Raccoon Rehabilitation: Parvovirus in Raccoons

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DISCLAIMER:
No part of this presentation is intended to provide veterinary advice or recommendations of any kind. Medications and Protocols administered by KWC are used under the advisement of our veterinarian of record.

Consult your own veterinarian before using any medication and do so only under his direct supervision.
“Not just live and let live....but live and HELP live.”
Kentucky Wildlife Center Mission

- Rescue and rehabilitate native wildlife
- Improve the welfare of wildlife through education
- Improve the field of wildlife rehabilitation through research
- Base new therapies and protocols on sound scientific research
- Do no harm
- Improve survivalability in the rehabilitation setting
- Share information
“Confusion is that wonderful state of mind right before clarity.”

Mandy Evans
Fluid Therapy: Overview

Determine How Much Fluid to Give

- Calculate Deficit - Assume a minimum of 5% (Replace over 24 hours in mammals)
- Determine Maintenance:
  - 70-90 ml/kg/day (Mitchell)
  - 50 ml/kg/day (IWRC)
- Neonates require 2 to 3 times the fluid of adults
- Adjust for ongoing losses - diarrhea, vomiting
- Clinical experience and research studies have shown that unless fluid deficit is replaced promptly, mortality is very high. One study (Azech, S. et al. 2010) showed that failure to replace deficit adequately within 8 hours led to poor outcome.
Subcutaneous Injection (SQ)

- Good for mild to moderate dehydration
- Neonatal maintenance requirements are 2-3 times that of an adult (120-180 ml/kg/day) or 1 ml/25 grams of body weight q 4-6h prn
- Warm the fluids
- Administer in the intrascapular space (between the shoulder blades)
- Continue for at least 24 hours or until full maintenance can be given orally
- Lactated Ringers Solution (LRS) (Isotonic crystalloid)
- Don’t give dextrose SQ
- Wide Safety Margin
Intravenous Injection (IV)

- Necessary for animals in severe shock
- Catheter is placed by our veterinarian
- Can be difficult to place in small neonates
- We use LRS with added Dextrose and Vitamin B Complex
Oral (PO)

- Never administer anything orally to an animal in shock
- Always warm the fluids to approximately 100°F
- In dehydrated animals, administer SQ before giving oral fluids.
- Administer no more than 5% of body weight at any one time.

*Never attempt to use a stomach tube without proper training*
Oral Rehydration

- Use LRS, Oral Rehydration Salts, Unflavored Pedialyte
- We add L-Carnitine, Glutamine, and Zinc
Intraosseous Administration (IO)

- Any fluid or drug that can be administered IV can be administered IO
- Good when IV access is difficult or impossible
Fluid Therapy - Keep It Simple

- Know the basics, but don’t get caught up in the numbers! The deficit, ongoing losses, age adjustment are **ESTIMATES**! The most important thing is to give fluids!
- Reassess regularly. When in doubt - Continue!

It truly can make the difference whether or not your patient survives!
Vitamin Supplements
Glutamine

- Conditionally essential amino acid during periods of stress or injury
- Preferential energy source for cells in the gut
- Helps protect gut mucosal barrier minimizing intestinal permeability
- Plasma Glutamine levels have been shown to decrease by 58% after injury or critical illness and may remain decreased for 3 weeks with increased mortality
- Glutamine supplementation has been shown to decrease incidence of sepsis, pneumonia, and bacteremia
- Dose 10 mg/kg/day

Zinc Supplementation

- Recommended in treating acute diarrhea by the WHO
- Affects immune function, intestinal structure, & epithelial recovery
- Used in conjunction with oral rehydration
- In numerous clinical trials, children had a significant faster recovery
- We use the recommended dosage in dogs 1.5-2.5 mg/kg zinc gluconate PO TID (Plumb’s Veterinary Drug Handbook)
- We mix zinc in oral electrolytes
**Tube Feeding**

**Overview:**
- Measure from tip of nose to last rib
- Mark with tape or marker
- Use appropriate size tube—don’t go too small! (esophagus is larger than trachea)
- Make sure the baby is sternal, nose up
- Lubricate the tube
- Pass down the left side of the mouth
- Gently glide, never force—should slide easily
- Make sure there is no air in the tube
- If you’re not sure, pull out and start over
- Can use a small amount of sterile saline to make sure placement is correct (nothing should come out nose)
- Give 5% of bodyweight, start with less
- Pinch tube before removal and remove quickly to prevent aspiration
- Remeasure tape regularly and adjust for growth

*Don’t try without proper training!*
Hypovolemic Shock

- Decreased volume of circulating fluid (plasma) in the blood
- Results in decreased perfusion and decreased oxygen delivery to tissues
- In neonates, most commonly results from diarrhea, vomiting, or decreased intake
- Neonates have inadequate or nonexistent compensatory mechanisms for dealing with shock. Adults compensate by increasing heart rate, concentrating urine, and decreasing urine output. (Appropriate concentration of urine is not seen until approximately 10 weeks of age.)
- Dehydration can rapidly progress to hypovolemic shock
- Must treat with aggressive fluid therapy. Give initial bolus of 45 ml/kg of warmed isotonic fluid (LRS). Follow with maintenance level of fluids and compensate for any ongoing losses.

Clinical Signs of Shock in the Neonate

- pale mucous membranes
- slow capillary refill time (>1.5 seconds)
- decreased urine output
- no nursing or suckle reflex
- cold extremities
- limp body tone
- constant crying
Managing the Sick Neonate

- Correct Hypothermia
- Correct Dehydration
- Correct Hypoglycemia
- Provide Nutrition
Polyflex (Ampicillin trihydrate for injection)

- Reconstitute by injecting 104.5 ml sterile water into 25 gram bottle for 200 mg/ml concentration
- Inject 1 ml of 200 mg/ml into 9 ml sterile diluent for a concentration of 20 mg/ml (more appropriate dosing concentration for neonates)
- Stable for 12 months if refrigerated (Plumb)
- Remember to label, note concentration and date
Ampicillin

- Beta-lactam antibiotic with similar spectrum as amoxicillin
- Increased activity against many strains of gram-negative aerobes not covered by natural penicillins including some strains of *E. coli* and *Klebsiella*
- Minimal toxicity associated with use
- Safe in neonates

**Ampicillin Sodium (for injection)**
- Stability is concentration dependent. Generally recommended use is within one hour of reconstitution. But, concentrations of 30 mg/ml are stable for 48 hours if refrigerated.

**Ampicillin trihydrate (Polyflex)**
- Manufacturer states that Polyflex is stable for 3 months after reconstitution if refrigerated. Both Plumb’s Veterinary Drug Handbook (6th Ed.) and Saunders Handbook of Veterinary Drugs (3rd Ed.) state that it is stable for up to 12 months if reconstituted if refrigerated.
Pharmacokinetics of enrofloxacin in neonatal kittens

- Used dose of 5mg/kg of enrofloxacin (Baytril)
- Evaluated kittens ages 2-8 weeks
- Half-life was shorter and elimination was greater in kittens than adults
- In neonatal kittens, IV and SQ was an effective route of administration
- Oral administration did NOT result in therapeutic drug concentrations in kittens
Baytril (Enrofloxacin)
Safety and Toxicity Considerations

- Cartilage Lesions in weight bearing bones of growing animals (potential degeneration and arthritis)
  - Affects dogs, not cats
  - No adverse side effects with doses of 5-25 mg/kg for 10 days in puppies ages 1-4 weeks
  - In puppies older than 6 weeks, lesions were dose and duration of treatment dependent.
  - Kittens dosed with 25 mg/kg for 30 days did not develop cartilage lesions

- Retinal Degeneration (blindness)
  - Affects cats, but not dogs
  - Dose dependent. Doses greater than 20 mg/kg
  - Studies showed dose of 5 mg/kg was safe to use in cats

- Relevance to Raccoon Rehabilitators
  - Use is extra-label
  - Great antimicrobial that can be given once a day
  - Kentucky Wildlife Center has used the 5 mg/kg dose for up to 14 days on many raccoons with no adverse side effects.
Diarrhea

Causes
- Overfeeding
- Introduction of formula too quickly
- Change in formula or food
- Medication
- Stress
- Poor hygiene or sanitation
- Spoiled formula or food
- Parasites
- Disease - bacterial or viral

Treatment
- Fluids
- Probiotics
- Rest the gut (skip feedings - fluids only)
- Diagnostics - fecal float, culture
- Metronidazole
- Famotidine
Septicemia

- Bacterial infection that overcomes the neonate’s defense mechanisms
- Common pathogens include: *Staphylococcus*, *Streptococcus*, *E. Coli*, *Klebsiella*, *Enterobacter*, *Clostridium*, and *Salmonella*
- Symptoms include excessive crying, restlessness, weakness, hypothermia, shock, reduced feeding ability, prolonged capillary refill time, respiratory distress
- Wild animals inherently mask disease so some neonates will simply die with no apparent symptoms
- Often presents with hypothermia, hypoxia, hypoglycemia, shock, dehydration
- Neonates have different pharmacological considerations that must be considered when calculating dosages.
- Do not give oral medications to critically ill neonates

Plasma Use

- We maintain a fresh-frozen plasma bank year round
- May not be feasible in most settings. We work with an amazing veterinarian
- Great for treating dehydration, shock, severe wounds, parvovirus, etc.
Plasma Collection
Plasma Administration

Subcutaneous (SQ)

Intraperitoneal (IP)

Intravenous (IV)
Use of Adult Cat Serum to Correct Failure of Passive Transfer in Kittens

IP and SQ administration of adult cat serum in three 5-ml increments at birth, 12h and 24h resulted in IGG levels equivalent to kittens that nursed normally.
After babies can thermoregulate, they are moved to kennels in the clinic.

Raccoons must have nest boxes to sleep and hide in to reduce stress. Simulates den sites. We make these nestboxes without bottoms so you can lift them up, clean and replace bedding, etc. Cheap to make.
Litter Boxes - Types of Litter

- Raccoons use latrine sites in the wild
- Easier to keep the cages clean
- We use wood pellets - safe, non-toxic
Socialization

- Critical for development
- Should always be with conspecifics. Network!
- Learn skills necessary to survive in wild
Social Companionship

- Socialization is critical for animals to form social attachments to their own species and create primary social bonds (Occurs 3-12 weeks of age in puppies and 2-7 weeks of age in kittens).
- Interactions such as grooming, play and physical contact result in social bonding.

McMillan, F. Development of a mental wellness program for animals. JAVMA. 2002;220(7):965-972.
Managing Stress

- Being an orphan is traumatic
- Being a wild animal in captivity is stressful
- Conspecifics and environmental enrichment are crucial
- Provide access to nest boxes, safe hiding places and choice
- Provide age appropriate caging to allow for adequate activity
- Prevent overcrowding
Quality of Life: The Five Freedoms

- Freedom from hunger and thirst by ready access to fresh water and a diet to maintain full health and vigor
- Freedom from discomfort by providing an appropriate environment, including shelter and a comfortable resting area
- Freedom from pain, injury, or disease by prevention or rapid diagnosis and treatment
- Freedom to express normal behavior by providing sufficient space, proper facilities, and the company of the animal’s own kind
- Freedom from fear and distress by ensuring conditions and treatment to avoid mental suffering

Stress Management
Mental Wellness

- Make sure all physical needs are met (access to fresh water, good nutrition, clean environment, freedom from injury and disease)
- Social companionship. Conspecifics are critical to emotional well-being
- Environmental enrichment and mental stimulation
- Control and Predictability of surroundings
- Reduce fear: loud noises, predators, domestic animals, etc.
- Limit caregivers. Don’t allow strangers to handle animals.
Antibiotics
Internal Parasites

- **Baylisascaris procyonis** is always a concern in raccoon rehab because of zoonosis. Infections from transplacental or transmammary transmission may occur in neonates. Patent infections can occur by 3 weeks of age.
- Use pyrantel pamoate (5-10mg/kg PO), repeat every 2-3 weeks. Pyrantel is generally considered very safe in neonates but prophylactic use generally begins at 3 weeks of age.
- Treat Giardia with metronidazole (60 mg/kg PO q24h for 5 days). Metronidazole should be avoided in very young neonates because of the potential for neurologic side effects (more permeable blood-brain barrier in neonates).
- Coccidia can be treated with ponazuril (Marquis) 50mg/kg or sulfadimethoxine (Albon) 50 mg/kg on the first day and 25 mg/kg for 10 days.
Baylisascaris procyonis
Raccoon Roundworm

- Nematode parasite commonly found in the small intestine of raccoons
- Prevalence rates can be as high as 85%, but can vary by region
- Generally asymptomatic in healthy individuals but can make concurrent diseases (such as parvo) worse. Heavy infestations may cause clinical signs in young animals
- Infected animals can shed extremely large amounts of ova. The ova are very hard and may remain infective in the environment for many years
- Zoonotic. There have been less than 20 cases of neural larval migrans reported in the U.S. All were males and were either children or mentally challenged individuals.
- Regularly deworm all raccoons in care
- Use common sense

Ponazuril for the Treatment of Coccidia

- **Dose:** 50 mg/kg PO once daily for 1-5 (may repeat in 1 week)
- **50 mg/ml solution = 10 ml paste + 20 ml water**
- Dose and concentration are both 50, so the calculations are easy!
- It has been used extensively in shelters

Source: Maddie’s Shelter Medicine Program
Cornell University College of Veterinary Medicine
Ponazuril for the Treatment of Coccidia

- Roadrunner Pharmacy (877) 518-4589
- Ponazuril Flavored Suspension
  (raccoons really like vanilla butternut flavoring 😊)
- One day treatment 227 mg/ml (dose .1 ml/lb)
- Two day treatment 90 mg/ml (dose .1 ml/lb)
Pain Management

- **NSAIDs**: Meloxicam (Metacam), Ketoprofen (Ketofen)
  - mild to moderate pain
  - make sure the animal is well hydrated
  - don’t use in neonates
- **Opioids**: Butorphanol (Torbugesic), Buprenorphine
  - moderate to acute pain
  - controlled substances
- Develop protocols with your veterinarian

Remember- Wild animals are adapted to mask pain
Shelter Medicine

- Animal shelters are similar to wildlife centers
- High-density, high-risk population
- High likelihood of exposure with possibility of devastating consequences
- We start vaccination protocol at 4 weeks of age
- Revaccinate every 2 weeks
- Decision is unique to each rehabber
  - number of animals admitted
  - current outbreaks in your area
Shelter Medicine

- Animal shelters are similar to rehabilitation facilities
- High-density, high-risk, high-stress population
- High likelihood of exposure with possibility of devastating consequences
- Must be considered when developing vaccine protocol
Vaccine Types: Inactivated (Killed) vs. Modified Live

- Inactivated (Killed) vaccines are less effective and take longer to induce an immune response than MLV.
- Current research shows that Duration of Immunity (DOI) after vaccination with MLV is 9 years or longer based on challenge and serological studies (CDV and CPV).
- MLV core vaccines are much less likely to cause adverse reactions than (inactivated) killed vaccines.
- MLV vaccines are more effective against waning maternal antibodies.

Source: Journal of Small Animal Practice © 2010 WSAVA
Vaccine Failure

- Maternal Antibody Interference
  - depends on titer of colostral antibody and the amount of antibody absorbed after birth
  - most common reason for vaccine failure
  - reason boosters are needed with last dose > 16 weeks in raccoons

- Vaccine is Poorly Immunogenic
  - manufacture (type of strain, passage history, production errors)
  - administration of vaccine to animal
  - incorrect storage, transportation, handling

- Animal is a Poor Responder to the Vaccine
  - animal fails to develop an antibody response
Vaccination of Sick & Injured Animals

- **EVERY** animal over 4 weeks of age should be vaccinated on intake, regardless of health status.
- Vaccines aren’t likely to be harmful, and the risk of exposure to deadly viruses is high in rehab facilities.
- It’s possible (but unlikely) that a sick animal may not elicit an immune response. But, it’s highly unlikely that the vaccine will adversely affect the animal. More importantly, there is a good chance the animal will gain protection.

Miller, L., Hurley, K. Infectious Disease Management in Animal Shelters. Wiley-Blackwell; 2009
Immunity Onset

- MLV vaccines provide rapid immunity in the absence of maternally derived antibodies (MDA)
- With MLV and recombinant vaccines for canine distemper, immunity develops within hours after vaccination (in the absence of MDA)
- 98%-99% of dogs vaccinated with MLV CPV-2 vaccine were protected when challenged 3 days post-vaccination (in the absence of MDA)
- Cats showed immunity to FPV when exposed almost immediately after MLV vaccination

Efficacy of Vaccination at 4 and 6 Weeks in the Control of Canine Parvovirus
De Cramer, K. et al., *Veterinary Microbiology*. 2011;149:126-132

- Monitored efficacy of high-titer CPV-2 vaccine (Merial) in puppies with high levels of MDA
- 80% of puppies vaccinated at 4 weeks of age seroconverted even in the presence of high levels of MDA
- Early vaccination may shorten the window of susceptibility and protect young animals in high-risk settings
Vaccine Protocol

- Essential to preventive care
- Goal: Vaccinate PRIOR to exposure.
- Vaccinate immediately upon intake if old enough
- The risk of adverse does not outweigh the benefit
- We start vaccination protocol at 4 weeks of age and continue until 16-20 weeks of age
- Revaccinate every 2-3 weeks based on risk
- Decision is unique to each rehabber
  - number of animals admitted
  - current outbreaks in your area
Vaccine Protocol Considerations

- Morbidity and Mortality of disease
- Prevalence rate of the disease
- Risk of individuals for exposure
- Efficacy of the vaccine
- Risks associated with vaccine
- Cost
Vaccine Protocol Rationale

- Prevention is definitely more time and cost efficient than treatment
- Wildlife rehabilitators have a responsibility to protect their intakes and the wild population from disease. Good vaccination protocol is the best insurance policy.
- Kind to the animals. Animals in rehab are exposed to lots of potential diseases that they may not have been exposed to in the wild and are more susceptible due to stressful conditions.
- Good vaccination protocols reduce disease and improve animal health. Healthy animals are able to be released sooner, with less potential to spread disease to the wild population once released.
- Kind to caregivers. Witnessing mass mortality that often accompanies an outbreak is disheartening and leads to burnout.

“An ounce of prevention is worth a pound of cure”

Henry de Bracton
Vaccine Protocol for Raccoon Rehabilitators

- Vaccine selected should be based on similarity of the hosts (FPV vaccine for RPV and CPV vaccine for mutated strains of CPV in raccoons, CDV)
- Use of these vaccines in wildlife is off-label
- Long history of use in wildlife with low risk of complications
- The few studies of parvovirus vaccination in wild animals suggest that the response is comparable to that in domestic animals
- Vaccination protocol should be based on the principles applied to the vaccination of domestic carnivores
- Rabies, Canine Distemper and Parvovirus are the most important infectious diseases in raccoons and should be included in all vaccination protocols

Relevance to Raccoon Rehabilitators

- Current research definitively shows that there are multiple strains of parvovirus that can cause clinical disease in raccoons
- RPV which is antigenically similar to FPV
- Recent research has identified a mutated variant of CPV that can infect raccoons
- Important considerations when developing vaccination protocols in the rehabilitation setting
Vaccines used by Kentucky Wildlife Center

- Chosen for safety and efficacy
- Protocol developed with our veterinarian of record
- Combination is needed to protect against the most common infectious diseases seen in raccoons (canine distemper, the multiple variants of parvovirus, and rabies)
- These are not the only vaccines. If you are using something that works.....continue.
Merial Recombitek C3 or C4/CV

- Combo vaccine that protects against Canine Parvovirus and canine distemper
- Canine distemper portion is canarypox vectored recombinant
- Canine parvovirus portion is Modified live high titer, low passage
- Recombitek C3 lacks Coronavirus but is cheaper
- Very Safe
- It can be used in young animals and in wildlife
Merial PureVax Feline 4

- Modified live virus vaccine
- Combo vaccine provides protections against Feline Panleukopenia
Canine Distemper (CDV)

- Incubation is typically 9-14 days, but may be as long as 6 weeks.
- Symptoms include fever, anorexia, depression, nasal and ocular discharge, diarrhea, ataxia, lack of fear, seizures. May not have all symptoms.
- Animal often recovers from respiratory symptoms only to develop neurological symptoms 2-3 weeks later.
- Consider differentials.
- Best to euthanize - incurable and highly contagious.
- Viral shedding can begin before clinical signs present and may continue for up to six weeks postinfection.
- VACCINATE all animals in your care immediately on intake! Vaccination is the most important method to prevent canine distemper.
We Do Not Use Distox-Plus (Killed Vaccine for MEV)

- MEV is closely related to FPV and RPV
- We use MLV vaccine for FPV and CPV
- Evidence of cross-species protection
- MLV are more effective against waning maternal antibodies
- Inactivated vaccines may interfere with antibody response of MLV vaccines
Summary of two studies that influenced our decision to eliminate MEV vaccine from our Vaccine Protocol for Raccoons

(1) Full protection in mink against mink enteritis virus with new generation canine parvovirus vaccines based on synthetic peptide or recombinant protein (Langeveld, et al. 1995)
  - Two recently developed vaccines—one based on synthetic peptide and one based on recombinant capsid protein—fully protected dogs against heavy challenge
  - Antigenic similarity between CPV, MEV, FPLV, and RPV suggests that the new vaccines could protect mink, cats, and raccoons against their respective host range variants
  - Both CPV vaccines were fully protective in mink against MEV

Conversely

(2) The Failure of an Inactivated Mink Enteritis Virus Vaccine in Four preparations to Provide Protection to Dogs Against Challenge with Canine Parvovirus2 (Carman, et al. 1982)
  - The inactivated MEV vaccines failed to provide protection in dogs against CPV-2 challenge
Serologic response to a canarypox-vectored canine distemper virus vaccine in the giant panda (Ailuropoa melanoleuca).

- Pandas at the Smithsonian National Zoo
- Vaccine proved to be safe
- Serum-neutralizing antibody titers interpreted as protective
Canine Distemper Vaccination is a Safe and Useful Preventive Procedure for Southern Sea Otters

- Southern Sea Otters at Marine Wildlife Veterinary Care and Research Center and Monterey Bay Aquarium
- Vaccine proved to be safe. No behavioral changes, clinical signs of pain, anaphylaxis or side effects
- Postvaccination antibody titers were considered protective against CDV

River Otter rescued by KWC
Canarypox Recombinant Vaccine for Canine Distemper

- Only uses a small portion of the genetic material of the pathogen, so it's impossible for the distemper virus to revert to virulence or be shed by the vaccinated animal
- Stimulates immunity without undergoing replication in mammals
- Safe and effective for use in wildlife
- The American Association of Zoo Veterinarians’ Distemper Vaccine subcommittee recommends the use of canarypox-vectored recombinant distemper vaccine (Merial) for extra-label use in exotic carnivore species that are susceptible to canine distemper.
Immunization of Puppies in the Presence of Maternally Derived Antibodies Against Canine Distemper Virus

- Study on 7-9 week old puppies with CDV serum-neutralizing antibody titers
- Seroconversion was demonstrated in all vaccinated puppies
- All unvaccinated (control) puppies showed signs of CDV 7-8 days post challenge
- All vaccinated puppies remained healthy when challenged with a highly virulent strain of CDV
- Vaccine immunized and protected puppies with maternally derived antibodies
Effect of vaccination with recombinant canine distemper virus vaccine immediately before exposure under shelter-like conditions.

Larson, L. Schultz R. Vet Ther. 2006;7(2) 113-8

- Puppies challenged 1 week after a single dose showed no clinical signs
- Puppies challenged 15 minutes to 4 hours after vaccination showed mild to moderate clinical signs that included diarrhea, lethargy, and anorexia, but all recovered. None developed neurologic symptoms.
- Puppies placed in a CDV-contaminated environment and allowed to comingle with CDV infected dogs hours after vaccination did not become sick
- All puppies were challenged using virulent CDV strain. All control group (unvaccinated) puppies died
- Provides protection against CDV in high-risk environments
Symptoms of Canine Distemper

- Loss of appetite
- Depression
- Fever
- Ocular and nasal discharge. Conjunctivitis
- Diarrhea
- Emaciation/Wasting
- Lack of fear of humans or other animals
- Convulsions-involuntary twitching, jerking, salivation
- Seizures
- Ataxia
- Circling, head tilt
- Paralysis

*May not have all of the symptoms, and the symptoms may not present concurrently!*

- Used Galaxy-D in the study (Modified Live Vaccine for Canine Distemper)
- No local or systematic adverse reactions in any of the raccoons
- Study used 47 wild caught baby raccoons divided into 6 groups. Of the 47 pups, 31 were seronegative & 16 were seropositive
- Some of the seronegative raccoons developed titers as early as 1 week PV and all vaccinated seronegative raccoons showed rises in titers between 2-4 weeks PV and remained high throughout the follow-up period
- Study suggests that after 5 months of age, a raccoon could benefit from a single dose of vaccine (if booster is unfeasible). Immunity from MLV Canine Distemper vaccine is long-lasting in the absence of maternal antibodies.
Maternal Antibodies

- All of the seropositive raccoon pups were from wild unvaccinated mothers.
- Maternal antibodies in all seropositive raccoons declined gradually to negligible levels by the time they had reached 20 weeks of age.
- Study showed that maternal antibodies will nullify or interfere with active immunization in raccoon pups until they reach 14-16 weeks of age.
- Vaccination failed to elicit a response before the 3rd vaccination (16 weeks of age) in 7 of the 8 raccoons with maternal antibodies.
- The immune status of raccoon pups is rarely, if ever, known.
- Vaccination protocol should extend to 16-18 weeks of age.

Challenge Study

- 20 raccoons were randomly selected for the challenge study.
- All 16 vaccinated raccoons survived the challenge with no clinical signs of disease.
- 3 of 4 unvaccinated, seronegative raccoons developed clinical signs significant enough to warrant euthanasia. The 4th raccoon had sub-clinical lesions on necropsy suggesting that it is likely that it would have developed neurological symptoms later.

Pathophysiology of Parvovirus

- Transmitted by oral exposure to feces of infected animals
- Attacks rapidly dividing cells beginning with the lymph nodes in the throat
- Followed by rapid viremia leading to systemic infection
- Virus attacks bone marrow causing a decrease in white blood cell count leading to a compromised immune system
- Primary site of viral replication is within the intestinal crypts resulting in enteritis and diarrhea
- The intestinal barrier is compromised resulting in translocation of bacteria into the bloodstream leading to septicemia
- Animals die of dehydration, septicemia, or endotoxemia
History of Parvovirus

- Feline Panleukopenia Virus (FPLV) is also known as Feline Parvovirus (FPV) or Feline Distemper
- FPV and Raccoon Parvovirus (RPV) isolates are indistinguishable. Mink Enteritis Virus (MEV) is a minor variant
- Canine parvovirus (CPV) probably derived by mutation from FPV or a closely related virus and first emerged in 1978 in dogs in Europe and quickly spread around the world
- Since 1978, CPV has gone through antigenic variations resulting in variant viruses and demonstrating the virus’s ability to rapidly evolve
- These variations have not influenced the efficacy of vaccination
- Raccoons were not susceptible to the original strains of CPV

Host Range Similarities

- Clinical presentation is almost identical in affected hosts
- Gross and microscopic lesions in all species are similar
- This is important to raccoon rehabilitators because we can extrapolate a lot of information from research of other animals

Anatomy of a Parvoviral Infection

- Villi: tiny finger-like protrusions that increase the surface area available for absorption of fluid and nutrients
- Villi possess Microvilli which further increase surface area
- Cells of the villi are short-lived and rapidly replaced by new cells
- Source of the new cells is the rapidly dividing area at the base of the villi known as the crypts of Lieberkühn
- Parvovirus attacks right at the crypt
- Without new cells from the crypt cells, the villi become blunted and unable to absorb nutrients
- Causes diarrhea and nausea leading to rapid dehydration
- Barrier that separates intestinal bacteria from the bloodstream breaks down
- Bacteria enters the bloodstream resulting in secondary infections and sepsis

Source: Parvovirus Information Center: VeterinaryPartner.com
Survival

- Depends on how quickly it’s diagnosed, virulence of the strain, size of virus exposure, age, health & immune status of the animal, and how aggressive the treatment protocol is.
- The goal is to keep the patient alive long enough for the immune system to recover and respond—antibodies are produced everyday that can bind and inactivate the virus.
- Accomplished through supportive and symptomatic care: fluid therapy, antibiotics, antiemetics, etc.
- Survivors have life-long immunity.
Prevention and Control

- Practice of shelter medicine protocol in rehabilitation facilities
- Vaccination to reduce the number of susceptible animals
- Quarantine
  - Long enough to encompass the incubation period
  - Long enough for development of antibodies post vaccination
- Minimize environmental contamination
Differential Causes of Diarrhea

- Overfeeding
- Introduction of formula or food too quickly
- Change in formula or food
- Medication
- Stress
- Poor hygiene or sanitation
- Spoiled formula or food
- Parasites
- Disease - bacterial or viral
- Toxins
Symptoms of Parvoviral Enteritis

- Diarrhea
- Vomiting
- Dehydration
- Fever
- Depression
- Anorexia
- Rapid weight loss
- Shock
- Hypoglycemia
- Acute death
Clinical Significance

- Animals may be found moribund (in dying state) or dead without noticeable symptoms
- Symptoms generally develop 4-5 days post-exposure
- Animals that resume eating within 3-4 days are likely to survive
- Most animals that are going to die succumb within 4-5 days
- Juveniles have higher mortality rates than adults
Treatment Protocol:
Aggressive Supportive Care

Medications and Protocols administered are used under the advisement of our veterinarian of record. Consult your veterinarian before using any medication.
Treatment of Parvoviral Enteritis

- **Standard (Essential) Care**
  - Fluid Therapy
  - Antibiotic Therapy
  - Management of Symptoms
  - Antiemetics, Pain Medication, Gastroprotectants
  - Antiparasitic Therapy

- **Adjunctive Therapies**
  - Supplements (Vitamins, Probiotics)
  - Tamiflu (oseltamivir)
  - Early Enteral Nutrition (EEN)
  - Plasma Transfer
Antibiotics

- Necessary to prevent secondary infections
- Do not use oral antibiotics because the GI tract is damaged
- Use a combination of 2 antibiotics to provide broad spectrum coverage against gram negative, gram positive and anaerobic bacteria that originate in the intestines
- (1) Beta Lactam antibiotic: ampicillin, cefazolin, penicillin and
- (2) Aminoglycoside: gentamicin, amikacin or Flouroquinolone: Enrofloxacin

Source: Treatment of Parvoviral Enteritis. Douglass K. Macintire, DVM, Auburn University College of Veterinary Medicine
Antibiotics Commonly Used in Parvoviral Treatment Protocol
Best to combine a Beta Lactam with either Aminoglycoside or Flouroquinolone

Beta Lactam Antibiotics

- Penicillins: broad spectrum activity against Gram-positive, Gram-negative, and anaerobic bacteria.
- Cephalosporins: Classified by generation. Spectrum of activity against Gram-negative bacteria increases with each generation, but decreases for Gram-positive bacteria. All can be used against anaerobes with varying results.

Aminoglycosides

- Synergistic activity when used with Beta Lactam Antibiotics
- Excellent against Gram-negative bacteria
- Use is contraindicated in dehydrated animals—can be nephrotoxic (make sure the animal is well hydrated)

Flouroquinolones

- Enrofloxacin (Baytril): May cause cartilage abnormalities if used in high doses for extended periods in young animals. Doses higher than 5 mg/kg can cause blindness in cats. No research on safety margin in raccoons. We have used 5 mg/kg in raccoons for short periods with no observed side effects.
- Broad spectrum against Gram-positive and Gram-negative, but poor activity against anaerobic bacteria
Antiemetic (Anti-nausea) Medications

- Cerenia (Maropitant)
- Reglan (Metoclopramide)

It may be helpful to administer antiemetic drugs (Reglan) 30 minutes before giving any oral medication (such as Tamiflu) if vomiting is present.
Pain Management

- NSAIDs: Meloxicam (Metacam), Ketoprofen (Ketofen)
  - mild to moderate pain
  - make sure the animal is well hydrated
- Opioids: Butorphanol (Torbogesic), Buprenorphine
  - moderate to acute pain
  - controlled substances
- Develop protocols with your veterinarian
- Wild animals are adapted to mask pain and discomfort
- Parvoviral enteritis can be very painful
Meloxicam (Metacam)

- New Manufacturer Warning: Repeated use of meloxicam in cats has been associated with acute renal failure and death
- Not sure of the pharmacological significance in the use of raccoons
- All NSAIDS should be used with caution in dehydrated animals
- Consider alternatives in raccoons with parvo
Gastroprotectants
Parvo can cause ulceration of the esophagus, stomach, and small intestine

Famotidine has longer duration of action and fewer drug interactions than other gastroprotectants such as Cimetidine
Antiparasitic Therapy

- Parasites can increase the severity of parvovirus
- Raccoons should be dewormed on intake and at regular intervals anyway due to the zoonotic potential of *Baylisascaris procyonis*
- Fecal examination is indicated to rule out or identify parasites
- Ponazuril to prevent opportunistic parasitic infections
Probiotics
Vitamin Supplements
Glutamine

- Conditionally essential amino acid during periods of stress or injury
- Preferential energy source for cells in the gut
- Helps protect gut mucosal barrier minimizing intestinal permeability
- Plasma Glutamine levels have been shown to decrease by 58% after injury or critical illness and may remain decreased for 3 weeks with increased mortality
- Glutamine supplementation has been shown to decrease incidence of sepsis, pneumonia, and bacteremia
- Dose 10 mg/kg/day

Zinc Supplementation

- Recommended in treating acute diarrhea by the WHO
- Affects immune function, intestinal structure, & epithelial recovery
- Used in conjunction with oral rehydration
- In numerous clinical trials, children had a significant faster recovery
- We use the recommended dosage in dogs 1.5-2.5 mg/kg zinc gluconate PO TID (Plumb’s Veterinary Drug Handbook)
- We mix zinc in Lixotinic or in oral electrolytes
- Use is anecdotal in treating parvoviral enteritis
Tamiflu (Oseltamivir)

- Human drug used off-label to treat parvoviral enteritis
- Use is controversial
- Decision must be made with your veterinarian
- Information provided is for reference purposes only and does not constitute a recommendation for or against its use
Pharmacology of Tamiflu in the Treatment of Parvovirus

- Originally developed to treat human influenza virus
- Tamiflu is a neuraminidase (NA) inhibitor
- CPV does not rely on NA for replication, so any beneficial effects would not be due to direct antiviral action
- Suspected beneficial mechanism of action in treating parvoviral enteritis is the inhibition of bacterial translocation through the gut epithelial cells

Use of oseltamivir in the treatment of canine parvoviral enteritis

- Dose: 2 mg/kg, PO, q 12h diluted in water 1:1
- Dogs that received oseltamivir had increased weight gain compared to dogs in the control group which showed significant weight loss
- Dogs that received oseltamivir did not demonstrate a decline in WBC. Dogs in the control group showed a significant decline in WBC. A higher WBC could be protective against the negative effects of sepsis
- Suspected mechanism of action is by blocking bacterial translocation through NA inhibition decreasing disease severity both locally in the gastrointestinal tract and systemically
- No major adverse side effects associated with the use of oseltamivir
- Recommends further investigation
Directions for Use

- Take (1) 75 mg capsule of Tamiflu and mix into 10 ml of juice, etc.
- Keep refrigerated. Shake Well
- Give .1 ml/lb every 12 hours for 10 treatments.
  (If you don’t get a response after the first dose, double the starting dose)
- Minimum dose should be .2 ml (even in small individuals)
- Do NOT exceed 12 hours between dosing. If you do, restart for another 10 treatments

Dr. Jack Broadhurst. A New Treatment For Parvoenteritis
Early Enteral Nutrition (EEN)

- Improved recovery time and decreased morbidity
- Early reintroduction of food does not seem to make symptoms worse even in severely affected animals
- Must weigh the risks and benefits in the presence of vomiting
- Anitemetics (such as Metoclopramide) may be beneficial if administered 30 minutes prior to feeding
- Feed small amounts, several times a day
- Nutrition is necessary for recovery
Effect of Early Enteral Nutrition on Intestinal Permeability, Intestinal Protein Loss, and Outcome in Dogs with Severe Parvoviral Enteritis

- Conventional treatment of parvoviral enteritis recommends “gut-rest”. Lack of controlled clinical studies to support this
- The most important stimulus for intestinal mucosal growth, repair, and integrity is the presence of nutrients in the intestine
- Documented benefits of EEN include:
  - reduced intestinal mucosal permeability
  - increased weight
  - reduced incidence of bacteremia, endotoxemia, and septicemia
  - reduced incidence of multiple organ failure
  - improved immune status
  - improved clinical symptoms: appetite, attitude, resolution of vomiting & diarrhea
  - reduced catabolism and malnutrition preventing additional intestinal inflammation
  - significantly higher survival rates
Transmission

- Sick animals can pass billions of infective virus per gram of feces
- Transmission is by the fecal-oral route
- High potential for contamination of environment
- Easily spread by fomites (inanimate objects) such as clothes, shoes, feeding utensils, litter, bedding, etc.
- Possibility of transmission by insects
Prevention and Disease Outbreak Management

- Isolate sick animals
- Quarantine exposed animals for at least 2 weeks
- Clean and disinfect the entire facility
- Wear protective clothing
- Launder clothing, bedding, towels, etc. in hot water with detergent and bleach and dry on high heat. Don’t overload!
- Make sure each room has its own cleaning tools
Outbreak Management

- Diagnosis and isolation of diseased animals
- Identification and management of exposed and at-risk animals
- Environmental decontamination
- Protection of newly admitted animals
- Documentation
- Communication

Make sure you use a parvocidal disinfectant and make sure the surface is clean (remove organic matter). The disinfectant should remain in contact for 10 minutes.
Proper Management to Reduce Risk of an Outbreak

- Quarantine new intakes
- Vaccinate on intake if old enough
- Reduce Stress - provide nest boxes for hiding and sleeping, provide enrichment, reduce noise, reduce exposure to strangers and domestic animals
- Segregate by conspecifics: by litter or age group
- Feed the best diet possible
- Keep cages and enclosures clean
- Deworm regularly
Cryptosporidium

- Coccidian parasites that are common in the small intestine
- Opportunistic pathogens, but can cause disease in young or immunocompromised animals
- Zoonotic
- Symptoms include diarrhea, anorexia, weight loss
- Usually self-limiting and will resolve
- More than 100 compounds have been tested for treatment but none have been able to consistently control clinical signs or completely eliminate infection
- Treatment is supportive: Fluid therapy, antimicrobial therapy (to prevent secondary infection), glutamine
- Anecdotal evidence suggests that azithromycin 10 mg/kg PO SID for a minimum of 10 days may be an effective treatment in some cases

Scorza, V. Update on the Diagnosis and Management of Cryptosporidium spp Infections in Dogs and Cats. 2010
Prevalence of Cryptosporidium in Raccoons

Indirect immunofluorescent detection of oocysts of Cryptosporidium parvum in the feces of naturally infected Raccoons (Procyon lotor) Snyder, D. J Parasitology. 1988 Dec; 74(6):1050-2

- Fecal samples from 100 raccoons
- 13% were positive for oocysts
- All positive samples were from juveniles

Canine Distemper in Wild Raccoons (Procyon lotor) at the Metropolitan Toronto Zoo.

- Cryptosporidia were found in 42% of the raccoons with canine distemper
Be Responsible

- Safety first
- Act professionally
- Keep good records
- Obey state and federal regulations
- Don’t let other people touch your animals
- Commit to continuing education
Euthanasia

- Hardest part of being a rehabber
- Develop protocol with your veterinarian
- Consider long-term quality of life, risk to other animals in your care, likelihood of recovery, amount of suffering involved, releasability
- Black and white decisions are always easier than the gray ones
- Try to view it as a kind alternative
- Trust your gut—experience helps. In hindsight, most animals that I thought I should euthanize but didn’t, ended up dying or being euthanized anyway.

Butorphanol & Xylazine are used to sedate prior to euthanasia
Burnout and Compassion Fatigue

No matter what you do or how hard you try.....some animals are not going to make it!

“We can do no great things, only small things with great love.”

Mother Teresa
Integrative Approach to Wildlife Rehabilitation

- Veterinarian
- Department of Fish and Wildlife
- Other Rehabbers - Networking is Crucial!
- Public - every encounter is an education opportunity
Be a better rehabber today than yesterday
High learning curve in wildlife rehabilitation
Forgive yourself when you make mistakes
Never stop learning
Keep an open mind
Parvovirus Overview

- Smaller than most viruses: name comes from the Latin parvus (small)
- Consists of a protein coat (capsid) and a single strand of DNA
- Virus capsids are the primary determinants of host range
- Not enveloped in fat like most viruses
- Extremely stable in the environment
- Resistant to most disinfectants
- Attack rapidly dividing cells: intestine, bone marrow, lymph nodes
- Highly contagious
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The End!