

## **Raccoon Rehabilitation: Infectious Disease Management**



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### **Presentation Overview**

- ❖ **Welcome! I appreciate that your time is valuable!**
- ❖ **Be prepared for information overload**
- ❖ **Intended to be a reference based on current research**
- ❖ **There are lots of ways to do things. This isn't the only way.**
- ❖ **All of the information is in the handouts and online**
- ❖ **Feel free to contact me**



**The photographs in this presentation are of animals rescued at our center!**



**DISCLAIMER:**

No part of this presentation is intended to provide veterinary advice or recommendations of any kind. Medications and protocols administered at the Kentucky Wildlife Center are used under the advisement of our Veterinarian of Record.



Consult your veterinarian before using any medication and do so only under his/her direct supervision.

### Disease Prevention and Control

- ❖ Practice of shelter medicine protocol in rehabilitation facilities
- ❖ Use good vaccine protocol to reduce the number of susceptible animals
- ❖ Quarantine new intakes
  - long enough to encompass the incubation period
  - long enough for development of antibodies post vaccination
- ❖ Have good cleaning and sanitation protocols
- ❖ Focus on wellness and minimization of stress
- ❖ Establish treatment plans and protocols prior to an outbreak
- ❖ Keep good records and documentation. Communicate with everyone involved.



### Shelter Medicine

- ❖ Animal shelters are similar to wildlife centers
- ❖ High-density, high-risk population
- ❖ High likelihood of exposure with possibility of devastating consequences
- ❖ Effects vaccine protocol decisions
  - number of animals admitted
  - current outbreaks in your area



### Stress Management

- ❖ Stress makes animals more susceptible to disease
- ❖ Being a wild animal in captivity is stressful
- ❖ 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
- ❖ 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



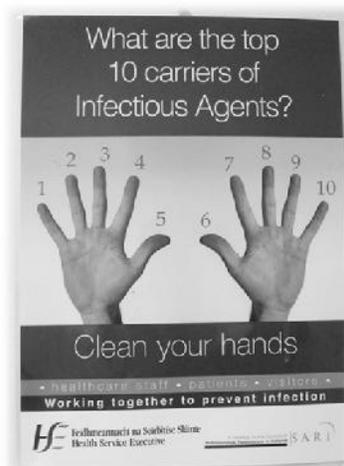
Miller, L.; Hurley, K. *Infectious Disease Management in Animal Shelters*. Wiley-Blackwell;2009.

### Cleaning and Disinfectant Protocol

- ❖ Remove all organic debris. The presence of organic material such as feces can inactivate most disinfectants
- ❖ Wash the area or item with detergent and water
- ❖ Rinse well and allow to dry. Some disinfectants can be inactivated by detergents
- ❖ Use a parvocidal disinfectant and allow proper contact time which is generally at least 10 minutes
- ❖ Rinse and allow to dry



### Proper Hygiene is Critical



### 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 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



Barker J, Parrish C. Infectious Diseases of Wild Mammals: Parvovirus Infections. Blackwell Publishing;2001: 131-146

### 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 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



### Handling of Vaccines

- ❖ Proper handling is crucial to efficacy
- ❖ Modified live vaccines are sensitive to temperature changes. Should remain chilled at all times (shipment, storage, prior to administration)
- ❖ Unstable after reconstitution. Should be kept chilled and given within 30 minutes of reconstitution



### 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.



Source: 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



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

### 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



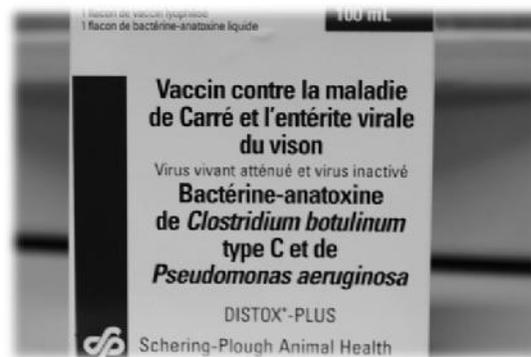
### Merial PureVax Feline 4

- ❖ Modified live virus vaccine
- ❖ Provides protection against Feline Panleukopenia



### 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

**Humoral Response and Protection from Experimental Challenge Following Vaccination of Raccoon Pups with a Modified-Live Canine Distemper Virus Vaccine**  
Pare, et al. Journal of Wildlife Diseases 1999;35(3):430-439

- ❖ 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 3<sup>rd</sup> 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



Pare, et al. Humoral Response and Protection from Experimental Challenge Following Vaccination of Raccoon Pups with a Modified-Live Canine Distemper Virus Vaccine. Journal of Wildlife Diseases 1999;35(3):430-439.

### 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 4<sup>th</sup> raccoon had sub-clinical lesions on necropsy suggesting that it is likely that it would have developed neurological symptoms later.



Pare, et al. Humoral Response and Protection from Experimental Challenge Following Vaccination of Raccoon Pups with a Modified-Live Canine Distemper Virus Vaccine . Journal of Wildlife Diseases 1999;35(3):430-439.

### Canarypox Recombinant Vaccine for Canine Distemper (rCDV)

- ❖ 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 .



**Serologic response to a canarypox-vectored canine distemper virus vaccine in the giant panda (*Ailuropoa melanoleuca*).**

Bronson, et al. *Journal of Zoo and Wildlife Medicine*. 2007;38(2):363-6.

- ❖ 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**

Jessup, et al. *Journal of Zoo and Wildlife Medicine*. 2009;40(4):705-710.

- ❖ 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*

**Immunization of Puppies in the Presence of Maternally Derived Antibodies Against Canine Distemper Virus**

Pardo, M. et al., *J. Comp. Path.* 2007, 137;72-5.

- ❖ 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



**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



**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 come in contact 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



**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.



### 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!

### Prevalence of Canine Distemper Antibodies in Wild Raccoons

❖ 23%

Mitchell, et al. Serologic Survey For Selected Infectious Disease Agents in Raccoons From Illinois. *Journal of Wildlife Diseases*. 1999;35: 347-355.

❖ 54%

Junge, et al. A Serologic Assessment of Exposure to Viral Pathogens and *Leptospira* in an Urban Raccoon (*Procyon Lotor*) Population Inhabiting a Large Zoological Park. *Journal of Zoo and Wildlife Medicine*. 2007;38(1):18-26.

❖ 33%

Bischof et al. Serologic Survey of Select Infectious Diseases in Coyotes and Raccoons in Nebraska. *Journal of Wildlife Diseases*. 2005;41(4):787-791.

❖ 16%

Raizman et al. Serologic Survey for Selected Infectious Diseases in Raccoon (*Procyon lotor*) in Indiana, USA. *Journal of Wildlife Diseases*. 2009;45(2):531-536.

## History of Parvovirus

- ❖ Feline Panleukopenia (FPV) and Raccoon Parvovirus (RPV) isolates are indistinguishable. Mink Enteritis Virus (MEV) is a minor variant
- ❖ Canine Parvovirus (CPV) is a variant of FPV
- ❖ CPV first emerged in the mid 1970s and spread worldwide in 1978
- ❖ Since 1978, CPV has gone through antigenic variations resulting in variant viruses and demonstrating the virus's ability to rapidly evolve
- ❖ It was originally believed raccoons were not susceptible to CPV
- ❖ Current research suggests that a host range variant of CPV has been circulating undetected in raccoons for at least 24 years



Allison, A. et al. The Role of Multiple Hosts in the Cross-Species Transmission and Emergence of a Pandemic Parvovirus. *J Virol.* 2012 Jan;86(2):865-72

## Role of multiple hosts in the cross-species transmission and emergence of a pandemic parvovirus

Allison AB, Harbison CE, Pagan I, Stucker KM, Kaelber JT, Brown JD, Ruder MG, Keel MK, Dubovi EJ, Holmes EC, Parrish CR. *J Virol.* 2012 Jan;86(2):865-72. Epub 2011 Nov 9

- ❖ Host range variant of Canine Parvovirus (CPV) has been circulating undetected in raccoons for at least 24 years
- ❖ Most of the raccoon viruses fell as evolutionary intermediates between CPV-2 and CPV-2a strains suggesting that raccoons assisted in the evolution of CPV-2a
- ❖ This study identified CPV isolates in raccoons from Virginia, Georgia, Tennessee, Florida, Kentucky, Wisconsin, New York and New Jersey



### 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



### 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





### 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



Barker I, Parrish C. Infectious Diseases of Wild Mammals: Parvovirus Infections. Blackwell Publishing;2001: 131-146

### 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, antimicrobials, antiemetics, etc.
- ❖ Survivors have life-long immunity



### Prevention and Disease Outbreak Management

- ❖ Isolate sick animals
- ❖ Practice No In- No Out Protocol During Outbreak. Stop admitting. Do not transfer. Do not release. Refer Calls. Try not to move animals if possible.
- ❖ Practice Shelter Medicine Vaccination Protocols (every 2 weeks for animals under 4 months of age due to possible MDA interference).
- ❖ 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 it's own cleaning tools



### 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



### 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



Barker I, Parrish C. Infectious Diseases of Wild Mammals: Parvovirus Infections. Blackwell Publishing;2001: 131-146

### Treatment of Parvoviral Enteritis

- ❖ Essential Care
  - Fluid Therapy
  - Antimicrobial Therapy
  - Management of Symptoms  
(antiemetics , pain medication, gastroprotectants)
- ❖ Adjunctive Therapies
  - Supplements (Vitamins, Probiotics)
  - Early Enteral Nutrition (EEN)
  - Plasma Transfer



## Fluid Therapy: Overview

### Determine How Much Fluid to Give

- ❖ Calculate Deficit- Assume 10% in most cases (Replace over 24 hours in mammals)
- ❖ Determine Maintenance\*:
  - 70-90 ml/kg/day (Mitchell)
  - 60 ml/kg/day (IWRC)
  - Neonates require 2 to 3 times the fluid of adults
  - 120-180 ml /kg /day or 1ml/25grams of body weight q 4-6h prn
- ❖ 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.

\*Maintenance is not linear. Traditional estimates tend to underestimate for small animals and overestimate for large animals. More accurate calculation:

$$132 \times (\text{weight in kg}^{.75})$$

## Hypovolemic Shock

- ❖ Decreased volume of circulating fluid (plasma) in the blood
- ❖ Results in decreased perfusion and decreased oxygen delivery to tissues
- ❖ Most common type of shock in young animals. Parvovirus patients are at especially high risk
- ❖ Can result from diarrhea, vomiting, or decreased intake, all of which are common symptoms of parvovirus infection
- ❖ Dehydration can rapidly progress to hypovolemic shock
- ❖ Must treat with aggressive fluid therapy



### 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 1ml/25grams of body weight q 4-6h prn
- ❖ Warm the fluids to body temperature
- ❖ 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 (>2.5%) SQ. Will make fluid hypertonic (draw fluid into the subcutaneous space)
- ❖ Wide Safety Margin



### Intravenous Injection (IV)

- ❖ Necessary for animals in severe shock
- ❖ Can be difficult to place in very young animals



### **Intraperitoneal (IP)**

- ❖ Injection into the peritoneum (body cavity)
- ❖ Warmed fluids given IP can be effective for treating hypothermia and increasing core body temperature
- ❖ Accuracy can be an issue. Always aspirate before injecting



### **Intraosseous Administration (IO)**

- ❖ Any fluid or drug that can be administered IV can be administered IO
- ❖ Good when IV access is difficult or impossible but the animal has poor perfusion or shock and requires aggressive treatment



### 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*

### Use of Stomach Tube



#### 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 animal 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 regularly and adjust for growth

*\*Don't try without proper training!*

### 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!



### Management of Septicemia

- ❖ Antibiotics-early treatment is crucial
- ❖ Supportive Care
  - Fluid Therapy
  - Glucose Replacement
  - Warmth
  - Oxygen Therapy
  - Nutrition



Antibiotics can take 12-24 hours to show any effect, so it's supportive care that can make the difference whether or not the animal survives

## Antimicrobial Therapy

- ❖ 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.

and

### 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)

or

### 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

## 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 young animals

### 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 (6<sup>th</sup> Ed.) and Saunders Handbook of Veterinary Drugs (3<sup>rd</sup> Ed.) state that it's stable for up to 12 months after reconstituted if refrigerated.



## 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/mg
  - 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 short-term (5-7 days) on many raccoons with no adverse side effects.



### Pharmacokinetics of enrofloxacin in neonatal kittens

Seguin, M. et al, *Am J Vet Res.* 2004;65(3):350-356.

- ❖ 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



### Hypothermia

- ❖ Heart rate drops
- ❖ GI motility decreases
- ❖ Body temperature below 94° F results in GI ileus
- ❖ Decreased ability for lymphocytes to transform and combat infection
- ❖ To prevent organ failure (especially of the heart and kidneys), always warm hypothermic animals slowly (no more than 2° F per hour)
- ❖ Never feed a hypothermic animal



### Hypoglycemia

- ❖ Symptoms include incoordination, muscle tremors, lethargy, depression, seizures, coma, death (similar to other disease processes....hard to know)
- ❖ Treatment is recommended for all animals in shock and all parvovirus patients
- ❖ 1-2 ml/kg of 10% dextrose orally every 15 minutes until normal
- ❖ Once stabilized, give L-carnitine 50 mg/kg PO BID. Increases the liver's ability to convert fat into glucose. L-carnitine can be used as a preventive in all high risk patients.



Fortney, William. *Managing and Treating Sick Neonates*. CVC in Kansas City Proceedings, 2008

### Oxygen Therapy

- ❖ Oxygen supplementation is easy to administer, readily available, and relatively safe
- ❖ In compromised animals, even a small increase in oxygen can be beneficial. **When in doubt, provide oxygen supplementation!**
- ❖ Improvement in clinical signs include decreased respiratory rate and effort, decreased heart rate, improved mucous membrane color, and reduced anxiety
- ❖ Indications include hypoxia, decreased oxygen delivery, and increased oxygen demand from conditions such as: pneumonia, shock, anemia, hyperthermia, fever, sepsis, seizures, hemorrhage, head trauma.



Bersenas A. Oxygen Therapy. 79<sup>th</sup> Western Veterinary Conference. 2007:V291.

## 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 (Torbugesic), 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



### Vitamin Supplements



### Probiotics



## 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



Saker, K. Nutrition and Immune Function. Vet Clin Small Animal 2006;36: 1199-1224.

## Zinc Supplementation

- ❖ Recommended in treating acute diarrhea by the World Health Organization
- ❖ Affects immune function, intestinal structure, and epithelial recovery
- ❖ Used in conjunction with oral rehydration
- ❖ In numerous clinical trials, children had a significant faster recovery
- ❖ 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



### 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
- ❖ Antiemetics (such as Metoclopramide) may be beneficial if administered 30 minutes prior to feeding
- ❖ Feed small amounts, several times a day
- ❖ The most important stimulus for intestinal mucosal growth, repair, and integrity is the presence of nutrients in the gut. (Mohr, 2003)



### Effect of Early Enteral Nutrition on Intestinal Permeability, Intestinal Protein Loss, and Outcome in Dogs with Severe Parvoviral Enteritis.

Mohr AJ, et al. *Journal of Veterinary Internal Medicine*. 2003;17(6):791-798.

- ❖ 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 &
  - reduced catabolism and malnutrition preventing additional intestinal inflammation
  - significantly higher survival rates

### 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.



### Tamiflu (Oseltamivir)

- ❖ Use is controversial
- ❖ Information provided is for reference purposes only and does not constitute a recommendation for or against its use
- ❖ Originally developed to treat human influenza virus
- ❖ Neuraminidase (NA) inhibitor
- ❖ Parvovirus 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



### Use of oseltamivir in the treatment of canine parvoviral enteritis

Savigny MR, Macintire DK. *Journal of Veterinary Emergency and Critical Care*. 2010;20(1):132-142.

- ❖ 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

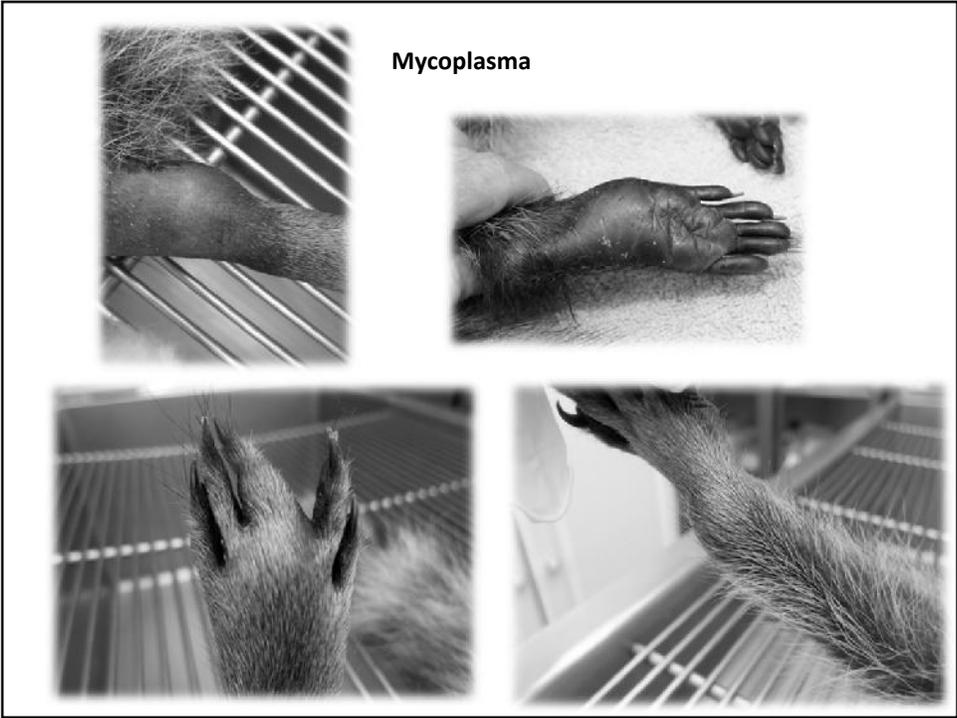
## Mycoplasma

- ❖ First described by Dr. Ian Barker veterinary pathologist and virologist at University of Guelph in the 1980s
- ❖ Mycoplasmas are the smallest free-living microorganisms.
- ❖ Contagious. Requires close contact. Does not survive long outside the host.
- ❖ Very fragile. Hard to culture. Diagnosis is often based on clinical signs.
- ❖ Clinical symptoms include painful swelling of the joints, reluctance to move, abscesses of toes, hands, feet, carpal joints (pus does not have a distinct odor)
- ❖ Has an affinity for the epiphyses (growth plates of long bones, highly vascular). Concern over long-term damage.
- ❖ Susceptible to Baytril (enrofloxacin), tetracycline, doxycycline, tylosin, erythromycin, azithromycin
- ❖ Requires long-term treatment., minimum of four weeks, possibly longer

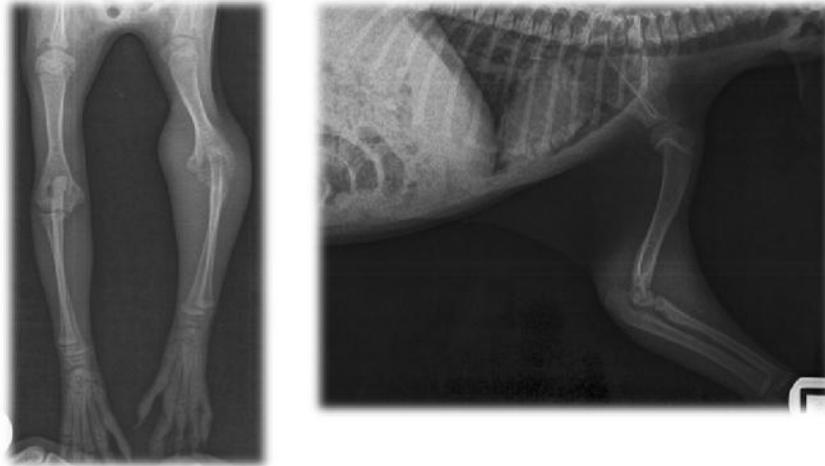
## KWC Treatment Protocol: Mycoplasma

- ❖ Azithromycin suspension 10 mg/kg POSID for a minimum of four weeks. Severe clinical cases are treated for 8 weeks
- ❖ Azithromycin has less adverse effects than erythromycin, more palatable than doxycycline (studies show azithromycin may be more effective than doxycycline in other species)
- ❖ Followed by probiotic daily 8-12 hours after antibiotic
- ❖ Any macrolide has potential for GI side effects. However, it was well tolerated with no adverse side effects in up to 8 weeks of treatment
- ❖ Clinical and exposed animals are quarantined for minimum of 8 weeks
- ❖ Most animals in our outbreak recovered with no recurrence and deemed releasable





### Mycoplasma



### *Klebsiella pneumoniae*

- ❖ Anaerobic gram-negative bacterium
- ❖ Opportunistic pathogen. Common in intestine but rarely causes disease.
- ❖ Can cause septicemia and death in immunocompromised animals
- ❖ In the absence of infectious disease (good vaccination protocol), common cause of mortality in weaned, pre-release animals
- ❖ Symptoms include lethargy, depression, anorexia, abscesses, fever. Some animals are found moribund (in dying state) or dead.
- ❖ We treat with Baytril (enrofloxacin) 5 mg/kg IM, SQ SID
- ❖ Also susceptible to Amikacin, Cefovecin, Gentamicin, Trimethoprim/Sulfamethoxazole



### ***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 Cryptosporidia**

#### **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.**

Cranfield, M. et al. Can Vet J 1984; 25: 63-66.

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



### 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***



### Special Thanks To:

- ❖ **Dr. Scott Tritsch**  
Central Kentucky Vet Center  
Kentucky Wildlife Center-Veterinarian of Record
- ❖ **Dr. Colin Parrish and Dr. Andrew Allison**  
Baker Institute for Animal Health  
College of Veterinary Medicine  
Cornell University
- ❖ **Dr. Justin Brown**  
Southeastern Cooperative Wildlife Disease Study  
College of Veterinary Medicine  
University of Georgia

**The End!**



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