

Nobody Puts Baby in the Corner: Neonatal and Pediatric Tips



Danielle Merriss, RVT VTS (ECC, SAIM)

MedVet Cincinnati



Neonate: 0-2 weeks of age
Infant: 2 weeks – 6 weeks of age



Initial Examination:

- Temperature
 - Between 96°-97° F until two weeks of age
 - Sits at 100° F by four weeks of age
 - Determined by environment
- Eyes
 - Neonates will not open their eyes until 12-14 days of age
 - A menace is not present for 3 months



Initial Examination:

- Tone
 - Flexor tone develops days 0-4
 - “Comma” shape
 - Extensor tone develops days 5-8
 - Stretching ability
- Movement
 - Purposeful movement develops around 16 days of age
- Pain
 - Present at birth
 - Keep in mind for procedures, injuries



Diagnostics:

- CBC
 - PCV is higher at birth (average is 47.5%)
 - Drops to approximately 29% in dogs and 27% in cats by 4-6 weeks of age
 - Slowly rises to adult numbers by 20 weeks of age
- Coags
 - PT and PTT are prolonged until after day 7
 - Overall decrease in all clotting factors until after day 7



Diagnostics:

Chemistry:

- BUN is low
- Albumin and Globulin (therefore TP) is low
- TBili is elevated
- ALP and GGT elevated up to 20x normal
 - Liver shunt closing and liver function increases



Diagnostics:

- Urinalysis
 - Dilute urine (less than 1.020)
 - Glucosuria
- Blood Pressure
 - MAP averages 50 mmHg at eight weeks of age



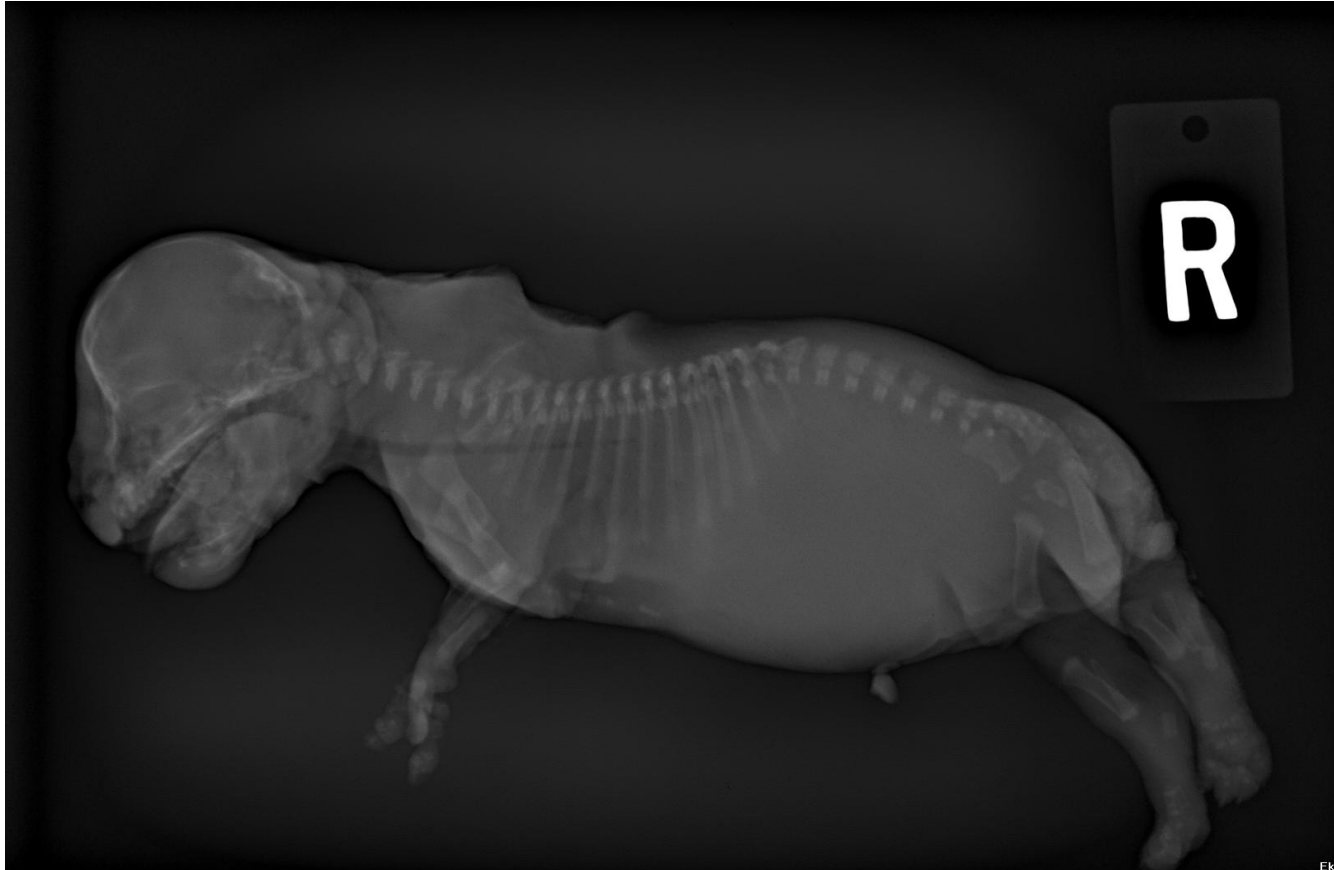
Diagnostics:

- Radiographs

- Thorax films show a triangle shaped thymus visible in left cranial thorax (mimics pneumonia)
- Increased fluid in lungs is also normal in neonates due to lungs not being dried out from birth yet
- Abdominal films show very little detail due to a lack of abdominal fat (mimics effusion)



Neonatal x-ray



Photograph credit: Wetaskiwin Animal Clinic, Wetaskiwin, Alberta Canada



Body Systems That Are Different In The Young:

Central Nervous System

Cardiovascular

Hepatic

Renal

Pain Sensation & Management



Central Nervous System:

- Autonomic nervous system is not complete until eight weeks of age
- Brain uses glucose as main source of energy
 - Young patients use up glucose at a much higher rate than adult patients
 - Hypoglycemia = brain damage if prolonged
 - Risk of seizures



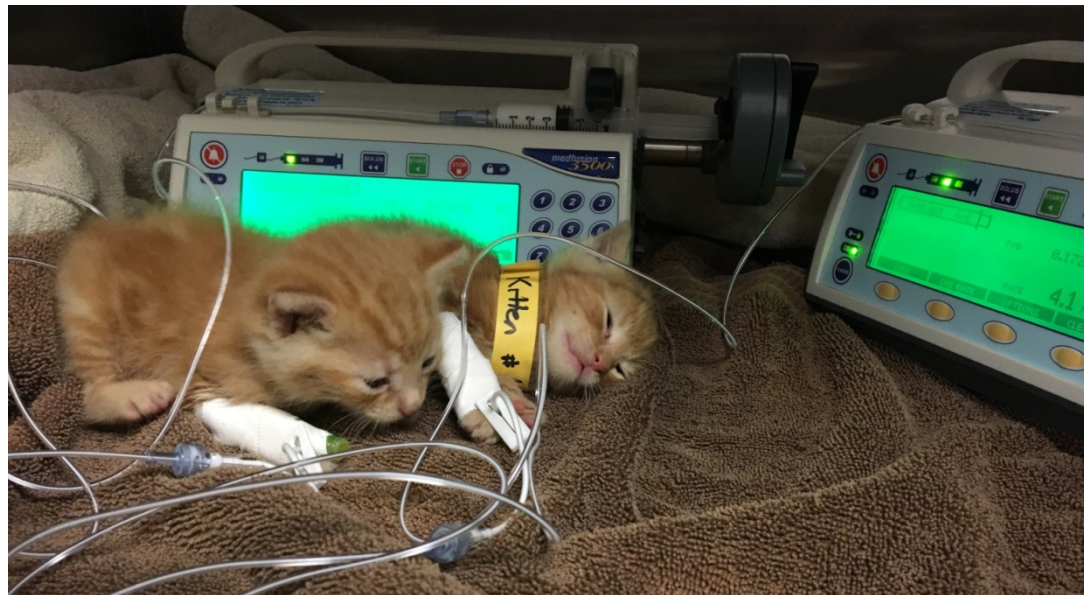
Central Nervous System:

- Neonates and pediatric patients have increased permeability of the blood brain barrier
 - Drugs have different pharmacological effects than in adults
 - Mannitol is contraindicated
 - Possibly better to not treat seizures due to increased side effects from anti-seizure medications



Cardiovascular System:

- Lower stroke volume than adults
 - HR basically determines CO
- Limited cardiac contractile reserves
 - Heart muscle uses glucose as primary fuel
 - Becomes a problem if hypoglycemic



Why Is This Important?

- A neonate/young pediatric patient will not respond to shock like an adult patient
- They lack compensatory mechanisms and can not work to improve their own perfusion (by increasing HR or SV)
- It is difficult to assess how critically sick they are
- They will also become more critical faster than an adult patient would without intervention



Hepatic System:

- Liver has an open ductus (shunt) that remains open for weeks
- 50% of neonatal blood bypasses the liver during this time



Why Is This Important?

- Drugs are metabolized very differently than they would be in an adult patient
 - Dose: Reduce by 30-50%
 - Duration: Dose interval is increased 30-50%



Hepatic System:

- Neonates and young pediatric patients have an incomplete gluconeogenesis system (decreased production of glucose)
- They also have decreased liver glycogen reserves

Both of these make these patients prone to hypoglycemia!



Renal System:

- Neonates and young pediatric patients have not yet developed renal auto-regulation
 - Auto-regulation is controlling renal blood flow via vasoconstriction or vasodilation
 - This is an effort to maintain a normal GFR regardless of what the body's blood pressure
 - This is a protective mechanism to the kidneys

Without this mechanism:

blood pressure drops = kidney damage



Renal System:

- Lack the ability to concentrate urine well
 - Immature nephrons = less water retained
 - Any young patient with greater than 1.020 USG is dehydrated
 - Greater fluid losses = greater fluid needs than adult patient



Renal System:

- These patients have large amounts of glucose spilled into urine instead of reabsorbed like adults
 - Resolves around 3 weeks of age in puppies
 - Adds to risk factors for hypoglycemia



Pain Sensation:

- Neonates have the ability to feel pain starting in utero
- However, their inhibitory system is not developed until sometime between 2-6w
- **Babies can feel pain (more than adult patients) and have no way to calm the sensation down**



Consequences of Pediatric Pain:

- Painful experiences cause increased sensitivity
- Increased sensitivity leads to formation of new afferents, increased innervation of wounds and hypersensitivity

- **Pediatric pain can equal increased pain for life**



Local Anesthesia:

- Bupivacaine:
 - Dogs
 - Neonate: 1mg/kg MAX dose
 - Juvenile (>3m): 2mg/kg MAX dose
 - Cats
 - Neonate: 0.75mg/kg MAX dose
 - Juvenile (>3m): 1.5mg/kg MAX dose



Local Anesthesia (Continued):

- Lidocaine:
 - Dogs
 - Neonate: 4mg/kg MAX dose
 - Juvenile (>3m): 8mg/kg MAX dose
 - Cats
 - Neonate: 3mg/kg MAX dose
 - Juvenile (>3m): 6mg/kg MAX dose



Local Anesthesia (Continued):

- Lidocaine/Prilocaine cream (EMLA):
 - Takes 30-60 minutes for effect
 - Prilocaine causes methemoglobinemia in cats when placed on broken/inflamed skin
- Maxilene:
 - Appears to work faster than EMLA
 - No prilocaine
- Lidocaine Viscous Gel 2%:
 - Can be used on mucous membranes and broken/inflamed skin



Opiates:

- Dose: Use ½ of adult dose to start
- Pure mu agonists:
 - Can use fentanyl, hydromorphone, morphine and methadone
 - Methadone can be given orally in cats/kittens
 - Can cause profound respiratory and cardiac depression
 - Watch closely
 - Administer oxygen if respiratory depression is noted



Opiate Reversal:

- Remember,
 - Bradycardia = hypotension
 - Hypotension = GFR and brain damage
- Naloxone: *Also works for dysphoria*
 - Take 0.1ml of naloxone (0.4mg/ml) + 4.9ml NaCl for small patients OR
 - Take 0.25ml naloxone (0.4mg/ml) + 9.75ml NaCl for large dogs (adults)
 - Administer 1ml/min IV until negative effects subside



Partial Mu and Agonist/Antagonist:

- Buprenorphine
 - Good for mild to moderate pain
 - Kittens +/- dogs?: 0.02-0.04mg/kg PO q4-8
 - Give 1 drop of dose at a time and watch effects
- Butorphanol
 - Good for mild to moderate pain or sedation
 - Will last 30-180 minutes



Non-Opiate Pain Medications:

- Ketamine
 - Prevents wind up syndrome
 - May abolish hypersensitivity syndrome
 - 0.05-0.25mg/kg IV q4 OR
 - 0.25mg/kg PO q4

- Gabapentin
 - 5-10mg/kg PO



Do NOT Use:

- NSAIDS
 - No indication in neonates or infants
 - Can use after 6w if healthy animal
- Alpha 2 agonists
 - No indication in neonates or infants
 - Can consider after 3m if healthy animal and no other options



Common Problems: (and what to do about them)



Photo credit: R. Halpin,
DACVECC

Neonatal Distress (Delivery)
Hypovolemia and Hypovolemic Shock
Hypoglycemia
Sepsis and SIRS
Head Trauma



Delivery



Newborn Distress:

- Newborns can become distressed during either a difficult vaginal delivery or by c-section



Photo credits: D. Degner, DACVS; Arbor Creek Veterinary Hospital, "Cat C-Section"



Newborn Resuscitation:

- Suction airway with bulb syringe
 - DO NOT SLING!
- Administer oxygen via small nose cone sealed tight over face
- Rub with dry towels to stimulate
- Tie off umbilical cord to prevent blood loss once cord is cut



Newborn Resuscitation:

- Don't forget drugs
 - If possible, reverse medications that were administered to mother
 - Epinephrine can be administered under tongue
 - Atropine unlikely to work due to immature autonomic nervous system
 - Vasopressin has not been studied in neonates
 - No doxapram



Newborn Resuscitation

- If no heart rate, start CPR
 - Perform compressions with thumb and forefinger
 - 100-120 bpm
- Consider acupuncture
 - GV 26 is an acupuncture site that stimulates both respirations and heart rate



GV (Governing Vessel) 26



- Insert needle where nose meets fur of the upper lip in the center
- Tap needle several times, then twist and remove

Photo credit: Dr. Doug Kneuvan, The Holistic Vet



Hypovolemia and Hypovolemic Shock:

- No compensatory mechanisms
 - No observable changes (even in severe dehydration)
 - HR
 - CRT
 - Mucous membrane color
 - Skin turgor
 - Moistness of mouth



Photo credit: R Halpin, DACVECC



Treatment:

- Monitor weight changes and USG for treatment progression
- Assume any neonate with losses and/or lack of intake is hypovolemic
- Place catheter and start fluids
 - IV catheter if possible
 - IO if not able to get IV
 - Bolus warm LRS at 45ml/kg, then continue fluids at 80ml/kg/day
- Feed puppies that are not vomiting

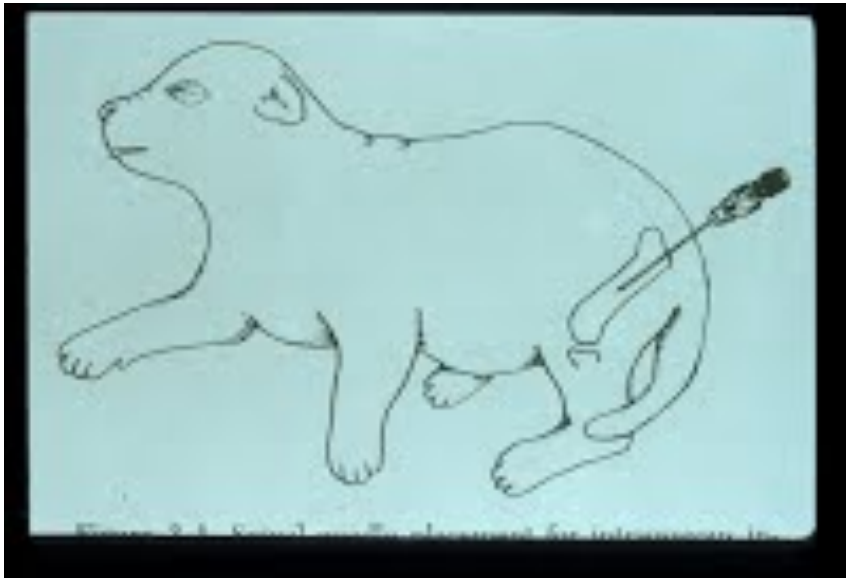


IV Placement:



Can place a 24g or 22g catheter in jugular (or cephalic vein in larger/older puppies)

IO Placement:



Can place a 22g or 20g needle into the femur, humerus or ileum

Photo credits: M Kustritz, DVM PhD; Emily Thomas, VetNowReferrals



Hypoglycemia

Can be a common problem because of several factors:

- Increased glucose demand
- Decreased glucose production
- Decreased glycogen reserves



Photo credit: R Halpin, DACVECC



Treatment:

- 50% Dextrose bolus 0.25ml/kg diluted 1:4
- Then start CRI of 1.25%-5% dextrose IV
- Use as low amount of dextrose as possible to prevent dehydration
- Feed puppies if they are not vomiting



Sepsis and SIRS:

- Very hard to detect in neonates and young pediatric patients
 - No typical signs (increased HR, temp, wbc and /or RR)
- Common causes include:
 - Wounds (tail docking, umbilical cord, bite wounds)
 - Respiratory infections (URI, pneumonia)
 - Gastrointestinal infections (parvo, parasites)



Treatment:

- IV fluids
- Culture if possible
- IV antibiotics and probiotics
 - Oral antibiotics are not recommended in neonates due to risk of destroying developing digestive flora
 - Dairy free probiotics are recommended if possible



Photo credit: M Doolan, DVM;
atdove.org



Head Trauma:

- CPP (cerebral perfusion pressure) = MAP – ICP
 - Head trauma raises intracranial pressure
 - Plus lower than adult MAP to begin with
 - Neonates with head trauma are at higher risk (than adults) for poor brain perfusion and brain damage



Treatment:

- No jugular catheter or jugular blood draws
 - Consider IO if too small for cephalic catheter
- Elevate head 30°
 - Place entire patient on gentle slope to prevent occlusion of jugular veins
- No Mannitol
- Weigh pros and cons of anti-seizure medications
- Don't forget pain control



Treatment:

- Oxygen
 - Use less than 40% oxygen cage
 - Neonates at risk for oxygen toxicity, retrolental fibroplasia and permanent blindness
 - More susceptible than adult patients



Photo Credit: R. Halpin,
DACVECC



Treatment Tips:

- For orphans or neonates too ill to nurse at birth, serum from a healthy adult can be administered to replace missing antibodies from colostrum
 - Dogs: 8-16ml of serum SQ administered at birth, 12 hours of life
 - Cats: 5ml of serum SQ administered at birth, 12 and 24 hours of life

Does not have to be from the dam or sire of litter

Can be any adult animal



Case Study: Sepsis

- “Glo”
 - 6d old Fe Schnauzer mix
 - History of failure to thrive and weak suckle since birth



- Entering complaint: lethargy and bloody diarrhea
- History:
 - Loose stool for 24 hours
 - Blood in stool just prior to presentation
 - Progressively worsening lethargy
 - Unknown dam vaccine status
 - Has been bottle raised since birth
 - Was administered 1ml SQ fluids twice



Physical Exam:

- Wt: 0.176 kg
- Temp: 83.9 F
- HR: 120
- RR: 30

- Slight increase respiratory effort
- No cleft palate or open fontanelle
- Thin body condition



C
B
C

Staff: Jennifer Christy, DVM

Status: Posted

Req ID: 26892 - Friday

4/1/2016 22:56:55

| Test | Results | Reference Range | Low |
|---------|---------------|-----------------|-------------------------------------|
| RBC | = 5.50 M/uL | L 5.65 - 8.87 | <input type="checkbox"/> |
| MCV | = 75.5 fL | H 61.6 - 73.5 | <input type="checkbox"/> |
| MCH | = 26.5 pg | H 21.2 - 25.9 | <input type="checkbox"/> |
| MCHC | = 35.2 g/dL | 32.0 - 37.9 | <input type="checkbox"/> |
| %Retics | = 0.3 % | | |
| Retics | = 16.5 K/uL | 10.0 - 110.0 | <input type="checkbox"/> |
| WBC | = 1.55 K/uL | L* 5.05 - 16.76 | <input checked="" type="checkbox"/> |
| %NEUT | * * 9.7 % | | |
| %EOS | = 1.9 % | | |
| %BASO | = 0.0 % | | |
| NEUT | * * 0.15 K/uL | L* 2.95 - 11.64 | <input checked="" type="checkbox"/> |
| LYMPHS | * * 1.02 K/uL | L 1.05 - 5.10 | <input type="checkbox"/> |
| MONOS | * * 0.35 K/uL | 0.16 - 1.12 | <input type="checkbox"/> |
| BASO | = 0.00 K/uL | 0.00 - 0.10 | <input type="checkbox"/> |
| HGB | = 14.6 g/dL | 13.1 - 20.5 | <input type="checkbox"/> |
| HCT | = 41.5 % | 37.3 - 61.7 | <input type="checkbox"/> |
| EOS | = 0.03 K/uL | L 0.06 - 1.23 | <input type="checkbox"/> |
| MPV | - --. fL | 8.7 - 13.2 | |
| %LYMPHS | * * 65.8 % | | |
| %MONOS | * * 22.6 % | | |
| PLT | * * 99 K/uL | L 148 - 484 | <input type="checkbox"/> |
| RDW | = 17.9 % | 13.6 - 21.7 | <input type="checkbox"/> |
| PDW | - --. fL | 9.1 - 19.4 | |
| PCT | - --. % | 0.14 - 0.46 | |
| Band | * * Suspected | | |

Lab Comments: Band neutrophils suspected



CHEMISTRY

Template: CHEMISTRY

Staff: Jennifer Christy, DVM

Status: Posted

Req ID: 26892 - Friday

4/1/2016 23:05:16

| Test | Results | Reference Range |
|-----------|---------------|-----------------|
| GLU | = 95 mg/dL | 77 - 150 |
| BUN/UREA | = 76 mg/dL | H 7 - 29 |
| CREA | = 0.3 mg/dL | 0.3 - 1.2 |
| PHOS | = 7.4 mg/dL | 5.1 - 10.4 |
| Ca | = 9.3 mg/dL | 7.8 - 12.6 |
| Sodium | = 143 mmol/L | L 145 - 157 |
| Potassium | = 4.6 mmol/L | 3.5 - 5.5 |
| Chloride | = 106 mmol/L | 105 - 119 |
| TP | = 5.2 g/dL | 4.8 - 7.2 |
| ALB | = 3.0 g/dL | 2.1 - 3.6 |
| GLOB | = 2.2 g/dL | L 2.3 - 3.8 |
| ALB/GLOB | = 1.4 | |
| ALT | = 124 U/L | H 8 - 75 |
| ALKP | = 248 U/L | 46 - 337 |
| GGT | = 24 U/L | H 0 - 2 |
| TBIL | = 2.2 mg/dL | H 0.0 - 0.8 |
| CHOL | = 196 mg/dL | 100 - 400 |
| AMYL | = 363 U/L | 300 - 1300 |
| LIPA | = 268 U/L | 100 - 1500 |
| OSM calc | = 307 mmol/kg | |
| BUN/CREA | = 253 | |
| Na/K | = 31 | |



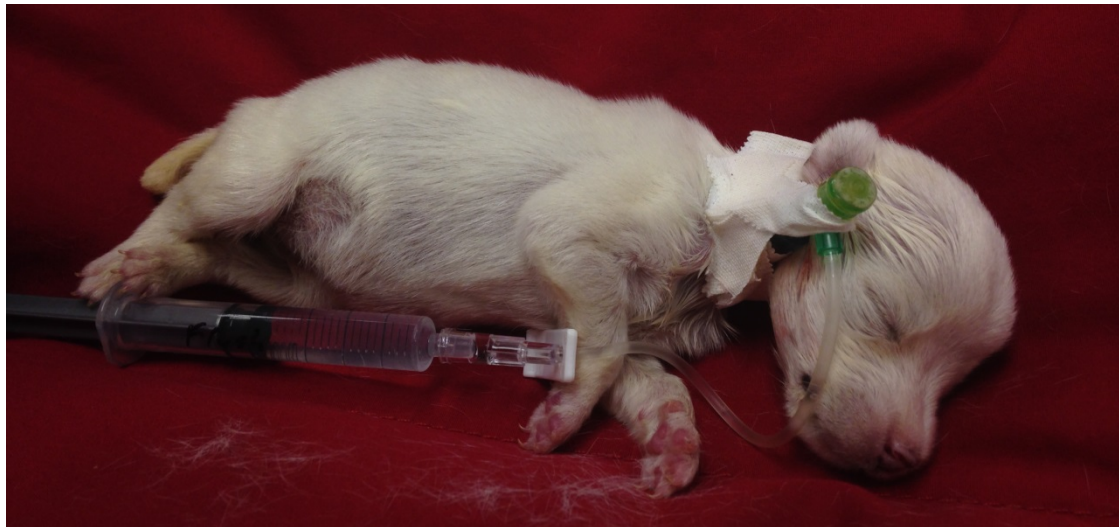
Additional Diagnostics:

- Unable to obtain a urine sample
- Parvo snap: Negative
- Unable to obtain blood pressure
 - Patient was significantly smaller than a size 1 cuff



Initial Treatments:

- Placed 20g IVC in right jugular vein
- Bolused 45ml/kg LRS (warmed)
- Started antibiotics
 - Ampicillin + sulbactam 30mg/kg IV q6
 - Enrofloxacin 10mg/kg IV q 24



Continued Treatments:

- IVF: LRS + 2.5% dextrose at 100ml/kg/day
- Heat support
- Stimulate to urinate/defecate
- Feed once above 94° F
- Monitor body weight and urine production



- Unfortunately, Glo remained unwilling to eat, even as her body temperature increased
- She began having bloody fluid from her nares on the overnight shift
- She went into cardiac arrest at 5:40a
 - CPR was not performed at owner's request



Case Study: Head Trauma

- “Coco”
 - 5w FE mix breed puppy
 - No previous health problems or medications



- Entering complaint: suspected head trauma
- History:
 - Owner let out in yard (unfenced, unattended) for 20 minutes prior to arrival
 - Owner found patient bleeding from left ear canal and left nostril
 - Presented to referring veterinarian
 - Administered 1mg diazepam IV
 - Transported for additional care



Physical Exam:

- Wt: 2.6kg
- Temp: 94.1
- HR: 130
- RR: 42
- MM: Pl pk/2 sec
- Mentation: Demented



Neurologic Exam:

- Normal palpebral reflex OU
- No menace OU
- PLRs normal OU
- Rotary nystagmus, fast phase to left
 - Worsens when placed on back
- Non-ambulatory
 - Rolls when picked up or handled
- Head and body turns to left



Initial Diagnostics:

- BG: 136mg/dl
- BP: 150mmHg
- TFAST: Normal
 - No pleural or pericardial fluid seen
- AFAST: Normal
 - No free fluid seen
 - Bladder intact



Initial Interventions:

- Placed IV catheter
- Fentanyl 3 mcg/kg IV, then 3mcg/kg/hr CRI
- Hypertonic Saline 4ml/kg IV
- Plasmalyte 100ml IV



Diagnostics:

- CBC
- Chemistry
- Radiographs



C B C

| Test | Results | Reference Range |
|---------|--------------|-----------------|
| RBC | = 6.90 M/uL | 5.65 - 8.87 |
| MCV | = 65.2 fL | 61.6 - 73.5 |
| MCH | = 23.0 pg | 21.2 - 25.9 |
| MCHC | = 35.3 g/dL | 32.0 - 37.9 |
| %Retics | = 0.1 % | |
| Retics | = 9.0 K/uL | L 10.0 - 110.0 |
| WBC | = 15.11 K/uL | 5.05 - 16.76 |
| %NEUT | = 79.4 % | |
| %EOS | = 0.4 % | |
| %BASO | = 0.1 % | |
| NEUT | = 12.01 K/uL | H 2.95 - 11.64 |
| LYMPHS | = 1.69 K/uL | 1.05 - 5.10 |
| MONOS | = 1.34 K/uL | H 0.16 - 1.12 |
| BASO | = 0.01 K/uL | 0.00 - 0.10 |
| HGB | = 15.9 g/dL | 13.1 - 20.5 |
| HCT | = 45.0 % | 37.3 - 61.7 |
| EOS | = 0.06 K/uL | 0.06 - 1.23 |
| MPV | = 9.1 fL | 8.7 - 13.2 |
| %LYMPHS | = 11.2 % | |
| %MONOS | = 8.9 % | |
| PLT | = 294 K/uL | 148 - 484 |
| RDW | = 15.6 % | 13.6 - 21.7 |
| PDW | = 11.2 fL | 9.1 - 19.4 |
| PCT | = 0.27 % | 0.14 - 0.46 |

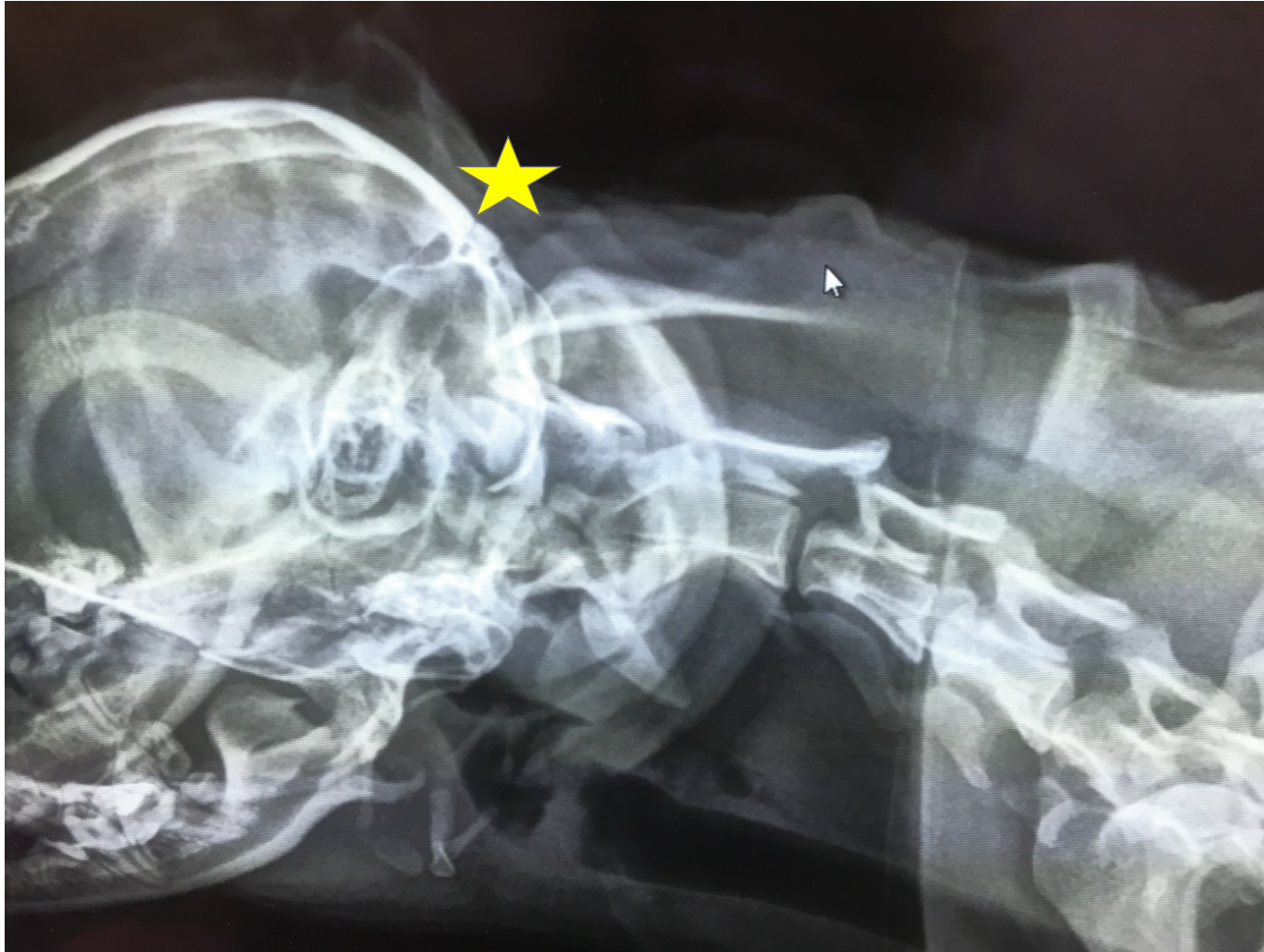


CHEMISTRY

| Test | Results | Reference Range |
|-----------|---------------|-----------------|
| GLU | = 115 mg/dL | 74 - 143 |
| BUN/UREA | = 11 mg/dL | 7 - 27 |
| CREA | = 0.5 mg/dL | 0.5 - 1.8 |
| PHOS | = 4.2 mg/dL | 2.5 - 6.8 |
| Ca | = 8.1 mg/dL | 7.9 - 12.0 |
| Sodium | = 152 mmol/L | 144 - 160 |
| Potassium | = 3.4 mmol/L | L 3.5 - 5.8 |
| Chloride | = 113 mmol/L | 109 - 122 |
| TP | = 5.0 g/dL | L 5.2 - 8.2 |
| ALB | = 2.9 g/dL | 2.3 - 4.0 |
| GLOB | = 2.1 g/dL | L 2.5 - 4.5 |
| ALB/GLOB | = 1.4 | |
| ALT | = 42 U/L | 10 - 125 |
| ALKP | = 37 U/L | 23 - 212 |
| GGT | = 5 U/L | 0 - 11 |
| TBIL | < < 0.1 mg/dL | 0.0 - 0.9 |
| CHOL | = 168 mg/dL | 110 - 320 |
| AMYL | = 618 U/L | 500 - 1500 |
| LIPA | = 2240 U/L | H 200 - 1800 |
| OSM calc | = 299 mmol/kg | |
| BUN/CREA | = 22 | |
| Na/K | = 45 | |



Radiographs:



Radiographs:



Radiograph Report:

- Poor positioning affected radiograph interpretation
- Possible left caudal skull fracture with no displacement
- Consider CT and/or sedated radiographs



Continued Interventions:

- Hospitalized in ICU
- BP monitoring q4
- Mannitol 1gm/kg IV once
- Maropitant 1 mg/kg IV
- IVF at 60ml/kg/day
 - Fentanyl CRI continued at 3 mcg/kg/hr
 - KCL added at 15 meq/L



Neurologist Consultation:

- Mental status: Moderate obtundation
- Posture and coordination: Significant L head turn and L head tilt
- Gait and Stance: Non-ambulatory tetraparetic, rolls to L
- Cranial Nerve Examination: Anisocoria (L pupil miotic), spontaneous horizontal nystagmus, reflexes intact (except crossed extensor reflex)

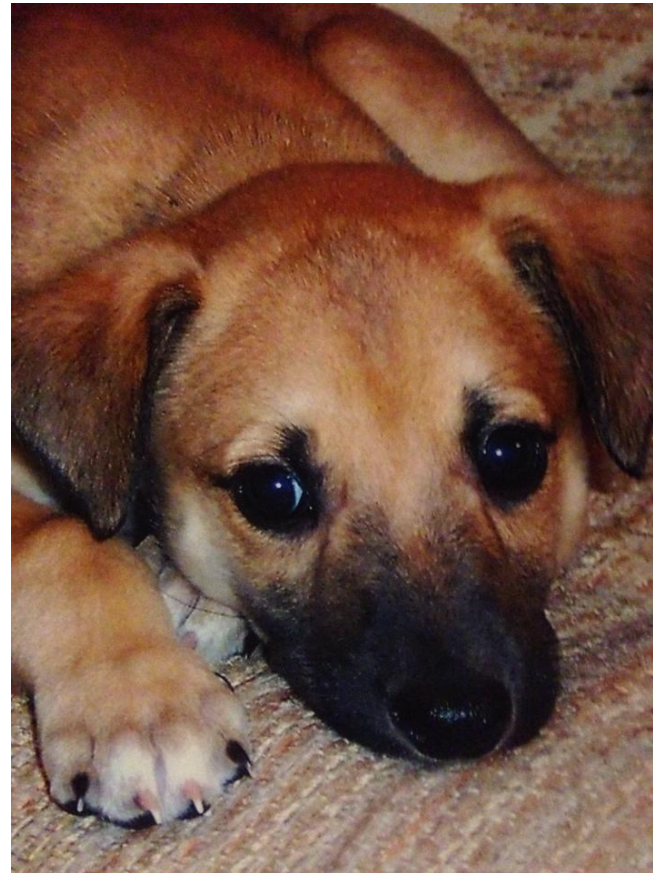


Neurologist Recommendations:

- **Diagnosis:** Multifocal neural localization (left forebrain and brainstem)
- Owners request outpatient symptomatic treatment
 - Continued hospitalization and CT declined
- Discharged on gabapentin and meclizine
- Recommend a recheck in two weeks



In conclusion, it is very possible to stabilize and treat very young critical patients as long as one keeps in mind their unique and challenging qualities. With appropriate changes to fluid rates, drug dosages and intervals and diligent monitoring, these patients can enjoy a successful recovery.



Any questions?



Danielle.Merriss@medvet.com

