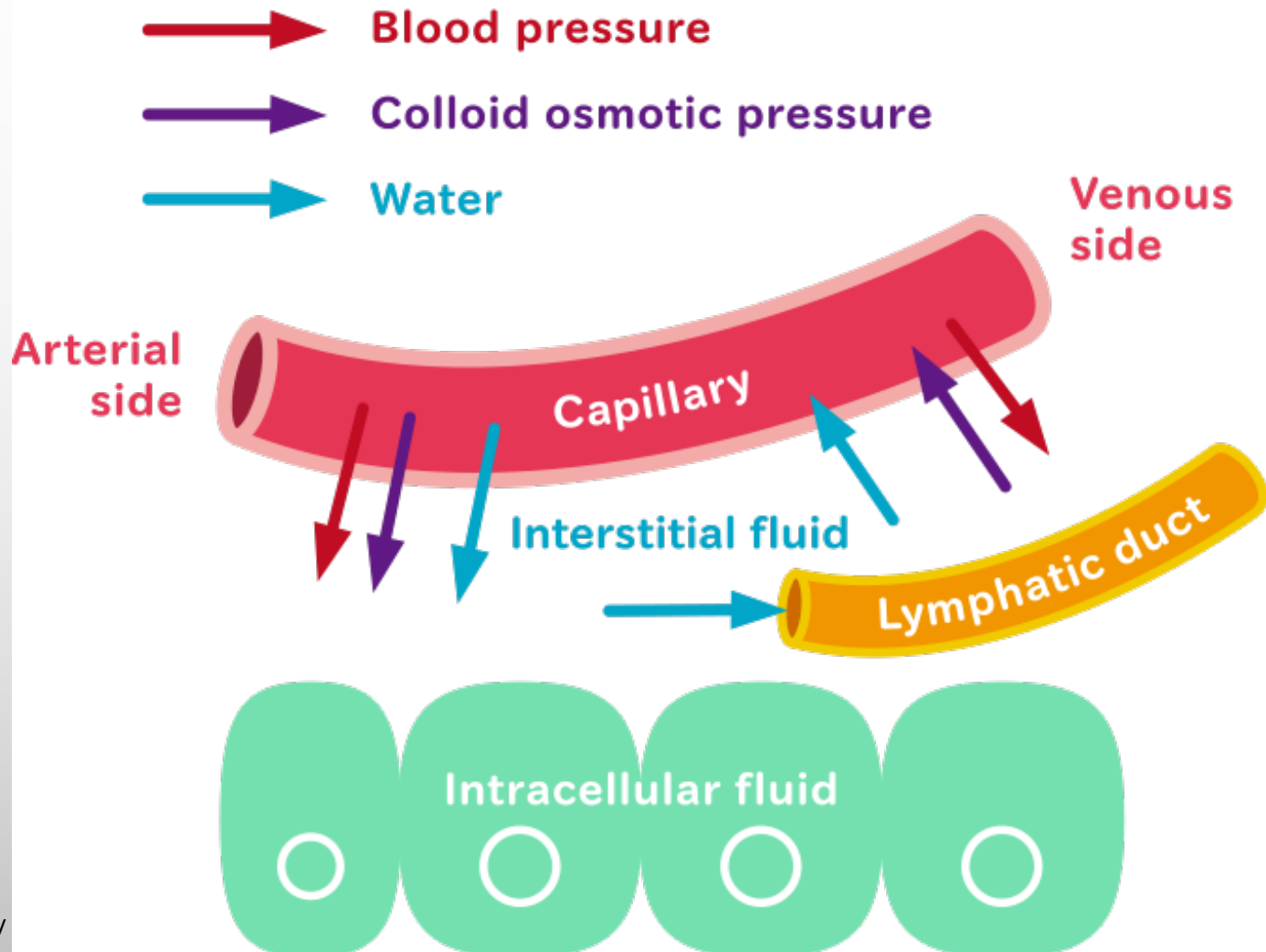


# 體液的循環及調控

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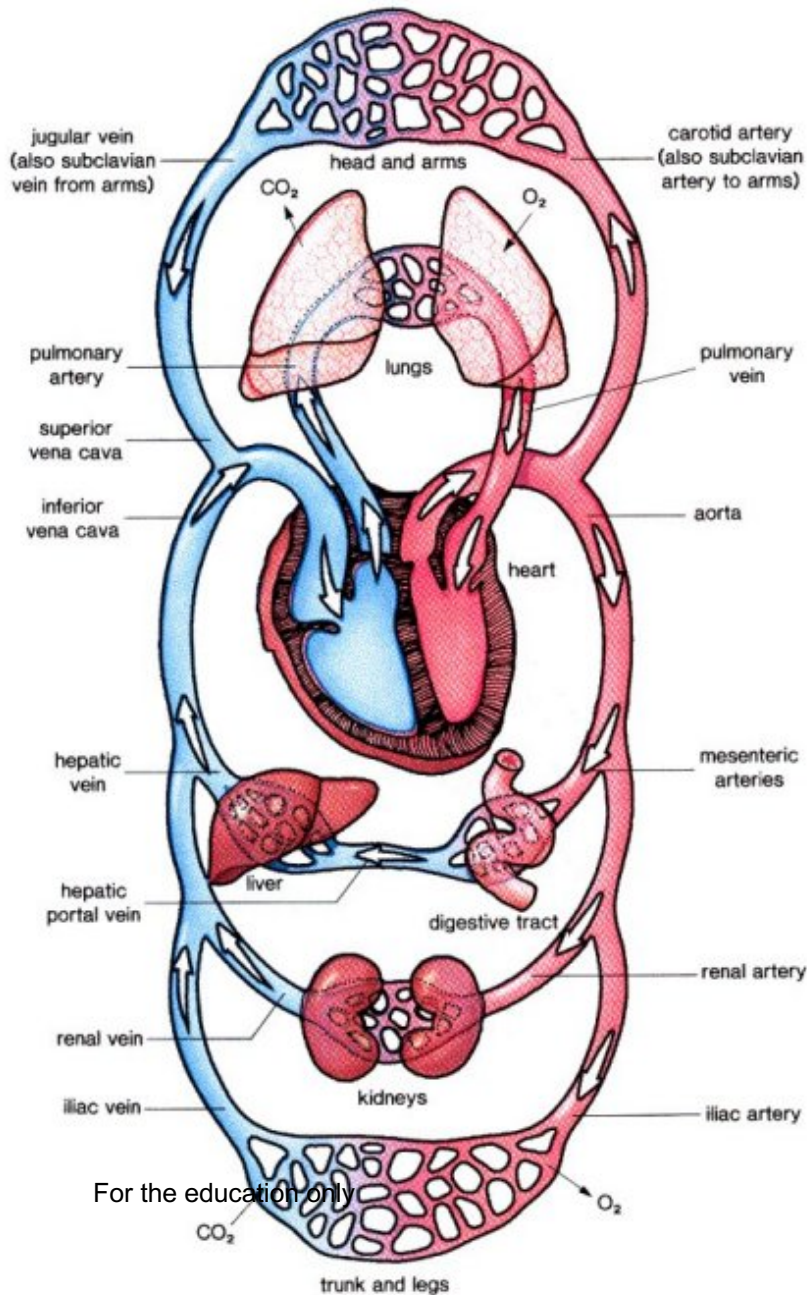


# Inlet and outlet of water from capillaries



# Local regulations

# Systemic regulations



## Neuro-humoral regulation system

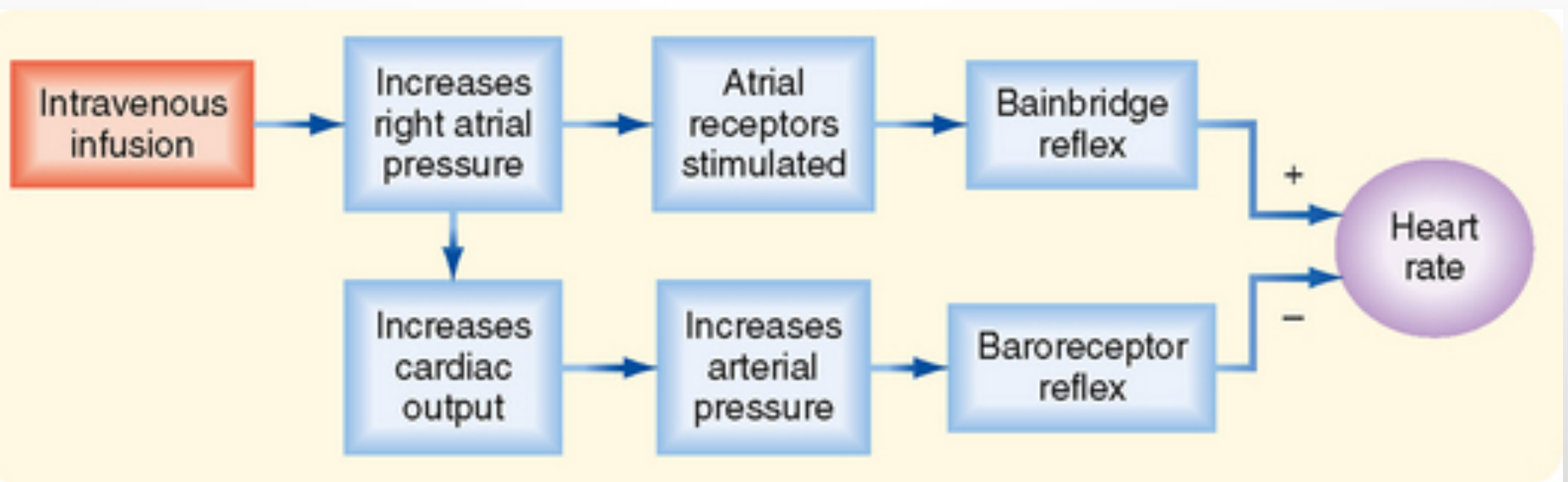
(to keep a stable flow with the principle of supply- demands)

- 自主神經系統 (Autonomic nervous system) (房靜脈反射)
- Renin-angiotensin-aldosterone system (腎素-血管收縮素-醛固酮系統)

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# 自主神經系統 AUTONOMIC NERVOUS SYSTEM

增加右心房壓力 刺激心房之受體 房靜脈反射

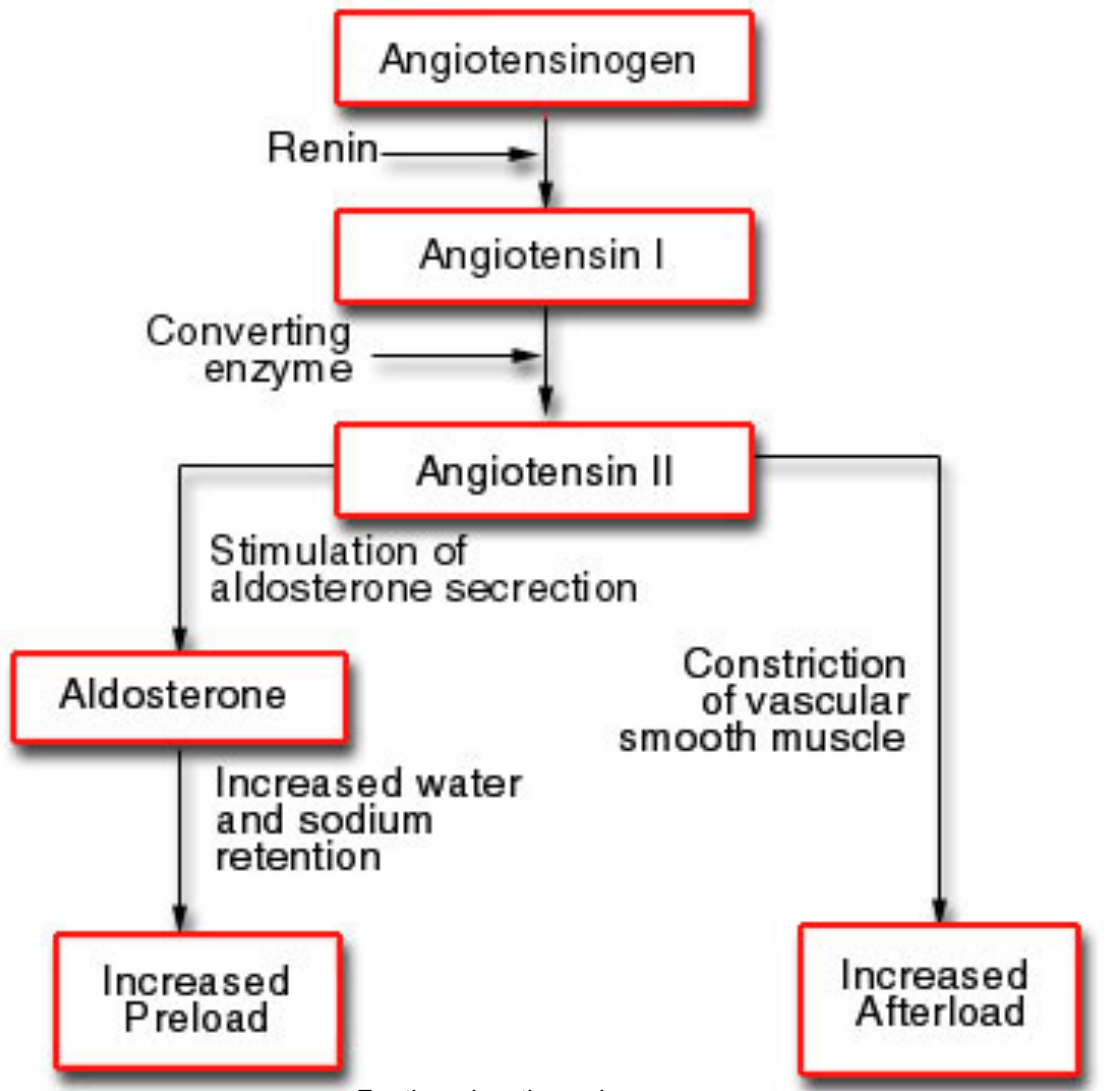


心輸出量增加

增加動脈壓

迷走神經反射  
壓力感受性反射

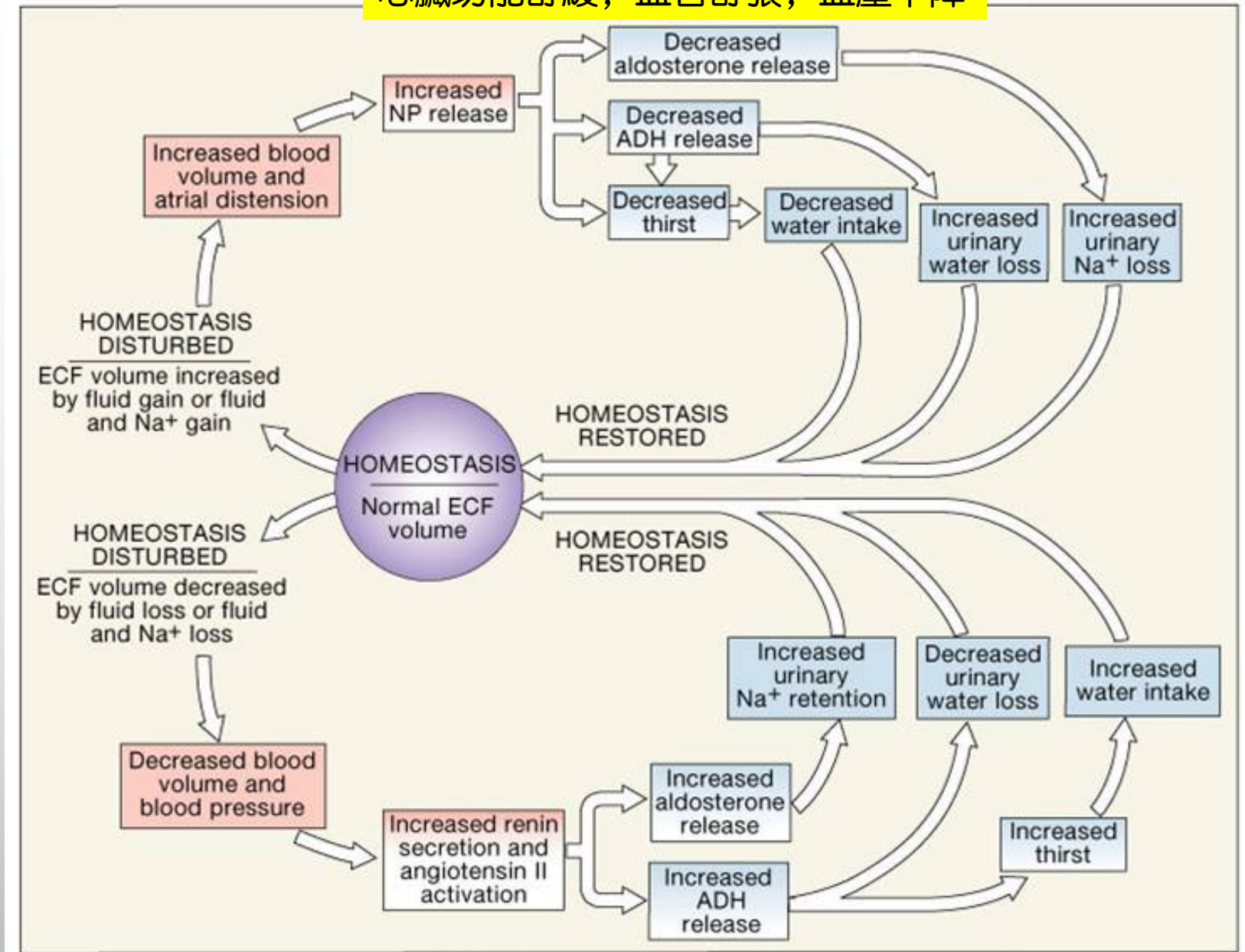
# 賀爾蒙的調控 Humoral regulations (Renin-angiotensin-aldosterone system, RAAS)



前負荷 (preload) 或容量負荷是指心脏在收缩之前所承受的負荷，相當于心臟舒張末期之容量 (血量)

後負荷 (afterload) 或壓力負荷是指心腔在收缩时所必須承受的負荷，相當于心腔壁在收缩时的張力，但一般常以主动脈壓作為左心室后負荷的指标 (血壓)

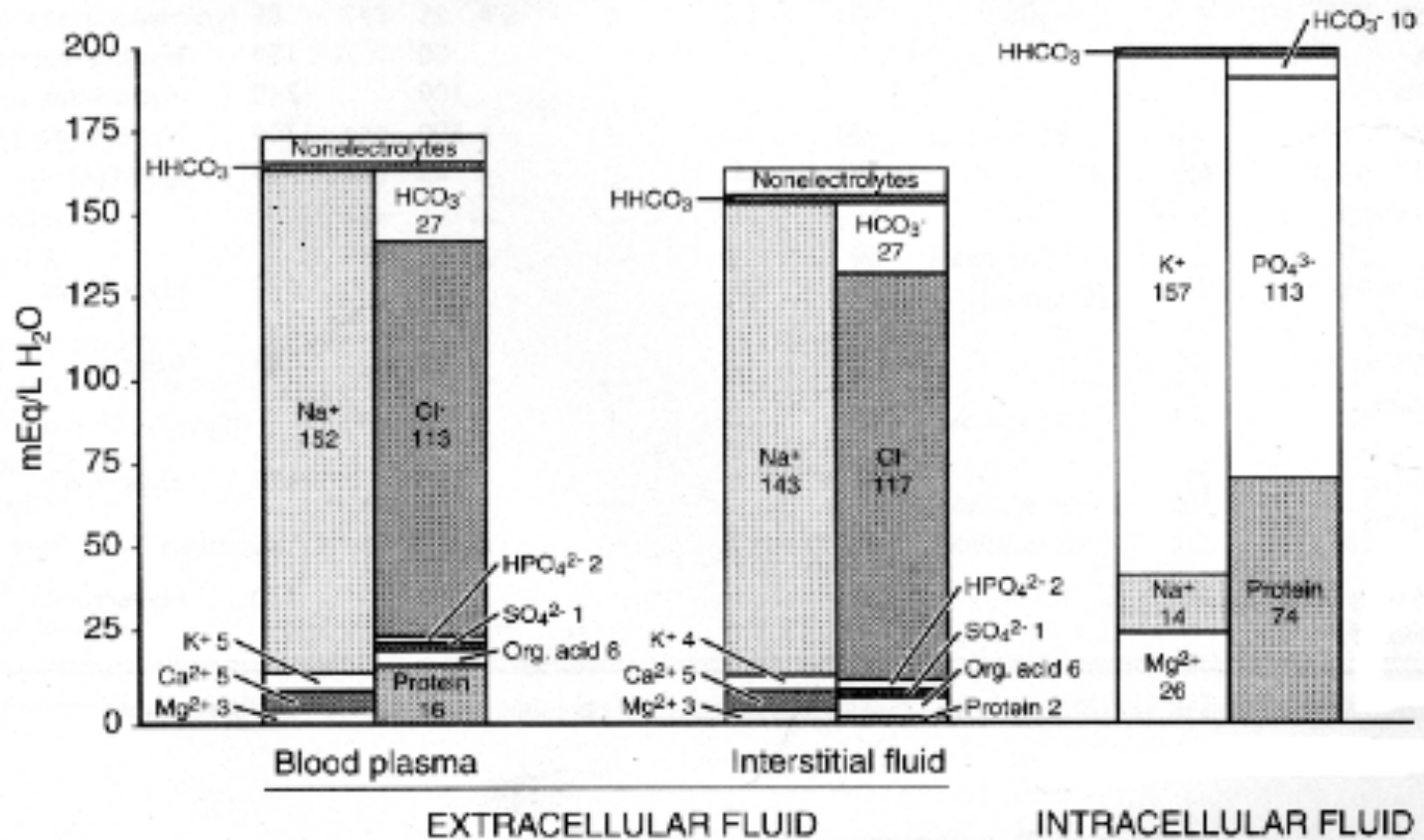
利鈉肽 (natriuretic peptide):  
心臟功能舒緩, 血管舒張, 血壓下降



# 電解質

- Sodium (Na)是細胞外液最主要的陽離子，而細胞內最主要的陽離子則是鉀
- 血漿鈉之值是維持細胞外液滲透壓最主要的因子之一。
- 細胞內的滲透壓則主要靠鉀維持。
- 細胞內主要的陰離子: Phosphate
- 細胞外主要的陰離子: chloride, bicarbonate
- 除了鈉以外，白蛋白albumin是另外一個主要維持細胞外滲透壓最主要的物質。
- 當白蛋白降低50%，會造成細胞外液滲透壓改變，而造成臨床上出現水腫現象。

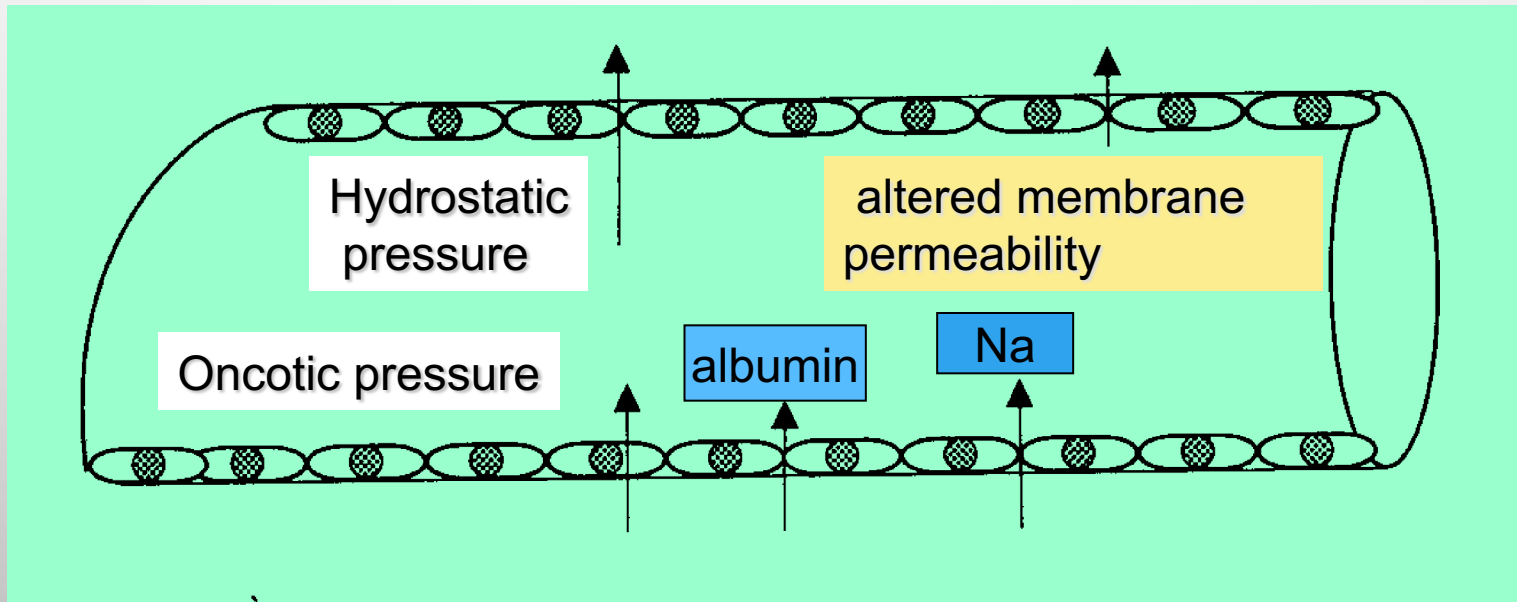
# 電解質的分佈



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# 血漿容量的維持 (MAINTENANCE OF PLASMA VOLUME) 血管內

- 靜水壓 (HYDROSTATIC PRESSURE)
- 膠體滲透壓 (ONCOTIC PRESSURE) : ALBUMIN, NA
- 膜通透性 (MEMBRANE PERMEABILITY)





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# WATER AND FLUID BALANCE

## 水及電解質之平衡

最重要的離子

水量

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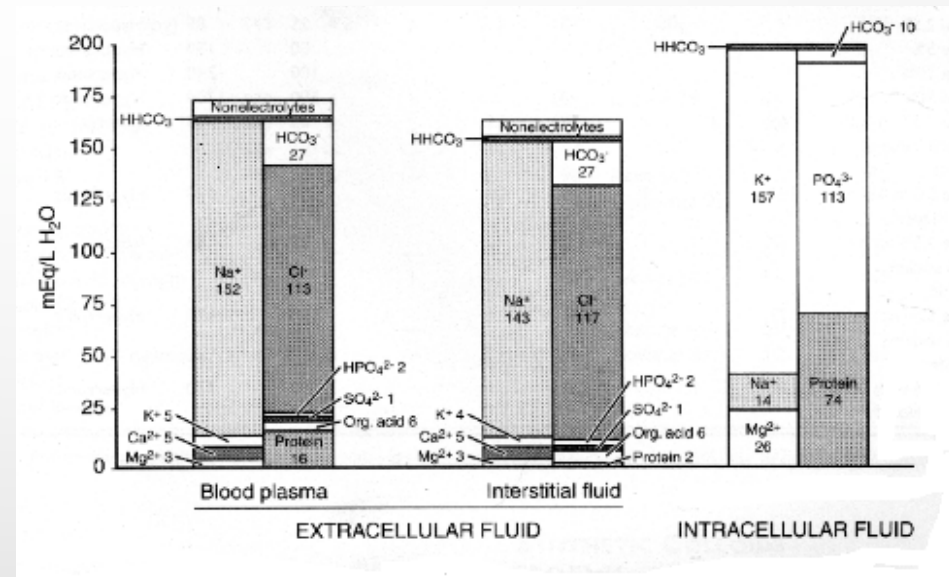
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# Sodium $\text{Na}^+$ 鈉離子

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# Sodium -introduction

- 大部分存在細胞外液中 (ECF)
- 通常食物中都是過量的，所以不大會因為食物的改變而影響全身的濃度
- 腎臟是最主要的調節器官 (腎小球濾，在近端及遠端腎小管重吸收 (受醛固酮控制))
- NA AND CL 是血漿中最影響滲透壓的離子



# Sodium -introduction

- 當出現代謝性的失常時（如嚴重嘔吐及下痢），需與其他的離子一起檢驗判讀（如Cl, K, bicarbonate）
- 在腎小管的重吸收受aldosterone, renin/angiotensin, atrial natriuretic peptide (ANP)調節
- 當與尿中的Na一起計算（電解質排除速率 fractional electrolyte excretion）可以用來評估腎臟的功能

# 腎臟 & Na<sup>+</sup> & 水

	Synthesis	Action	Action on sodium and water
Aldosterone	Secreted by the zona glomerulosa of the adrenal cortex	Regulates the Na <sup>+</sup> →K <sup>+</sup> exchange and Na <sup>+</sup> →H <sup>+</sup> exchange at the renal tubules	Sodium and water retention
Renin-Angiotensin system	Release of renin by the juxtaglomerular cells	Angiotensin-II ↑BP by vasoconstriction of the arterioles. It also stimulates aldosterone production	Retention of sodium and water
Atrial natriuretic peptides (ANP)	Stimulation of atrial stretch receptors	Inhibit renin and aldosterone secretion – cause elimination of sodium	Increases urinary excretion of sodium
Anti-Diuretic Hormone	Under control of hypothalamus, posterior pituitary release ADH	Increase the water reabsorption by the renal tubules	Retention of water

# 高血鈉 hypernatremia – 症狀 (dog >160meq/L; cat >170 meq/L)

- Lethargy
- Confusion
- Muscle weakness
- Seizures
- Coma

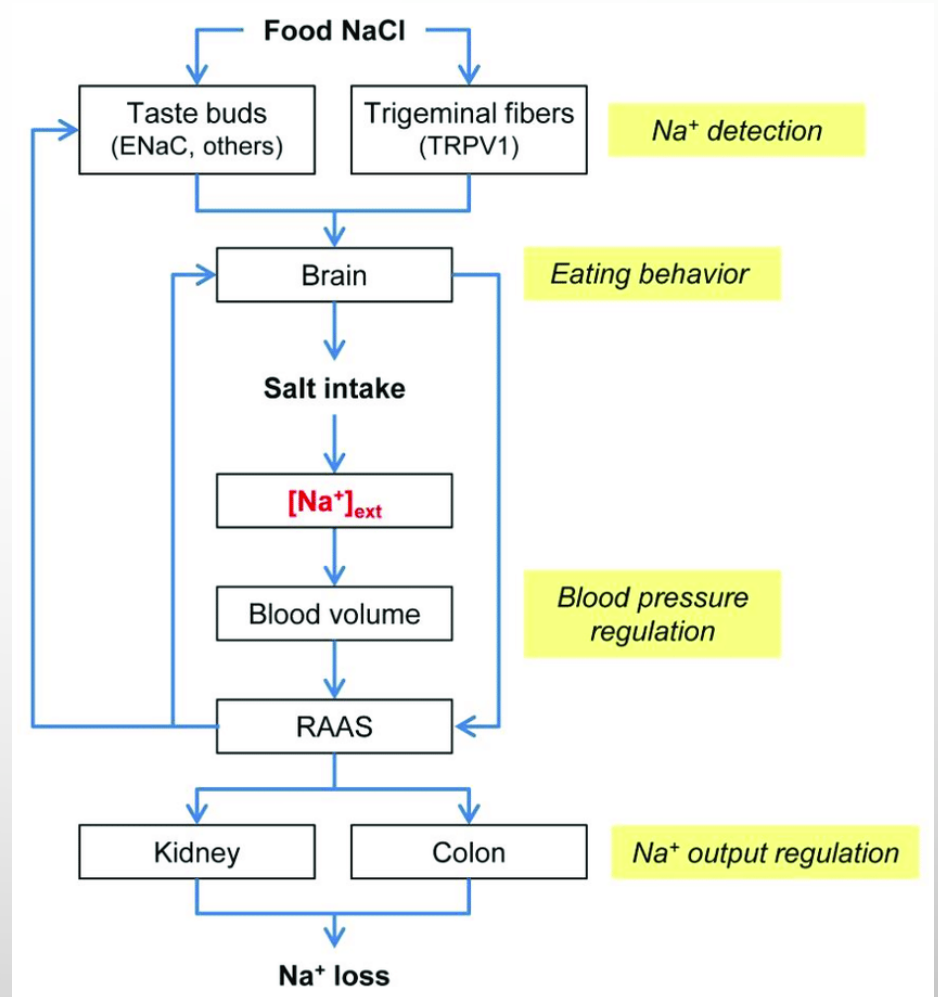


# 高血鈉 hypernatremia – 原因分類 (dog >160meq/L; cat >170 meq/L)

- 低血量 (hypovolemic hypernatrinemia)
  - Vomiting, diarrhea, adipsia, hypodipsia, fever, hyperventilation, urinary obstruction, diuresis, kidney failure, abnormal liquid accumulation
- 正常 (normovolemic hypernatrinemia)
  - Diabetes insipidus (central di: decrease of ADH), iatrogenic, hypodipsia/adipsia
- 高血量 (hypervolemic hypernatrinemia) (edema)
  - Hypercorticism, hyperaldosteronism, iatrogenic (hypertonic nacl, nahco<sub>3</sub>)

# 低血鈉 hyponatremia – 原因

- Routes of loss with sodium
  1. 腎性 renal
  2. 非腎性 non-renal





# 低血鈉 hyponatremia – 原因

- Normal plasma osmolality
  - Pseudohyponatremia
    - Hyperlipemia
    - Hyperproteinemia
- High plasma osmolality
  - Hyperglycemia – diabetes mellitus
  - Mannitol infusion
- Low plasma osmolality

# Hyponatremia – low plasma osmolality

- 正常水和 normal hydration
  - Hypotonic fluid (5% dextrose in water)
  - Psychological polydipsia
- 過度水和 overhydration (edema)
  - Congestive heart failure
  - Severe liver disease – ascites
  - Nephrotic syndrome
- 脫水 dehydration
  - Vomiting, diarrhea
  - Third space loss (pancreatitis, peritonitis)
  - Hypoadrenocorticism (renal)
  - Diuretic treatment (furosemide)
  - Renal disease (polydipsia)

# Clinical approach to the patient with hyponatremia

Decreased serum Na <140mEq/L

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Serum osmolality determination

Normal Posm  
290-310

Low Posm <290

High Posm  
>310

Hyperglycemia?  
Mannitol infusion?

Evaluation of volume status

Hyperlipemia?  
Hyperproteinemia?

hypervolemia

Normovolemia

Hypovolemia

pseudohyponatremia

Severe hepatic diseases  
CHF  
Nephrotic syndrome  
Advanced renal failure

Psychogenic PD  
SIADH  
Antidiuretic drugs  
Myxedema coma  
Hypotonic infusion

Non-renal route

GI loss  
Third space loss

Renal route

Hypoadrenocorticism  
Diuretic administration

SIADH= syndrome of inappropriate antidiuretic hormone

# Hyponatremia-treatment (human)

- Severe hyponatremia (<110 meq/L) → give 3% nacl over 24 hrs
  - Required na (meq/L) =  $0.2 \times \text{kg} \times (\text{normal na} - \text{patient's na})$
  - Correct slowly as oversupplement, too fast can cause central pontine myelinolysis
- Less severe (<120 meq/L) → correct underlying cause and give 0.9% nacl
- Use of 3% nacl is not recommended for dogs and cats; myelinolysis was reported in two dogs after correction of hyponatremia associated with trichuriasis (鞭蟲症) (o'brien et al.1994)



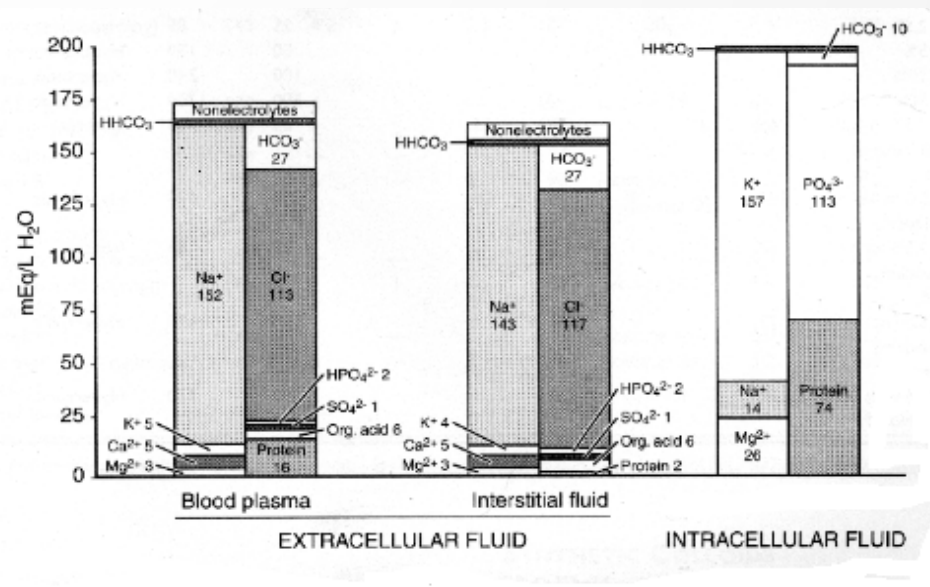
Potassium K<sup>+</sup>

鉀離子

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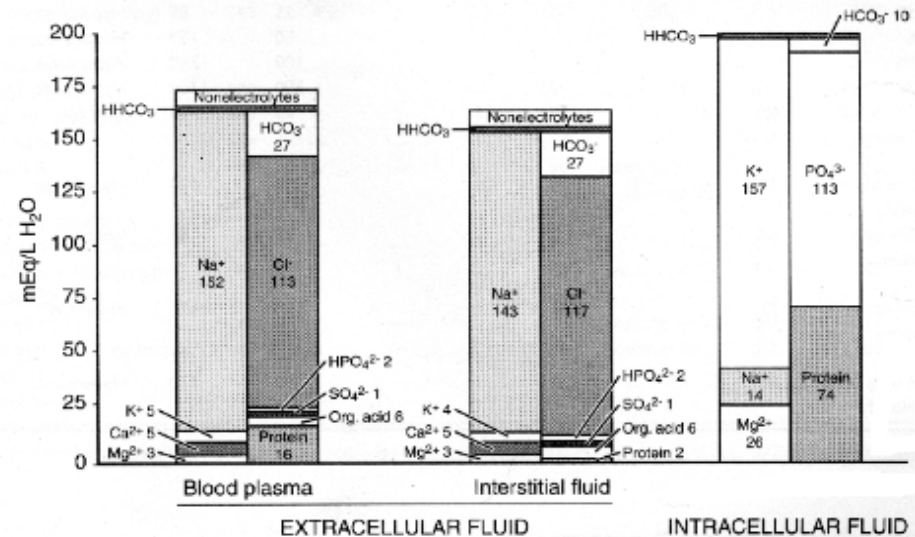
# Potassium

- 98%  $k^+$ 在細胞內 可以被動或是自由擴散進出細胞
- 是神經脈衝及肌肉（包含心肌）收縮不可或缺的離子
- 細胞內主要的陽離子major intracellular cation.
- 細胞內外的交換主要由 atp - dependent na:k pump作用
- 主要在近端小腸吸收，可以因為胰島素或醛固酮（腎）快速的由細胞外進入細胞內

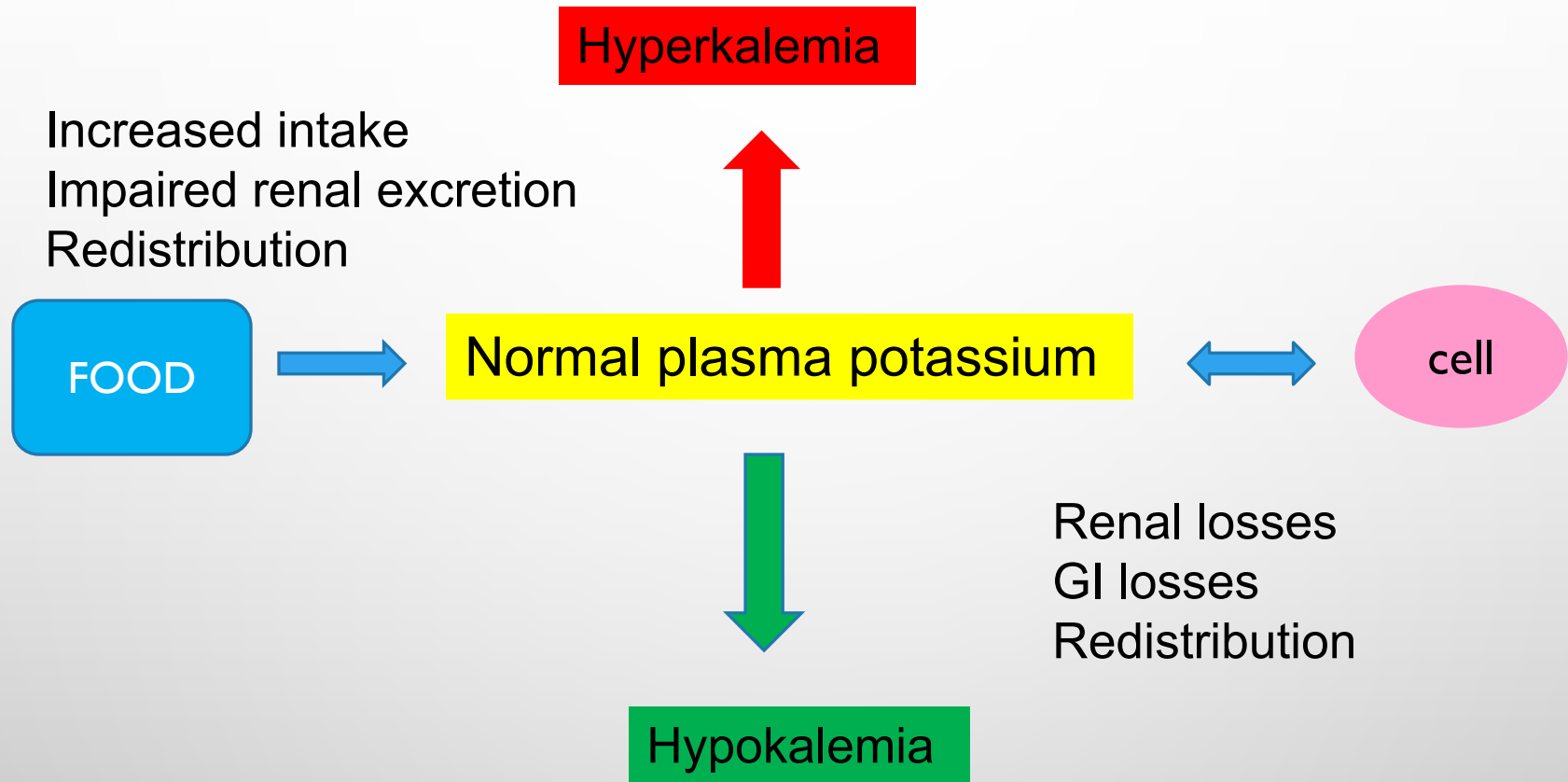


# Potassium

- 血漿中濃度的改變反應了體液的平衡、腎臟排除速率及細胞內外液的平衡
- 當出現代謝性的失常時（如嚴重嘔吐及下痢），需與其他的離子一起檢驗判讀（如 Cl, K, bicarbonate）
- Normal range: 3.5–5.5 (3.6–5.8) meq/L



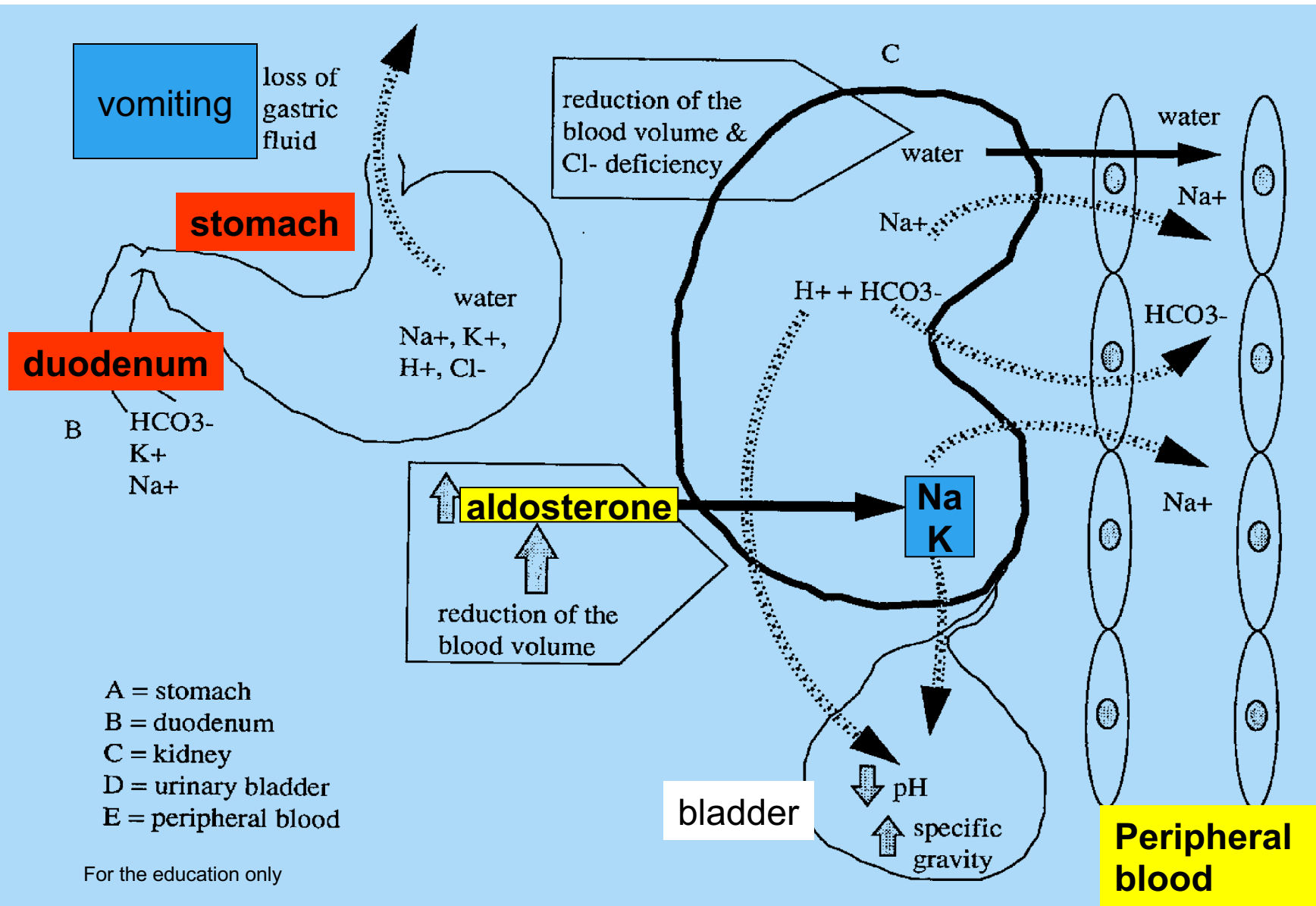
# The main mechanisms leading to the development of hyper- or hypokalemia





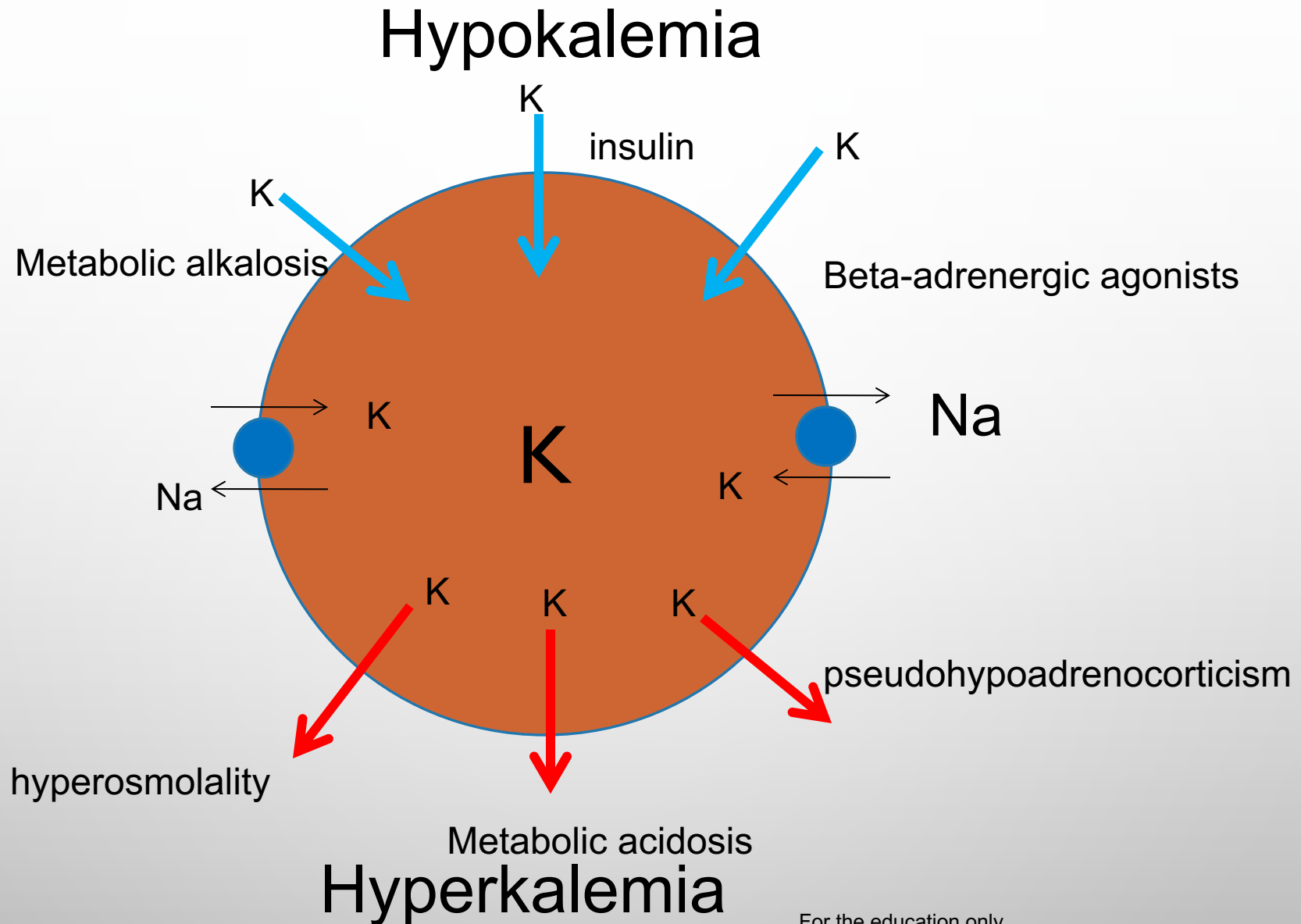
# 低血鉀 hypokalemia

- Abnormally low potassium concentration in the blood.
- Hypokalemia is a manifestation of disease not a diagnosis.
- Results from
  1. Decreased intake
  2. Excessive loss (loss from gi or renal)
  3. Extracellular to intracellular shift
  4. Dilution



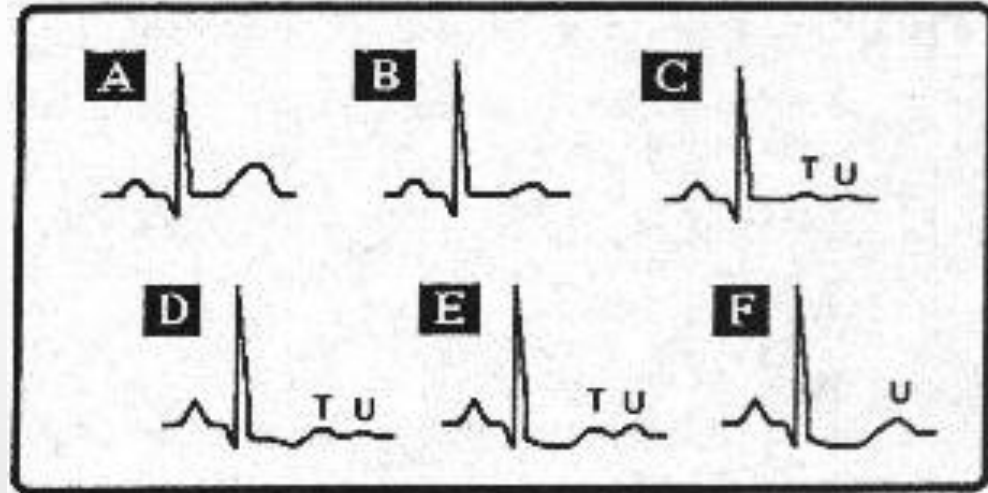
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# Factors affecting K movement into and out of the cell



# Hypokalemia - 症状

- Asymptomatic: 3.0–4.0 meq/L
- Skeletal muscle weakness (<2.5 meq/L)
  - Cat: ventroflexion of the neck, forelimb hypermetria, a broad-based hindlimb stance
- (Acute) paralysis
- Risk of arrhythmia
- ECG: ST wave decreased



# Hypokalemia – 原因

- 腸胃道流失 (vomiting, diarrhea)
- 靜脈注射低鉀輸液
- 腎臟 renal:
  - 腎衰竭 (polyuria, 20–30% of cats with CRF showed hypokalemia; 10% of dogs)
  - Post-obstructive renal disease
  - Diuretic therapy (furosemide)
  - Hyperaldosteronism

# Hypokalemia – 原因

- 代謝性 metabolic:
  - Diabetic ketoacidosis (polyuria, osmotic diuresis)
  - Insulinoma
  - Insulin administration
- Burns
- Hyperadrenocorticism ( increased secretion of K in kidney)
- Alkalosis
- Prolonged anorexia
- 偽性增加
  - Extreme hyperproteinemia
  - Lipemia

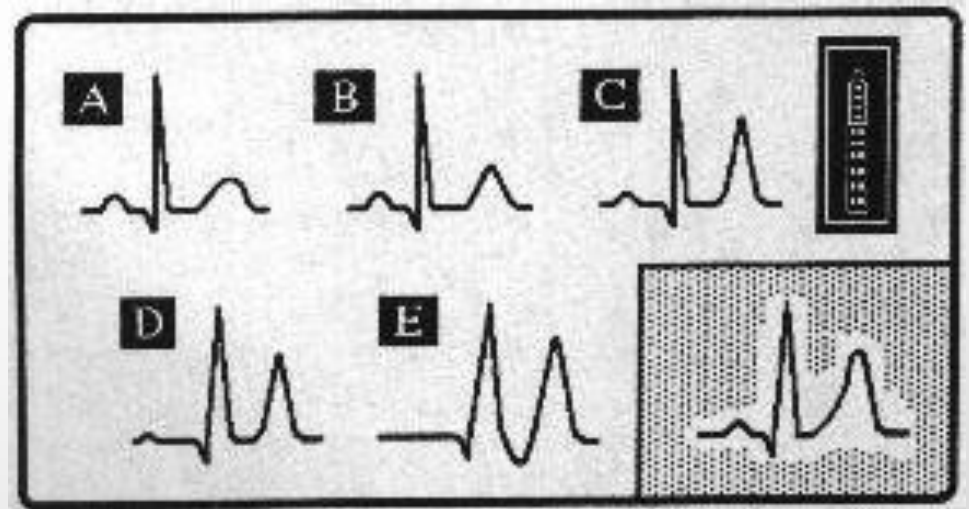
# Potassium supplementation

Serum K+ mEq/L	mEq/L in 1L	Maximum rate of infusion (mL/kg/hr)
3.5-4.0	15	30
3.0-3.5	28	16
2.5-3.0	40	12
2.0-2.5	60	8
<2.0	80	6

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# 高血鉀 hyperkalemia - 症狀

- $K^+ > 7.5 \text{ meq/L}$
- 心臟傳導混亂
- 心肌損傷
- 心跳停止





# 高血鉀導因於

1. Increased intake
2. Decreased urinary excretion (most common)
3. Intracellular to extracellular shift

# Hyperkalemia – 疾病原因

- Hypoadrenocorticism
- Post renal obstruction ( feline urethral obstruction will induce hyperkalemia in 48 hours)
- Acute renal failure
- Metabolic acidosis
- Diabetic ketoacidosis
- Extensive tissue damage (especially muscle)
- Drugs: digoxin, ACE inhibitors (enalapril), k-sparing diuretics (spironolactone, triamterene)

# Hyperkalemia – 原因

- 假性高血鉀 (pseudohyperkalemia)
  - Sample aging due to release from platelets
  - Thrombocytosis ( $>1,000,000/\mu\text{l}$ )
  - K-EDTA or k-heparin contamination of sample
  - Hemolysis in japanese akita, most breeds have low concentration of K within erythrocytes so hemolysis does not result in elevation.
  - Often show spectacular elevation of k if sample not analyzed immediately

# Symptomatic therapy for hyperkalemia

Degree	Management
Mild 5.5–6.5	Potassium-free fluid: 0.9% NaCl 5% dextrose
Moderate 6.5–8	<ol style="list-style-type: none"><li>1. Potassium-free fluids</li><li>2. Calcium gluconate: 0.5–1.0 mL 10% solution, 10–15 min slow IV (does not lower the K level, reverses toxic effects on the heart)</li></ol>
Severe >8.0	<ol style="list-style-type: none"><li>3. Dextrose and insulin: 0.25–0.5IU/kg regular insulin, IM or IV + 2g dextrose per Unit insulin (shift K from ECF into ICF)</li><li>4. Sodium bicarbonate: based on blood gas analysis or 1–2 mEq/kg</li></ol>

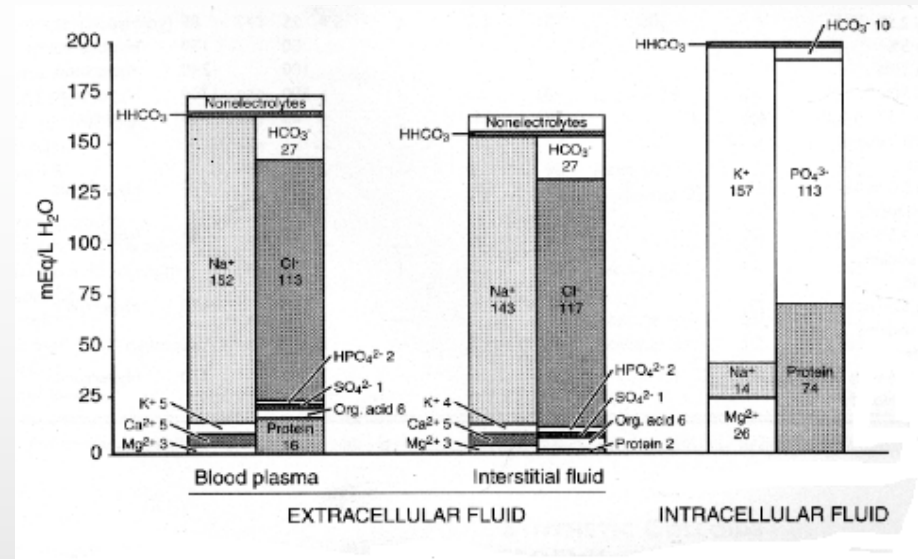
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# Chloride Cl<sup>-</sup>

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# Chloride

- 與bicarbonate一起為主要之陰離子
- 自由擴散進出細胞
- 主要在迴腸吸收，由腎臟排除



# Hyperchloremia

- Metabolic acidosis usually associated with dehydration:
  - Diarrhea (small intestinal diarrhea, more  $\text{HCO}_3^-$ , less  $\text{Cl}^-$ )
  - Shock
  - Renal failure
  - Diabetes ketoacidosis
  - Ethylene glycol poisoning
- Metabolic acidosis (hyperchloremic)
- Hypertonic fluid therapy (0.9% NaCl + 20 meq/L KCl  $\rightarrow$  154 meq/L + 20 meq/L = 174)

# Hypochloremia

- Metabolic alkalosis (esp. Vomiting after feeding)
- Conditions causing a decrease in plasma sodium
- Excessive diuretic therapy
- Hypoadrenocorticism
- Respiratory acidosis (hyperventilation, compensation in kidney, excretion  $\text{Cl}^{\uparrow}$ )



# 輸液之原則及方式 迷失。。。。。

為何需要輸液？ ？ ？ ？

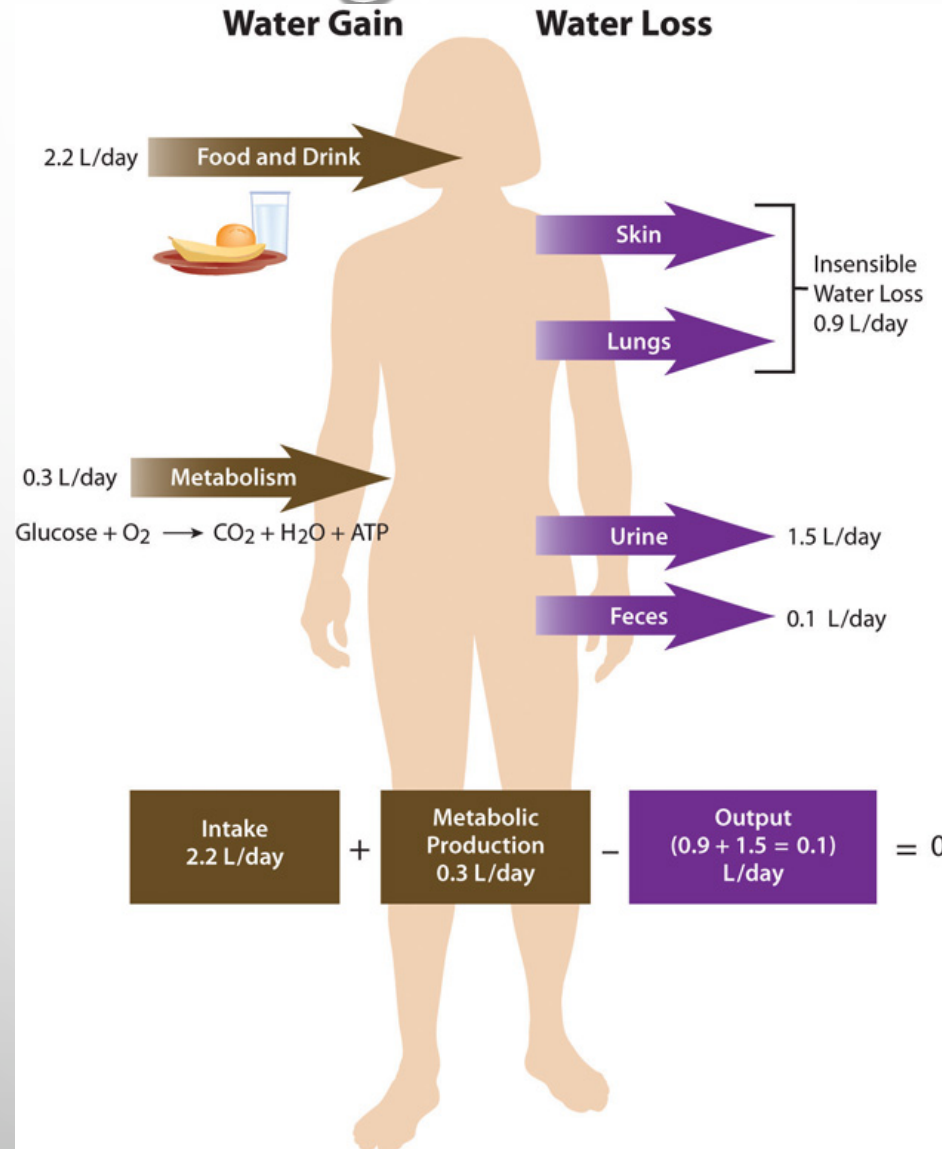
脫水才需輸液

# 因為脫水

- 動物脫水?
- 何種脫水?
  - 血壓低?
  - 心跳高?



# 水和平衡 VS 不平衡



# 體液平衡 Water/ fluid balance

## 體液來源

1. 喝水 water that is drunk
2. 食物中 water ingested in food
3. 代謝食物 water that results from the metabolism of food (metabolic water)

## 正常體液排除路徑

1. 尿液urine
2. 糞便fecal water
3. 流汗sweat (horse)
4. 呼吸 respiration (important in dogs with panting)

# 體液不平衡之分類

## 水合過多 hyperhydration

1. 高張 hypertonic
2. 等張 isotonic
3. 低張 hypotonic

## 脫水 dehydration

1. 高張 hypertonic
2. 等張 isotonic
3. 低張 hypotonic

# HYPERHYDRATION

## Water intoxication



身體水過多

How much water is too much?  
Depends on:  
1. How fast you drink it  
2. How good your kidneys are

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# 過度水合評估表

	血量過多 (vascular hypervolemia)	間質水量過多 (interstitial hypervolemia)
臨床症狀	<ol style="list-style-type: none"><li>1. 頸靜脈擴張</li><li>2. 體重增加</li><li>3. 強而有力如彈跳的脈搏 (bounding pulse )</li><li>4. 高血壓</li><li>5. 於X光片中可見肺靜脈或後腔靜脈擴張</li></ol>	<ol style="list-style-type: none"><li>1. 口鼻水樣分泌物</li><li>2. 皮下水腫、周邊水腫、結膜水腫、拉皮測試有凝膠感</li><li>3. 腹水、胸水</li><li>4. 呼吸速率增加、爆裂音 (crackle) 、X光片中可見肺間質性水腫</li></ol>

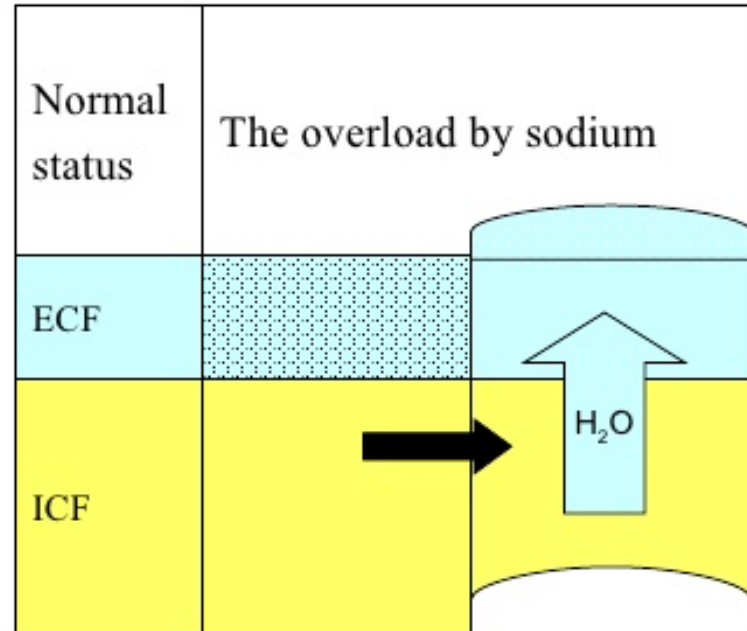
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# 高張性水過多

## HYPERTONIC HYPERHYDRATION

NA ↑; HCT, RBC, HB, TOTAL PROTEIN ↓

- 典型原因
  - 食入過多鹽類/礦泉水
  - 喝海水
  - 含太多鈉的輸液
  - 產生過多的醛固酮(aldosterone)
- 後續結果
  - ECF變得高張 (高血鈉) → 高血鈉
  - 水份由ICF → ECF (滲透壓)
  - Ecf (肺部) 水腫 + 細胞內脫水
  - ↑ADH (保留水份)
  - ↑ANP (利鈉肽) / 尿舒張素 (urodilation) 主要排出鈉
  - 抑制RAAS





# 等張性水過多

## ISOTONIC HYPERHYDRATION

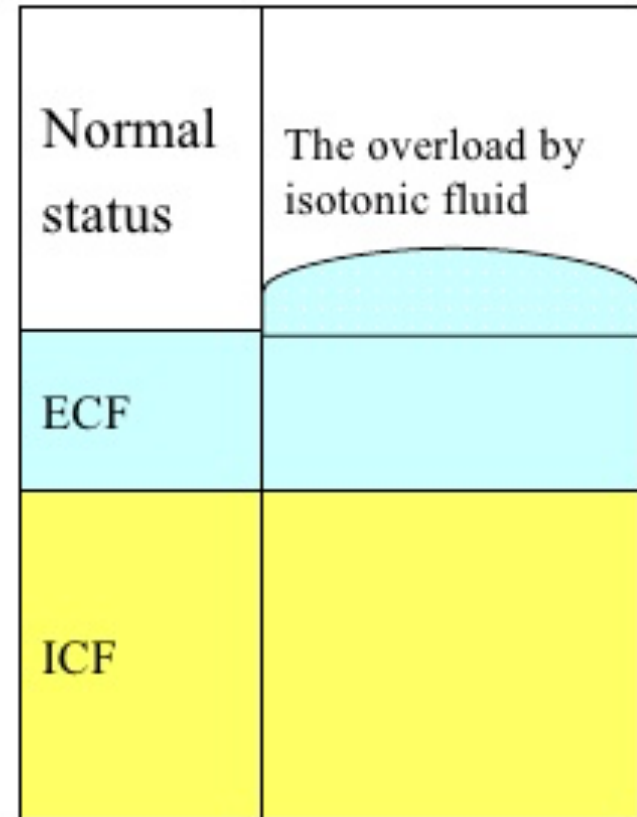
HCT, RBC, HB, TOTAL PROTEIN ↓

- 典型原因

- 打入過多的等張性輸液
- 心衰竭
- 腎臟疾病（二次性高醛固酮症）

- 後續結果

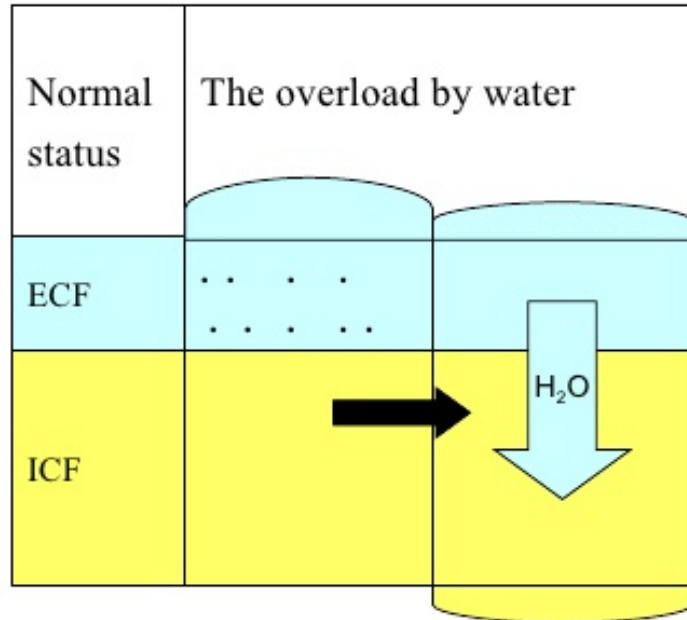
- ECF量擴張
- ECF 水腫



# 低張性水過多

## HYPOTONIC HYPERHYDRATION

NA ↓, HCT, RBC, HB, TOTAL PROTEIN ↓



\* syndrome of inappropriate ADH

- 典型原因
  - 喝入過多純水
  - SIADH \*, 可能因為緊迫、創傷、感染或是胃灌洗
  - 注入太多的葡萄糖輸液
- 後續結果
  - ECF量擴張
  - ECF低張 (低血鈉)
  - 水進入ICF(滲透壓)
  - ICF+ECF 水腫
  - ADH產生下降 (水排出)

# 脫水 dehydration

**SIGNS**  
of a **Dehydrated Dog**

Make sure your pup gets plenty of shade and water.  
If you notice any of these symptoms, contact a pro ASAP.



**HEAD**  
Lethargic, visibly tired

**EYES**  
Sunken

**NOSE**  
Dry, chapped

**MOUTH**  
Dry mouth and gums, thick saliva

**LUNGS**  
Excessive panting

**STOMACH**  
Vomiting, diarrhea, loss of appetite

**FEET**  
Wobbly and unsteady on feet

**URINE**  
Very dark, concentrated color

**SKIN**  
Parched, lacking elasticity

**BACK**  
Warm to the touch

**DogVacay**

**Eyes: sunken**



**Nose: dry and chapped**

**Mouth: dry with thick saliva**



**Lungs: Excessive panting**

**Stomach: vomiting, diarrhea, loss of appetite**



**Feet: loss of balance**



**Urine: very dark**

**Skin: dry, no elasticity**



**Back: warm to the touch**



# 脫水程度評估表

水損失比例 (% 體重)	脫水程度	臨床症狀
1-4	非常輕微	無法偵測
5-6	輕微	皮膚些微失去彈性
7-9 (6-8)	中等	皮膚明顯延遲恢復到正常位置 CRT延長 眼球可能凹陷 黏膜可能乾燥
10-12 (8-10)	嚴重	皮膚拉起後維持在原處 明顯CRT延長 眼球凹陷 黏膜乾燥 可能出現休克症狀(心跳過速、肢體冰冷、快且弱的脈搏)
13-15	非常嚴重	出現休克症狀、瀕死

# 等張性脫水

## ISOTONIC DEHYDRATION

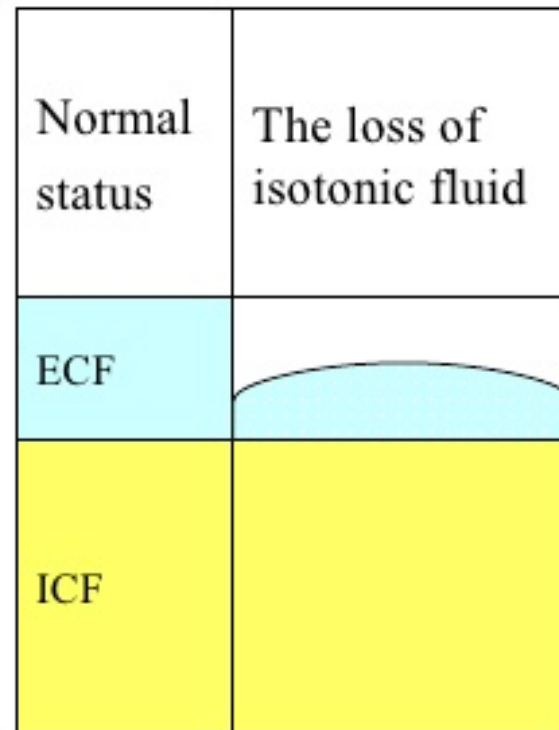
THE PLASMA NA, CL LEVELS REMAIN CONSTANT; PCV, TP↑

- 典型原因

- 嘔吐
- 下痢
- 出血
- 燒傷（腹水）

- 後續結果

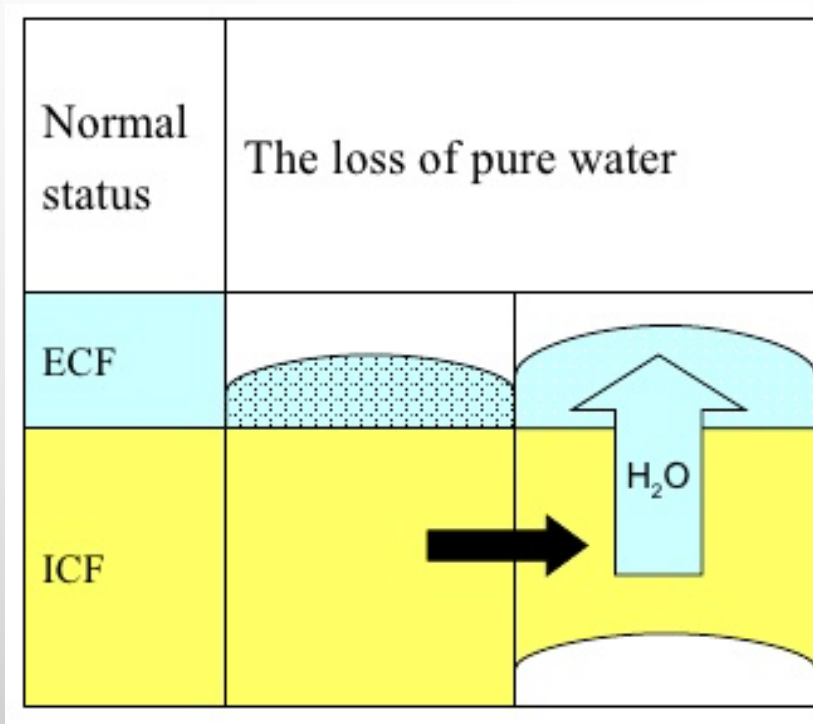
- ↓ ECF 量（低血量）
- 促進RAAS



# 高張性脫水

## HYPERTONIC DEHYDRATION

THE PLASMA NA, CL LEVELS INCREASE, PCV, TP↑



### • 典型原因

- 過度換氣
- 喝水過少 (老年人)
- 滲透壓式利尿
- 缺乏ADH (尿崩症)

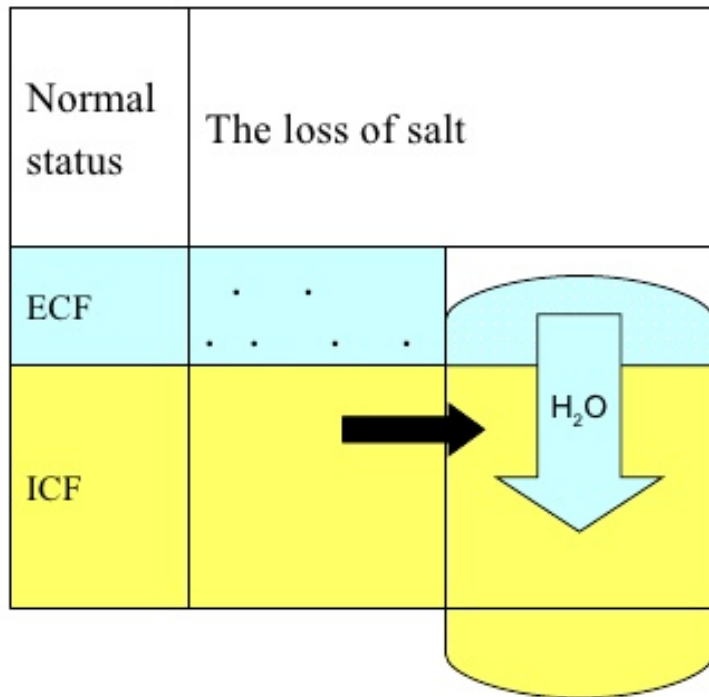
### • 後續結果

- 低血量
- ECF變成高張 (高血鈉)
- 水因滲透壓緣故，由 ICF → ECF
- ↑ADH產生 (水滯留在體內)

# 低張性脫水

## HYPOTONIC DEHYDRATION

THE PLASMA NA, CL LEVELS DECREASE, PCV, TP↑



- 典型原因

- 醛固酮缺乏
- 利尿劑
- 嘔吐、流汗及下痢

- 後續結果

- ECF 為低張 (低血鈉)
- 水份由ECF到ICF, 低血量+細胞內水腫
- ICF水過多, 會增加顱內壓→增加大腦水腫的機率
- ADH產生降低 (水排除) + 刺激RAAS

# 如何輸液？

- 種類
- 途徑
- 量



# 種類

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# 常用晶體輸液成分之比較

	pH	Na <sup>+</sup>	K <sup>+</sup>	Ca <sup>2+</sup>	Cl <sup>-</sup>	Lact.	Glu.	Cal.	張力	滲透壓
LR	6.5	130	4	3	109	28			等張	273
R	5.8	147	4	3	155				等張	309
0.45% NaCl		77			77				低張	155
0.9% NaCl	5.4	154			154				等張	310
DLR	5.0	130	4	3	111	28	50	170	高張	525
Norm osol-R	6.2	140	5	Mg <sup>++</sup> 3	98	Acetate 27 Glucon ate 23		18	等張	295

# 常用晶體輸液成分之比較

Sol.	pH	Na <sup>+</sup>	K <sup>+</sup>	Ca <sup>2+</sup>	Cl <sup>-</sup>	Glu.	Cal.	張力	滲透壓
2.5% Dextrose / 0.45% NaCl 4.5	4.5	77			77	25	85	等張	280
5% Dextrose / 0.45% NaCl 4.0	4.0	77			77	50	170	高張	405
5% Dextrose / 0.9% NaCl 4.0	4.0	154			154	50	170	高張	560
5% Dextrose 4.0	4.0					50	170	低張	253
50% Dextrose 4.2	4.2					100	340	高張	2525

# 常用膠體輸液

Sol.	Na <sup>+</sup>	K <sup>+</sup>	Ca <sup>2+</sup>	Mg <sup>2+</sup>	Cl <sup>-</sup>	Buffer mEq/L	pH	滲透壓
Hetastarch 6% in 0.9% NaCl 5.5	154				154		5.5	
Dextran 70 6% w/v in 0.9 % NaCl	154				154		4.5– 7	300 – 303
Plasma (Dog)	145	4.2	5	2.5	108	20	7.4	290

# 輸液種類及身體之分布

輸液類型	臨床使用之種類	增加血漿1公升所需之液體量	分布區域	臨床使用之適應症
膠體溶液 colloid	Starch Gelatin Dextrans	1L	血漿	<ol style="list-style-type: none"> <li>1. 低血量</li> <li>2. 低血壓</li> <li>3. 正常全血量時之血液稀釋</li> <li>4. 低白蛋白血症</li> </ol>
高張晶體溶液 Hypertonic crystalloid	7.5% Saline	300 mL	由細胞內抽取大量的水份進入血管中，使血漿量大增	<ol style="list-style-type: none"> <li>1. 低血量性休克</li> <li>2. 大腦水腫</li> </ol>
等張晶體溶液 Isotonic crystalloid	0.9% Saline LR Ringer's	3L	細胞內液及細胞外液（血漿）皆增加	<ol style="list-style-type: none"> <li>1. 脫水</li> <li>2. 低血量</li> <li>3. 低血壓</li> <li>4. 正常全血量時之血液稀釋</li> </ol>
低張晶體溶液 Hypotonic crystalloid	5% Dextrose <small>for education only</small>	14L	增加全身體重（主要為細胞內液之增加）	<ol style="list-style-type: none"> <li>1. 純水的缺乏</li> <li>2. 高血鈉</li> </ol>

# 途徑

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# 途徑

- 靜脈（急性期及嚴重脫水時）
- 皮下
- 兩種方式一起
  - HR, RR, BP, IN/OUT, UOP (ml/kg/hr)

# 何時可以採用皮下注射方式及注射量

- 輕微脫水
- 等張溶液 (0.9% SALINE, LR, RINGER'S)
- 每一個注射的地方不超過10-20ML/KG
- 注射地方消毒乾淨
- 應該在6-8 HR吸收
- 如果皮下吸收困難則改由靜脈注射



# 何時雙管齊下？

- 多尿期，追不上損失的尿量時
- 開始打皮下時，靜脈的量需要逐漸緩慢下降
- TAPER...TAPER...TAPER
- 監控產尿量

學習

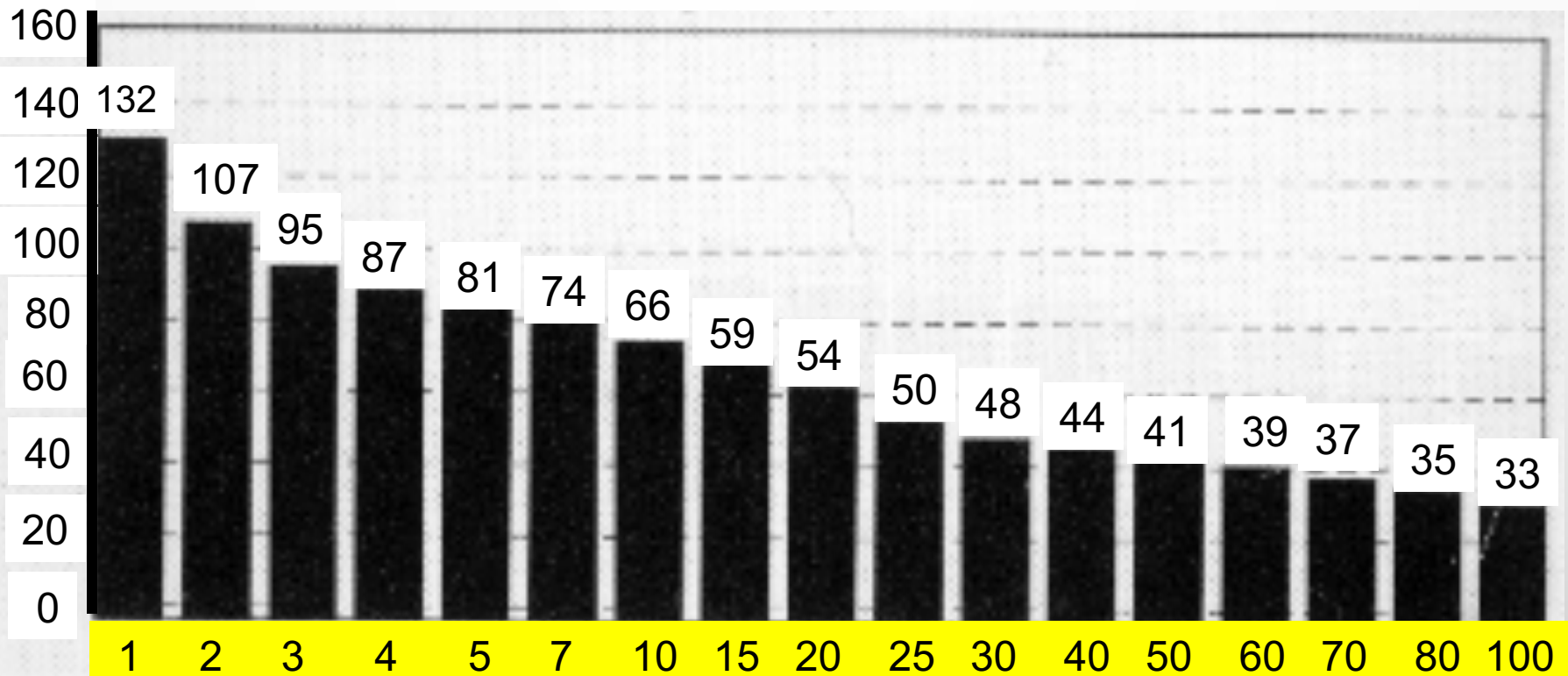
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# 低血量脫水的補充：此時才能大量及快速補充

- 動物通常出現心跳較快及血壓正常或偏低現象
- 除非動物有心肺功能不良的問題，否則應以下列公式計算所需的輸液量 (ml)  $[\text{脫水}\% \times \text{動物體重 (kg)} \times 1000] \times 0.8$ 。最好在治療的前期4－24小時內補充完畢，目的為快速增加腎臟灌流並減少腎臟局部缺血所造成的損傷
- 另外一方式為可以在一開始的10分鐘內靜脈注射一次 (bolus injection) 20 ml/kg的輸液量或是1/4-1/5的上述公式所計算出的量，觀察動物是否出現不耐的情形。
- 正常的狀況下，若為脫水性低血量情形，在第一次bolus之後，心跳會減慢一點，血壓也會上升一點。若無此現象，表示臨床檢查及判讀有錯誤。

# 狗每日所需之水量

mL water maintenance /kg

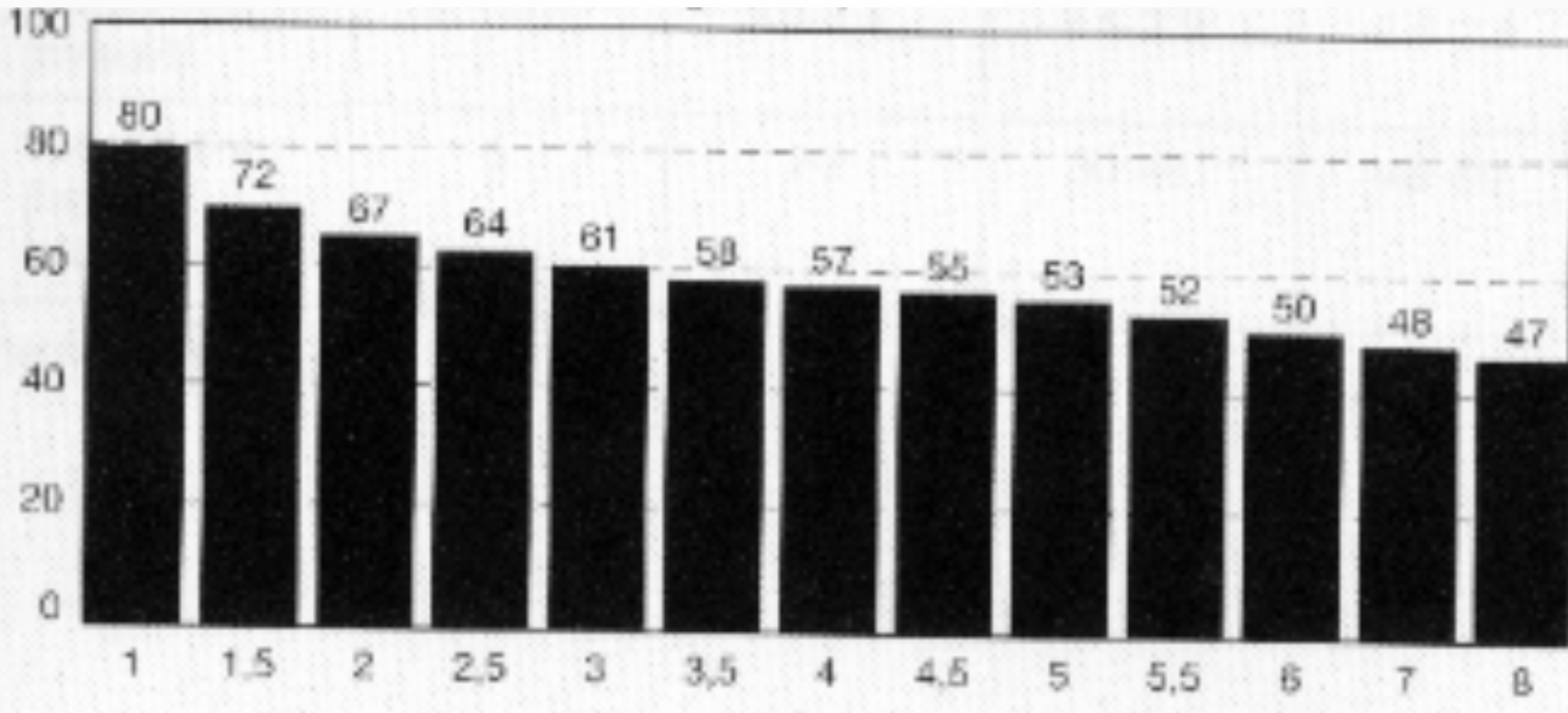


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Body weight in kg

# 貓每日所需之水量

mL water maintenance /kg



For the education only

Body weight in kg

**TABLE 14-1 Daily Water and Calorie Requirements for the Dog\***

Body Weight (kg)	Total kcal/day or Water	
	mL/day	/kg /hr
1	132	132 6
2	214	107 9
3	285	95 12
4	348	87 15
5	407	81 17
6	463	77 19
7	515	74 21
8	566	71 24
9	615	68 26
10	662	66 28
11	707	64 29
12	752	63 31
13	795	61 33
14	837	60 35
15	879	59 37
16	919	57 38
17	959	56 40
18	998	55 42
19	1037	55 43
20	1075	54 45
21	1112	53 46
22	1149	52 48
23	1185	52 49
24	1221	51 51
25	1256	50 52
26	1291	50 54
27	1326	49 55
28	1360	49 57
29	1394	48 58
30	1427	48 59
35	1590	45 66
40	1746	44 73
45	1896	42 79
50	2041	41 85

**TABLE 14-2 Daily Water and Calorie Requirements for the Cat\***

Body Weight (kg)	Total kcal/day or Water	
	mL/day	/kg /hr
1.0	80	80 3
1.5	108	72 5
2.0	135	67 6
2.5	159	64 7
3.0	182	61 8
3.5	205	58 9
4.0	226	57 9
4.5	247	55 10
5.0	268	53 11

*From Haskins SC: A simple fluid therapy planning guide, Semin Vet Med Surg (Small Anim) 3:232, 1988.*

*\*80 kcal/kg<sup>0.75</sup>; Nutritional requirements of the cat, National Research Council, 1987, Bethesda, MD.*

The background of the slide is a light gray gradient with several realistic water droplets of various sizes scattered across it. The droplets have highlights and shadows, giving them a three-dimensional appearance.

# 水合的監控

HR RR BP BW IN/OUT  
UOP

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# 監測:UOP

- 產尿量:

- 是監測腎臟功能最佳的方式（前提是動物的水合狀態及血壓足夠），犬隻正常的產尿量為1-2 ml/kg/hr，貓正常的產尿量則為1-1.5 ml/kg/hr。犬貓在有輸液的狀況下應該會有2-5 ml/kg/hr的產尿量。
- 體重：可以監控體重來評估水合狀況，建議每6-12小時測量一次體重，若出現水量過多的徵兆則需要更頻繁的監控體重變化。可以配合in/out做判斷。（不要有豬隊友！）
- 聽診：在無尿或寡尿的動物出現喘鳴聲（wheezes）或爆裂音（crackle）時，通常已是較晚期水分過多的症狀。



# UOP監測方式

- 留置導尿管 (INDWELLING URINARY CATHETER) : 最為準確，但需連接尿袋。太久易造成膀胱及尿道細菌感染。
- 狗：秤看護墊及毛巾吸尿
- 貓：貓砂盆扣重或貓砂秤重（不同品牌差異）
- 超音波測量膀胱大小
- 需同時監測體重變化。

### 治療記錄表

ID: \_\_\_\_\_ Name: \_\_\_\_\_ Date: \_\_\_\_\_

Fluid Therapy	On	Off	Vol.	On	Off	Vol.	On	Off	Vol.	On	Off	Vol.

Medication/Management	Time	Time	Time	Time	Medication/Management	Time	Time	Time	Time

**Patient condition**

Time												
Activity												
RR/SpO <sub>2</sub>												
HR/PR												
BP												
BT												
BW												
In/Out												
Time												
Defecation												
Urination												
UOP (ml/hr)												
[ml/kg/hr]												
Vomiting												

**Feeding record**

Time	App.	Food	Drink	Water	Time	App.	Food	Drink	Water

**Memo**

Time \_\_\_\_/VA \_\_\_\_/Doc \_\_\_\_ | Time \_\_\_\_/VA \_\_\_\_/Doc \_\_\_\_ | Time \_\_\_\_/VA \_\_\_\_/Doc \_\_\_\_

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# SUMMARY

- 重建損失量
- 決定給予何種輸
- 決定給多少，多久時間
- 決定如何給予：靜脈或是皮下
- 監控
  - Vital signs:
    - HR, RR, BT mucous membrane color, capillary refill time, BW
  - Labs:
    - PCV, TP, alb, BUN, glucose, electrolytes, blood gas
  - Others:
    - Blood pressure, pulse oximetry, urine output

# 輸液過量之臨床症狀

Early signs	Late signs (serious overloading)
<p>顫抖Trembling 噁心Nausea 激動/喘氣 Excitation/panting 呼吸加快Tachypnoea 嘔吐Vomiting 多尿Polyuria (variable)</p> <p>For the education only</p>	<p>心跳快Tachycardia (非常嚴重時心跳慢 bradycardia if very serious) 流鼻水Nasal discharge 結膜水腫Chemosis 咳嗽Coughing 呼吸困難Dyspnoea 皮膚水腫Subcutaneous edema (from the tarsal 跗骨 and intermandibular region) 下痢Diarrhea Exophthalmia 凸眼 沈鬱Mental depression 肺水腫 Pulmonary edema/ crepitation on auscultation 胸水 Pleural effusion (貓)</p>

# 如何治療輸液過量

- 預防勝於治療，一旦給予過多輸液量將會很難處理
- 停止輸液治療並重新評估
- 使用利尿劑
- 腹膜透析或血液透析移除多餘水分，重新建立體液平衡

# 過度水合之後可以促進尿量之內科療法

- 先評估水分大約多了多少？ BW, HR, RR, UOP
- Furosemide (lasix):
  - 建議初始劑量在犬為0.5-1mg/kg 稀釋後IV，在貓則為0.25 – 1mg/kg IV。效果在靜脈注射半小時後會出現
  - 若15-30分鐘未尿或是膀胱未變大，則可以追加 2 倍劑量IV
  - 若15-30分鐘還未尿或是膀胱未變大，則改2mg/kg IV
  - 若利尿效果於1小時內無顯著發揮，可以重複給予2 – 3次（總劑量不超過 8 – 16 mg/kg）。
  - Furosemide可能會惡化gentamicin所造成的腎毒性，兩者須避免同時使用。

# 過度水合之後可以促進尿量之內科療法

- Mannitol:
  - 若為滲透壓型的利尿劑，建議劑量為0.5 – 1 g/kg，以15 – 20分鐘的時間緩慢靜脈注射。
  - 若在投予後無顯著效果，可以每2-4小時重複給予一次，劑量為0.25 – 0.5 g/kg，一天總量不可超過2 g/kg。
  - 產尿量在投予後的1個小時內呈現顯著增加才表示有效。多次使用時須注意是否出現容積擴充或是肺水腫等併發症出現。
  - 若寡尿的狀況持續或是全身過度水合（overhydration）太厲害，時則不可繼續使用。

# 寡尿動物水合之後可以促進尿量之內科療法

- Dopamine:
  - 將其加入0.9%生理食鹽水中，以2 – 5  $\mu\text{g}/\text{kg}/\text{min}$ 的速率靜脈注射或定速靜脈注射，AKI的使用以不超過5 $\mu\text{g}/\text{kg}/\text{min}$ 為原則。
  - 快速泡法：50mL 0.9% NaCl (D5W, LR, R)加入0.075XBW (mL)，美打1mL/hr=1 mcg/kg/min，動物水多太多時，可以濃縮
  - 也可以dopamine如上述泡法定速靜脈注射，合併使用furosemide (0.25 – 1 mg/kg/h) ，有些動物可加強利尿效果。
  - 目的是增加腎臟血液灌流與產尿量，注意AKI動物在使用dopamine 時劑量不可超過 5  $\mu\text{g}/\text{kg}/\text{min}$ 。
  - 與鹼性溶液併用會被不活化，故不可加入含有sodium bicarbonate的輸液當中。
  - Metoclopramide為dopamine拮抗劑，不可同時使用。
  - 使用dopamine時也須監控心跳速率及血壓。



# 總結

- 每一隻動物都是個別的
- 動物的年齡、體重、腎臟功能（U O P）、心臟功能、白蛋白、電解質決定了輸液的種類、量及方式
- 當進了那村，要選對店，在正確的時機用藥
- 過了那村就沒那店了

THANK YOU FOR YOUR  
ATTENTION

