



Practical Fluid Therapy In The Emergency Patient

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Conflicts of Interest & Disclaimer

- + Yvonne McGrotty is an employee of IDEXX Laboratories UK and also an employee of AniCura France.

- + *The information contained herein is intended to provide general guidance only. As with any diagnosis or treatment, you should use clinical discretion with each patient based on a complete evaluation of the patient, including history, physical presentation, and complete laboratory data. With respect to any drug therapy or monitoring program, you should refer to product inserts for a complete description of dosages, indications, interactions, and cautions. Diagnosis and treatment decisions are the ultimate responsibility of the primary care veterinarian.*

Fluid Physiology

- + Approx 60% of body is water
- + 67% of TBW is intracellular (ICF)
- + 33% of TBW is extracellular (ECF)
 - + 25% of ECF is in interstitial space
 - + 8% of ECF is intravascular



Water Loss

- Sensible fluid loss
 - Urinary/faecal
 - 20ml/kg/24hrs
- Insensible losses approx 20ml/kg/24hrs
 - Respiratory
 - Sweat (minimal in animals)
- Total = 40ml/kg/24hrs



Approach to Fluid Therapy

- + Does the animal require fluid therapy?
- + What type of fluid is required?
- + Which route should be used?
- + How much fluid is needed?
- + How long should fluid therapy be continued?



Does the
animal need
fluids?

And if so
which route?



Dehydration vs Hypovolaemia

Hydration Parameters

- + Skin turgor
- + Sunken eyes
- + Mucous membrane dryness
- + Body weight

Perfusion Parameters

- + CRT
- + Mucous membrane colour
- + Pulse quality/Arterial BP
- + Heart rate
- + Urine output (1-2ml/kg/h)
- + Rectal temperature

Dehydration

Clinical Signs	% Dehydration
No signs, but history of fluid loss	<5
Tacky oral and ocular mucous membranes	5-6
Skin tenting, slight increase in CRT	6-8
Tachycardia, prolonged CRT	8-10
Weak pulses	10-12
Collapse, tachycardia, tachypnoea, hypotension	12-15

How Much Fluid?- Daily Fluid Requirements

+ $30 \times \text{BW kg} + 70 = \text{ml/kg/day}$

+ $132 \times \text{BW kg}^{0.75}$

+ For cats use $80 \times \text{BW kg}^{0.75}$

+ 40-60ml/kg/day



Pardo M, Spencer E, Odunayo A, Ramirez ML, Rudloff E, Shafford H, Weil A, Wolff E. 2024 AAHA Fluid Therapy Guidelines for Dogs and Cats. J Am Anim Hosp Assoc. 2024 Jul 1;60(4):131-163.

Calculating Fluid Requirements

+ Fluid **deficit** = % dehydration x Bodyweight (kg) x 1000

+ Add **maintenance** fluids = 30-50mls/kg/day

+ Add **ongoing losses** (vomiting, diarrhoea, polyuria)

+ Total requirements = **deficit** + **maintenance** + **ongoing losses**

Example

+ 30kg dog which is 10% dehydrated
+ tachycardia, dry mm, prolonged CRT

+ Fluid deficit = 3000mls ($0.10 \times 30 \times 1000$)

+ Maintenance = 1500mls (50×30)

+ Total fluid requirement for 24 hours

= 4500mls/day!!!! + ongoing losses = 187ml/h



How Long?- Avoid Fluid Overload with ROSE

+ Resuscitation

- + Rapid administration over a few mins
- + Fluid boluses of balanced crystalloids

+ Optimisation

- + Maintain effective circulation
- + Lasts a few hours

+ Stabilisation

- + Maintenance fluid therapy
- + Lasts a few days
- + Weigh patient twice daily

+ Evacuation

- + Patient eliminates excess fluids via the kidneys
- + May lead to oedema if vascular damage present



Crystalloids

+ Balanced

- + Lactated Ringers (isotonic)
- + Similar composition and osmolarity to plasma

+ Unbalanced

- + 0.9% Saline (isotonic),
- + 5% Glucose (hypotonic)

+ Bolus 15-20ml/kg over 15mins (cats 5-10ml/kg)

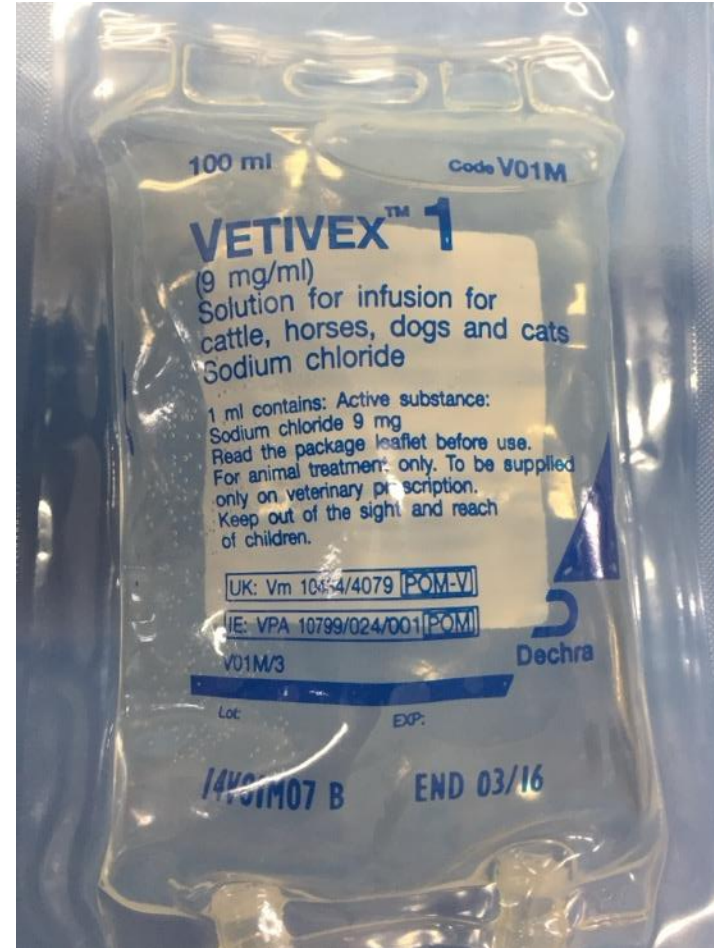
- + Reassess vitals every 15 mins
- + Repeat bolus X 4 (3 in cat)
- + Once perfusion parameters are improved change to maintenance rates

+ Care with congestive heart failure, cerebral oedema, renal dysfunction!



0.9% Saline

- + High sodium & chloride content
 - + No potassium
 - + Slightly acidifying
 - + Isotonic
 - + Unbalanced
-
- + Used for gastric vomiting
 - + Used to administer drugs
 - + Concurrent with blood transfusions



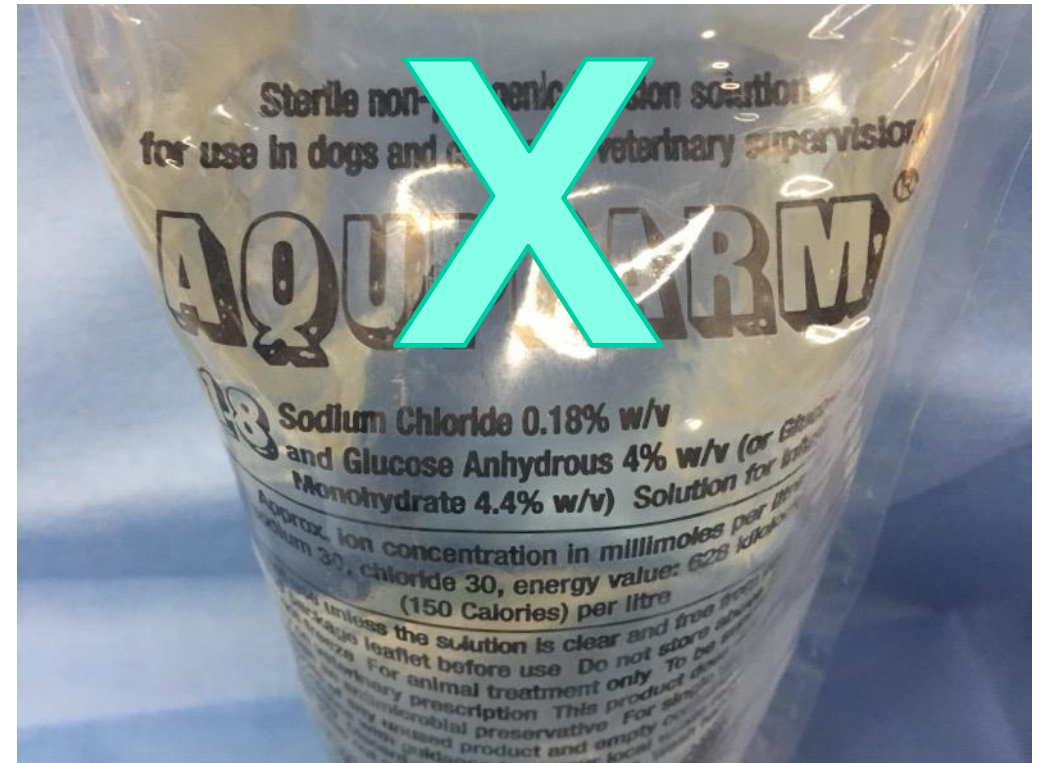
Lactated Ringers Solution

- + Also called Hartmann's
- + High sodium content (less than 0.9% saline)
- + Contains small amounts of potassium
- + Contains calcium
 - + Incompatible with blood products
- + Contains lactate
 - + Metabolised to bicarbonate
- + Useful in most cases and during surgery



Fluids with Glucose!!!

- + 0.18%NaCL + 4% dextrose
- + NO USE for replacement therapy
- + **The DEVIL's Fluid! Do not use**
- + All glucose is metabolised to free water
- + Causes dilution of all electrolytes
- + Not indicated in emergency patients



Hypertonic Saline 7.2%

- + 2-5ml/kg IV over 10mins in dogs
- + Sudden change in osmotic gradient expands plasma volume rapidly
- + Improvements noted in 1-2 mins
- + Other effects
 - + Modulates inflammation
 - + Increases cardiac contractility
 - + Causes mild vasodilation
 - + Decreases intracranial pressure/oedema



Care!!!

Keep separately to other crystalloids!

Do not use if dehydrated or hyponatraemic

Best given by central line

Extravasation causes oedema and tissue damage/necrosis

Colloids

- + Plasma expanders
- + Contain large solutes that are retained within vascular compartment
- + Draw fluid from interstitial space
- + 10-20ml/kg over 15 mins in dogs/5ml/Kg over 15mins in cats

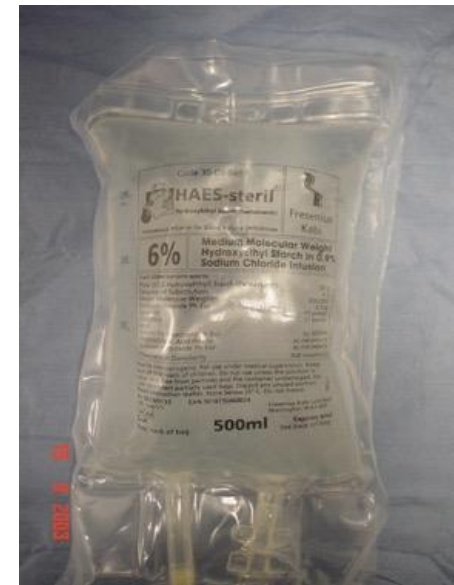
+ Natural Colloids

- + Whole Blood
- + Plasma
- + Canine albumin
- + Human albumin



Synthetic Colloids

- Dextrans
- Hydroxyethyl starches (Voluven)



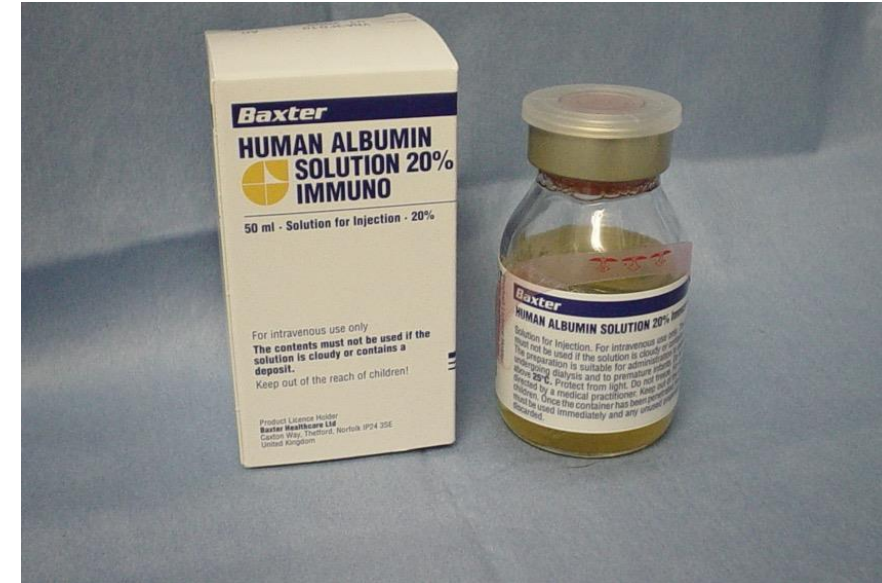
Colloids Adverse Effects

- + Volume overload
- + Anaphylaxis
- + Increased risk of bleeding/coagulopathies
 - + Specific antithrombotic action
- + Renal failure
- + Interfere with refractometer measurement of TS
- + Acute kidney injury associated with their use in humans
 - + Colloids removed from market
 - + Not documented in animals



Albumins

- + Canine specific albumin and human albumin
- + This is NOT a treatment for chronic hypoalbuminaemia
 - + Treat the underlying condition
- + Very expensive
- + Human albumin
 - + Only use in life threatening hypoalbuminaemia where other colloids are not available
- + Adverse effects
 - + Hypersensitivity reactions and AKI reported for human albumin
 - + Volume overload
 - + Coagulopathies



Mazzaferro EM, Balakrishnan A, Hackner SG, Forman M, Foster JD, Calabro J, Cianciolo RE. Delayed type III hypersensitivity reaction with acute kidney injury in two dogs following administration of concentrated human albumin during treatment for hypoalbuminemia secondary to septic peritonitis. J Vet Emerg Crit Care (San Antonio). 2020 Sep;30(5):574-580. doi: 10.1111/vec.12976. Epub 2020 Jul 11. PMID: 32652787.

+Shock

Decreased circulating volume



Types of Shock

+ Hypovolaemic

- + Haemorrhage/dehydration/trauma

+ Cardiogenic

- + CHF/dysrhythmias/drugs

+ Distributive

- + Sepsis/SIRS/anaphylaxis/hypoadrenocort/toxins

+ Obstructive

- + GDV/pericardial effusion with tamponade/dirofilarial/thromboembolism

+ Metabolic

- + Severe anaemia/severe hypoxia/hypoglycaemia



Phases of Shock

- + Compensatory phase
 - + Rarely identified in cats
 - + Difficult to recognise
 - + Rapid
- + Early decompensatory phase
 - + Tissue hypoperfusion develops
- + Late decompensatory phase
 - + Prolonged tissue hypoxia
 - + Irreversible



Small Volume Resuscitation

- + Administer small volumes fluid
- + Aim to restore mean BP to 60mmHg
 - + Systolic of 100mmHg, Diastolic of 40mmHg
- + Can use 5ml/kg boluses of colloids
 - + Remains in circulation for longer
- + May help reduce risk of further bleeding in cases of haemorrhage





Fluid Overload

Patients At Risk of Fluid Overload

- + All patients
- + Impaired renal function
 - + Especially oliguric renal disease
- + Heart disease
 - + Care with occult disease in cats
- + Liver disease



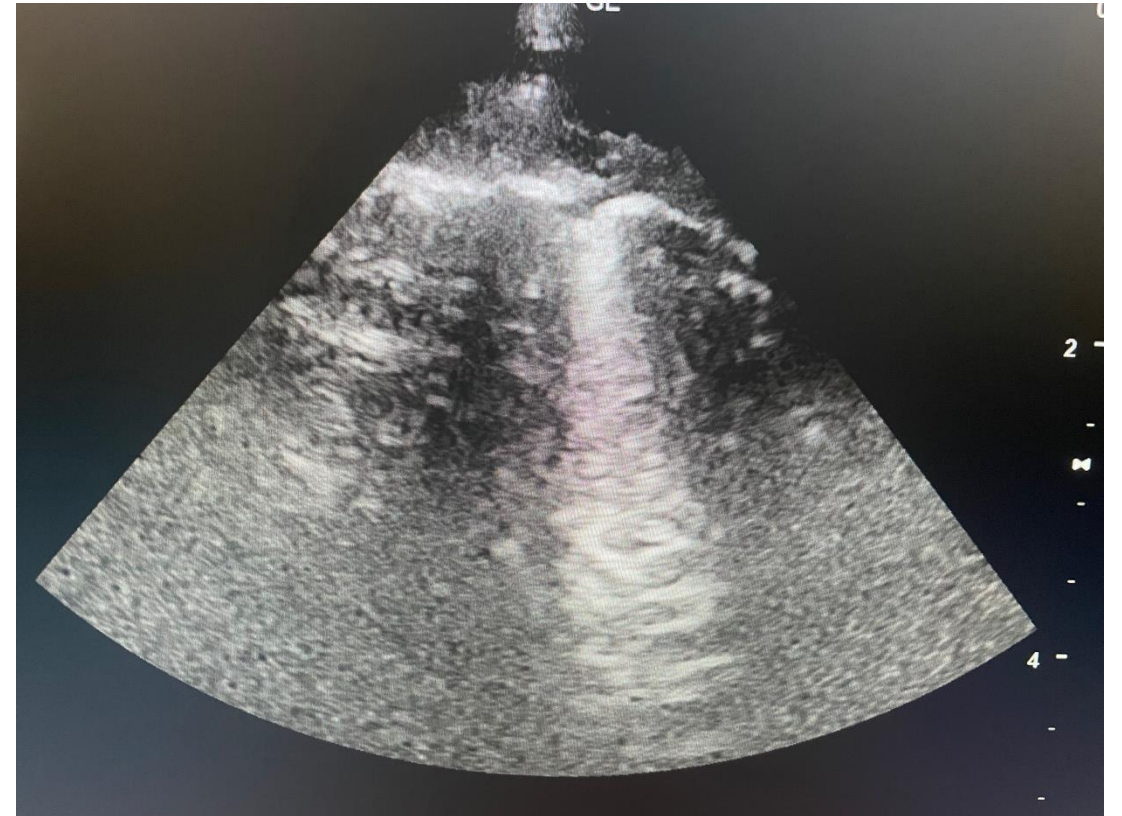
Clinical Signs of Fluid Overload

- + Increased body weight
- + Tissue oedema
 - + Chemosis
- + Serous nasal discharge
- + Tachypnoea
- + New heart murmur
- + GI signs- diarrhoea



Ultrasound Evidence of Fluid Overload

- + Pleural effusion
- + B-lines
- + Enlarged La:Ao
- + Decreased CVC collapsibility
- + Gall bladder wall oedema
- + Hepatic congestion



Effects of Fluid Overload

+ Hypervolaemia

- + Dilution of coag factors

+ Renal oedema

- + Decreased GFR
- + Decreased renal blood flow

+ Brain oedema

- + Reduced consciousness

+ Myocardial Oedema

- + Arrhythmias
- + Decreased cardiac output

+ Lung oedema

- + Pulmonary oedema
- + Pleural effusion
- + Hypoxaemia

+ Intestinal oedema

- + Intestinal ileus
- + Increased gut permeability
- + Vomiting and diarrhoea

Treatment for Fluid Overload

- + **Stop fluids**
- + Give oxygen
- + **Diuretics**
- + Thoracocentesis if necessary
- + Haemodialysis?





Case Studies

Case 1- Roy

Roy, 5yr old Golden Retriever, 32kg

- + Episode of respiratory distress & vomiting
 - + Occurred immediately after eating a bone the day before
 - + Not eaten or drank since
- + Presented in lateral recumbency
- + Hyperthermic (T 40°C)
- + Red mucous membranes
- + Rapid CRT (1 sec)
- + Tachycardia (160bpm) & tachypnoea (60bpm)
- + Weak peripheral pulses (SBP 70mmHg)



Is hypovolaemia present?

Dehydration vs Hypovolaemia

Hydration Parameters

- + Skin turgor
- + Sunken eyes
- + Mucous membrane dryness
- + Body weight

Perfusion Parameters

- + CRT
- + Mucous membrane colour
- + Pulse quality/Arterial BP
- + Heart rate
- + Urine output (1-2ml/kg/h)
- + Rectal temperature

Roy's clinical exam

- Red mucous membranes
- Rapid CRT
- Tachycardia
- Weak peripheral pulses
- Dry mucous membranes



Which is most appropriate fluid? Which is most appropriate route?

- + Is there obvious blood loss?
 - + No
- + Balanced crystalloid for shock
 - + Lactated ringers
- + Oral route not indicated
- + IV route is route of choice
 - + Wide bore catheter
- + Bolus therapy indicated



Roy's Results

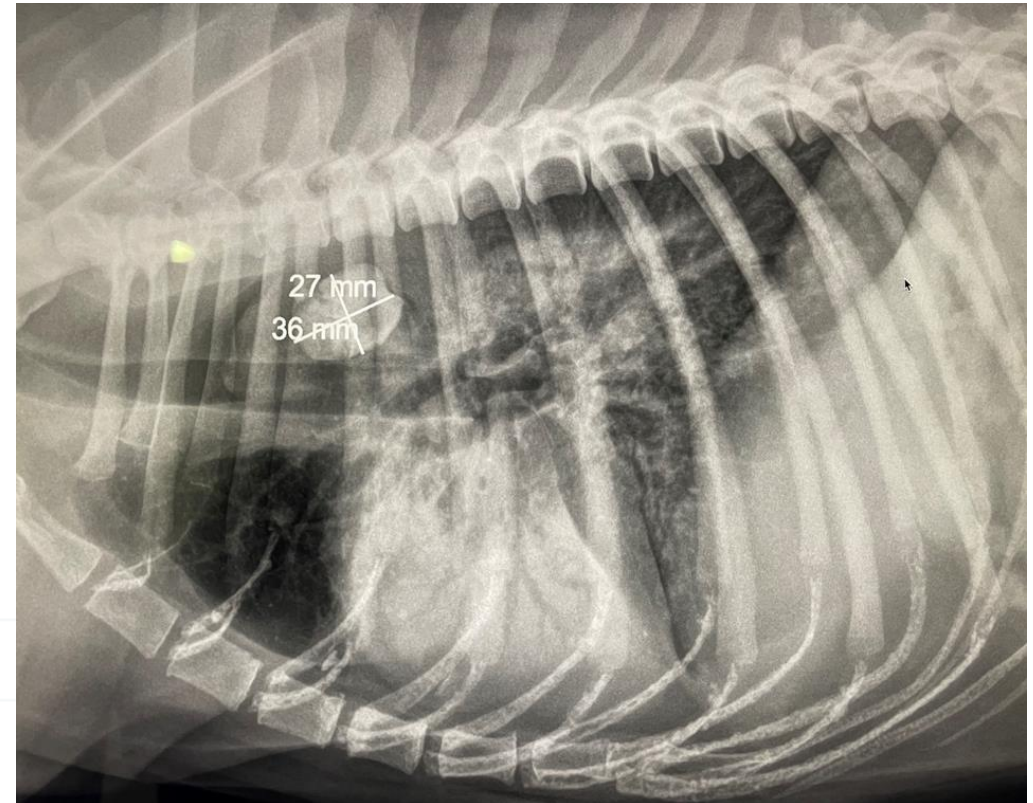
WBC	3,25	5,05 - 16,76 x10 ⁹ /L	
% Neutrophils	2,5	%	
% Lymphocytes	54,5	%	
% Monocytes	41,5	%	
% Eosinophils	1,5	%	
% Basophils	0,0	%	
Neutrophils	0,08	2,95 - 11,64 x10 ⁹ /L	
Lymphocytes	1,77	1,05 - 5,10 x10 ⁹ /L	
Monocytes	1,35	0,16 - 1,12 x10 ⁹ /L	
Eosinophils	0,05	0,06 - 1,23 x10 ⁹ /L	
Basophils	0,00	0,00 - 0,10 x10 ⁹ /L	

Chemistry

28/08/2024
15:43



Glucose	3,44	4,11 - 7,94 mmol/L	
Creatinine	90,17	44,2 - 159,12 μmol/L	
Urea	8,5	5,25 - 20,24 mmol/L	



Fluid Plan- What volume of fluid is needed?

+ Distributive shock/sepsis

+ Fluid bolus

- + 10ml/kg bolus IV over 20mins
- + Minimal improvement
- + Repeat bolus IV over 20 mins

+ Replace Deficits

+ Glucose bolus (50% glucose)

- + 0.5ml/kg diluted and given IV

10 x 32= bolus of 320mls over 20 mins
(fluid rate of 960ml/hr)

After initial bolus

Pulses a little stronger
Still tachycardic but less so

Repeat IV bolus

Another 320ml bolus over 20 mins
More aware, less tachycardic
Pulses stronger, SBP 90mmHg

Replace remaining deficits over 12-24h

0.10 x 32 X 1000 = 3200ml

Outcome- In case you are wondering

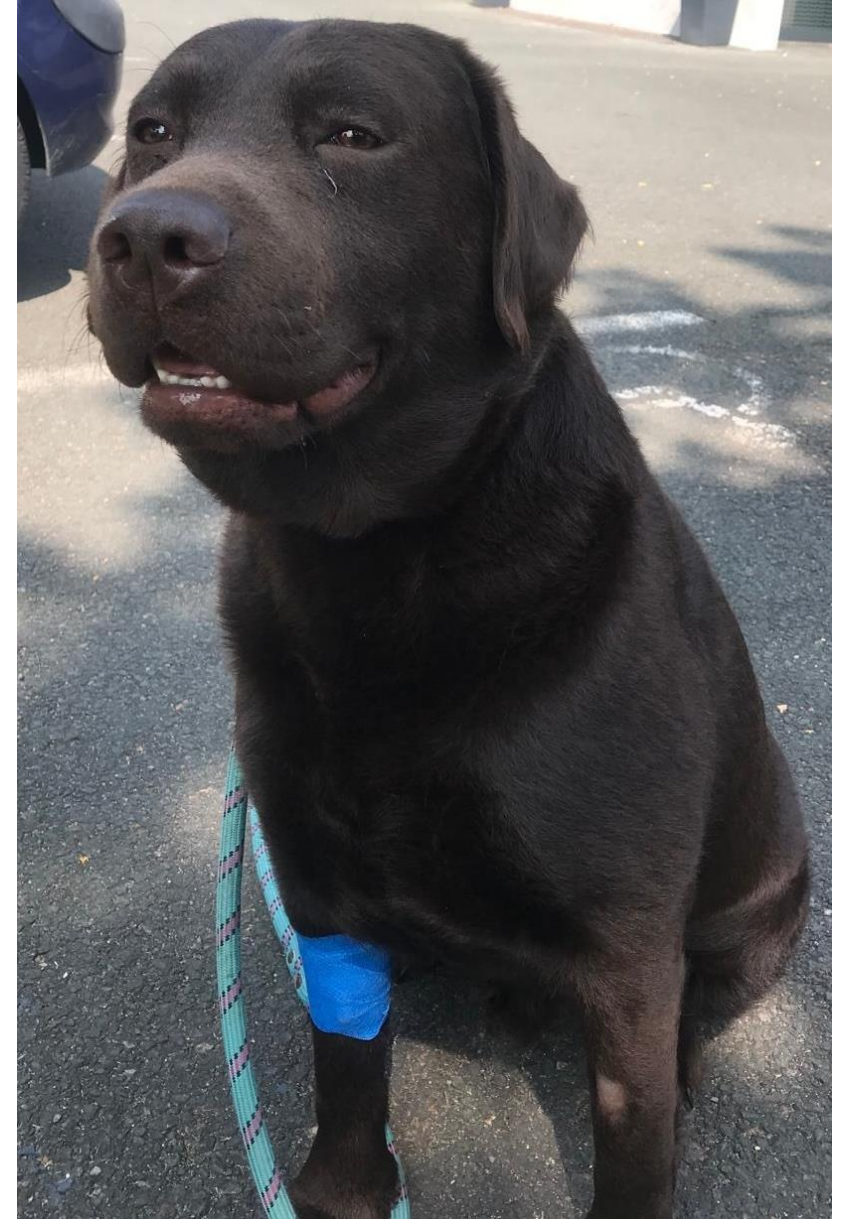




Case 2- Taz

Taz, a 2yr old MN Labrador

- + Presented to RVS with lethargy and anorexia
- + Blood showed severe azotaemia
- + Urine analysis shows glycosuria (BG normal)
- + Treated with 5L of Lactated Ringers over 2 days
- + Noted that he only produced a small amount of urine during this time
- + Gained 5kg in weight over 2 days



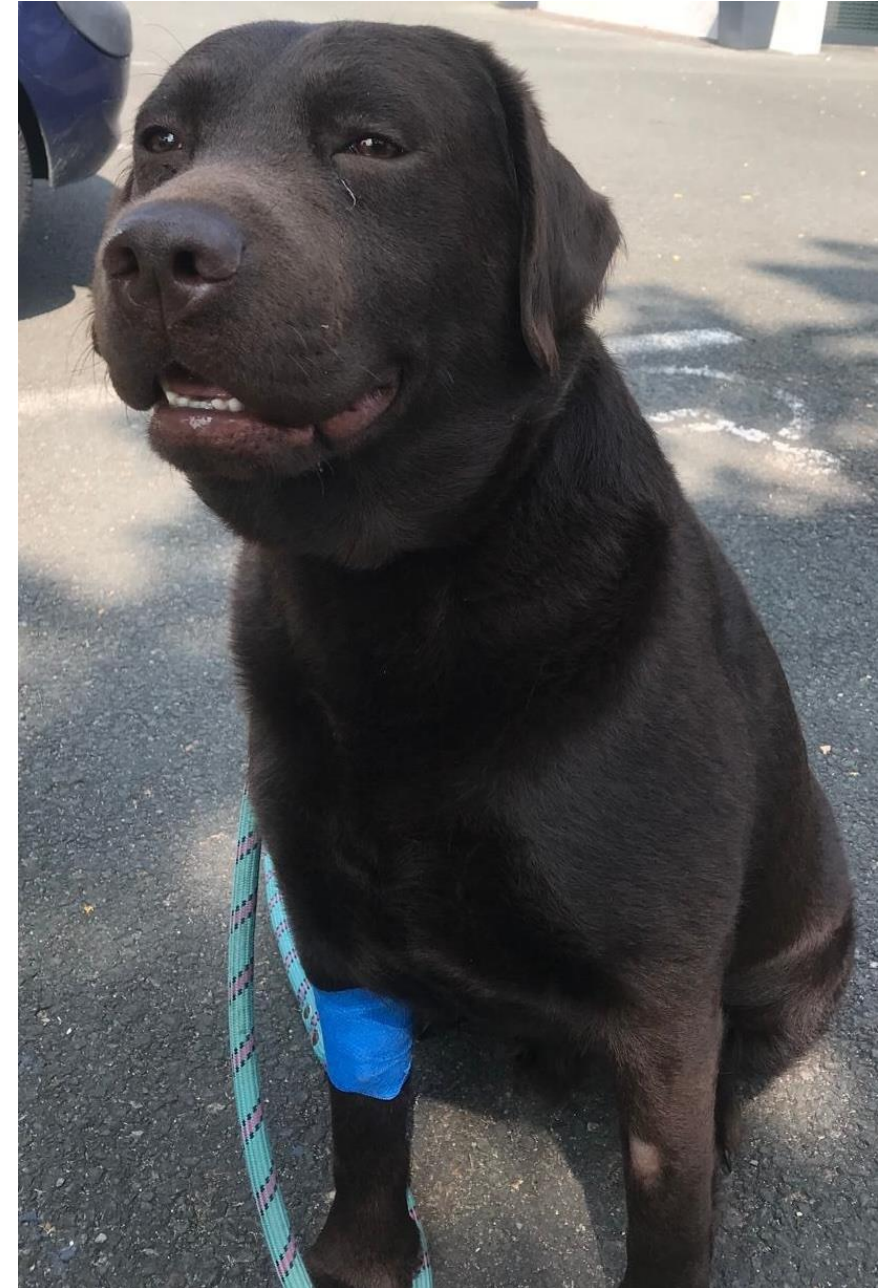
Clinical Exam

Oedematous

Very lethargic

Pain on abdominal palpation

Small bladder



Taz's Results

Chemistry
<

20/08/2024
15:22

Creatinine

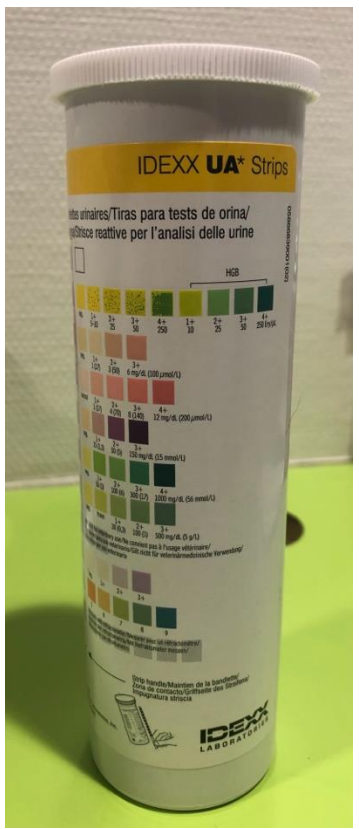
1463,02

44,2 - 159,12 $\mu\text{mol/L}$

Urine Glucose 2+

Urine SG 1.025

Leptospira spp. RealPCR	POSITIVE
Clinical Pathologist Report	A positive result indicates that DNA from pathogenic Leptospira was persistently detected in the sample.



Treatment in Hospital

- + Urinary catheter
 - + Oliguria
- + Frusemide IV
- + IVFT
 - + Ins and Outs measured
 - + IV fluid rate adapted to cover output
- + Weigh animal twice daily
- + Feeding tube (deduct oral fluids)

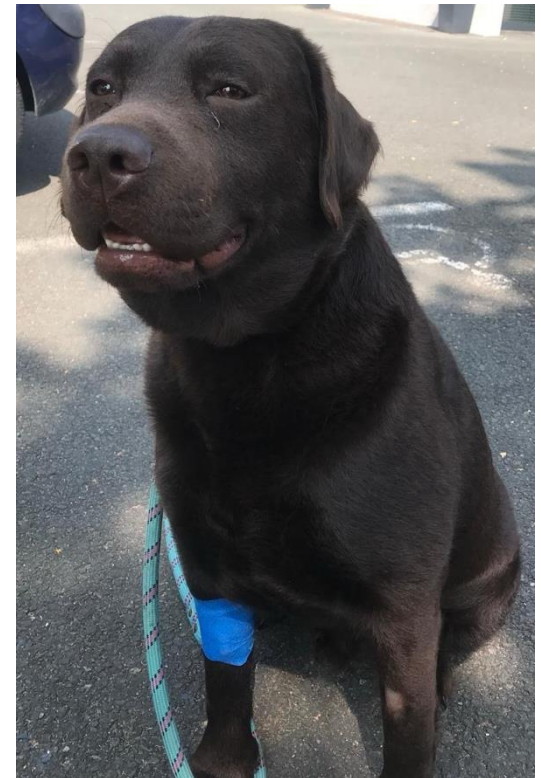


Progression over 2 weeks

Chemistry	03/09/2024 15:20		26/08/2024 10:06					
	Value	Reference Range	23/08/2024 09:32	21/08/2024 11:14	21/08/2024 10:53	20/08/2024 15:22	20/08/2024 10:54	
Creatinine	149,4	44,2 - 159,12 $\mu\text{mol/L}$	551,62	1447,99	>1202,24	1463,02	>1202,24	
Phosphorus	1,24	0,81 - 2,2 mmol/L	3,59					



Wt loss of 7kg





Thanks for Coming

Questions?

