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Captive Red Panda Medicine

Joost Philippa and Ed Ramsay

Wildlife Conservation Society, Field Veterinary Program,
Viet Nam and Indonesia, Bogor, Indonesia; Department of Small
Animal Clinical Sciences, College of Veterinary Medicine,
University of Tennessee, Knoxville, Tennessee; Knoxville Zoological Gardens,
Knoxville, Tennessee USA

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Red pandas are popular exhibit animals and their veterinary care has attracted a fair amount of study and attention. While the information we have on the health of red pandas relies on observations of a relatively small captive population, there have been regular reviews of the pathology of captive red pandas [1–5] (see Chapter 16). Additionally, reports on the management of clinical diseases have slowly increased.

As with many captive animals, red panda health problems can be categorized into two age-based groups: paediatric and adult. This chapter addresses the broad health concerns of those two groups, followed by sections on parasites, infectious diseases, and vaccination, and concludes with suggestions for chemical restraint and anaesthesia of red pandas.

PAEDIATRIC HEALTH ISSUES

It has been said that if a red panda does not die within the first year, it is likely to survive and become aged. Certainly, neonates experience a large number of severe health problems and still have a disappointingly high mortality rate. Different authors define the neonatal period, and therefore what constitutes a neonatal death, differently, so comparisons among reviews are difficult. At the Knoxville Zoo, 25% of the 91 red pandas born alive at the Knoxville Zoo died within the first 30 days of life. This neonatal mortality rate is very close to the average 26% seen in the red panda studbook population since 1994 (see Chapter 16), but is lower than the N. American average of 42%.

Many neonatal red pandas suffer from emaciation, inanition, or trauma, or a combination of these [1,2,4,6,] (see Chapter 16). Both emaciation and inanition are assumed to be a result of maternal neglect or insufficient lactation. Poor or insufficient lactation may have several causes. Subclinical mastitis has been described as a cause of decreased milk production in one dam [7]. Malnourished dams may have insufficient milk and stressed mothers also are at risk for poor milk production. Better observation of maternal behaviour and routine weighing of mother-reared infants may help identify cubs at risk before severe problems arise. Supplemental (tube) feeding of infants left with mothers has decreased the number of infants dying of emaciation and inanition, and is performed at many US zoos for cubs with poor weight gains. This allows a cub to stay with its mother and siblings for social contact while continuing to grow at a normal rate. Supplemental feeding is not routinely performed in Europe. Despite aggressive surveillance and interventions, however, 'poor mothering' continues to be a problem for captive red pandas.

The most common traumatic injuries of neonates are superficial bite wounds to the neck, which occur when mothers carry the young. Moist dermatitis at the thoracic inlet, presumably secondary to the mother salivating and/or biting the infant while carrying it, is also common. Severe bite wounds and cannibalism also occur with some frequency. Stress is assumed to be one of the most common factors leading to infant trauma, cannibalism, and decreased nursing [2]. There also seems to be a relationship between temperature and the time the mother spends with infants. If nest boxes are not adequately insulated the dam may not nurse her young adequately in hot weather.

Septicaemia and pneumonia are major causes of captive neonatal deaths. A variety of bacterial pathogens have been cultured from these cases, suggesting that the infections are opportunistic or secondary to other problems. Poor nutrition due to poor mothering may predispose an infant to developing sepsis or pneumonia, particularly if the newborn does not receive sufficient colostrum. Many neonatal and juvenile pneumonias have been caused by, or are suspected to be caused by, aspiration of milk or food. Neonatal red pandas are very aggressive feeders. Better hand-rearing techniques, including careful monitoring of bottle and feeding, and oro-gastric tube feeding of young neonates, has decreased the number of pneumonia cases seen in the Knoxville Zoo collection.

Congenital defects appear to be rare in captive red pandas. An intersex individual [8], a cub with ancephaly, hypoplastic limbs, and truncus arteriosus [1], and cubs with hydrocephalus [9] have been reported. Avascular necrosis of the femoral heads, resembling Legg-Calve-Perthes disease, was diagnosed in one 17-month-old red panda [10].

Juvenile red pandas, those between one month and one year of age, have fewer problems but cases of pneumonia and septicaemia still occur. Weaning can be very stressful for both mother-reared and hand-reared cubs and is a time of potential health problems. Weights of weanlings should be carefully monitored to assure that an individual does not lose too much weight and become compromised. Heat stress has also been identified as a cause of death in neonates and juveniles [4], and the cubbing dens should be air conditioned in hot and humid climates.

Dermatophytosis

One of the most important infectious diseases of captive neonate and juvenile red pandas is dermatophytosis (also called dermatomycosis, or ringworm). A review of 14 cases at Knoxville Zoo revealed that all but one affected animal were less than 4 months old [11] and the senior author is aware of only one clinical case in a red panda over one year of age. *Microsporium gypseum* has been cultured from all cases of red panda dermatophytosis, regardless of institution.

Clinical signs of mild dermatophytosis include diffuse crusting, hair loss, and thickened or flaky skin. Severe lesions may ulcerate or become purulent (Figure 15.1) and covered with a thick crust – a lesion termed a kerion. The latter appears most commonly on the tail and at the thoracic inlet. This disease does not appear to be pruritic in red pandas.

Red pandas with mild lesions of the appendages or face typically respond to clipping the affected area, cleaning the lesion with tamed iodine soaps, and topical therapy. A variety of topical antifungal agents commonly used in domestic carnivores have been used in red pandas with positive results.

Severe lesions may result in severe scarring or, in the case of the tail, the need for amputation if early and aggressive treatment is not instigated. Any suspected dermatophytosis lesions on the tail or at the thoracic inlet should be immediately clipped, cleaned with tamed iodine soap, and treated with topical agents. Animals with these lesions should also be put on systemic antifungal therapy. Itraconazole (5–10 mg/kg p.o. q.12–24 h) has been used for as long as 3 months in a neonatal red panda without adverse effects.

ADULT HEALTH ISSUES

It has been observed that red pandas have “few species specific [disease] peculiarities” [3]. Adult red pandas at Knoxville Zoo (all fulgens subspecies) have lived an average of 8.7 years (range = 1.5–18.1 years; n = 24) although we expect animals to live and breed into their teens. The captive longevity record for the oldest red panda was for a male at the Rotterdam Zoo who died at 21 years, 7 months of age. Red pandas older than 12 years should be considered geriatric. One review indicated that adult deaths occur most frequently in the winter [8]. The reasons for this may be increased weather-related caloric needs, or stresses of being kept indoors for greater periods of time.

Reviews of red panda pathology suggested that stomatitis, periodontitis, gastric ulcers, fatty livers, and enteritis are the most common health problems of the adult captive population [1,2]. The aetiology of gastric ulcers observed in adult animals has not been



FIGURE 15.1 A severe, ulcerative dermatophytosis of the tail of a red panda cub. *Microsporium gypseum* was cultured from this lesion (Photo courtesy of Houston Dale, University of Tennessee, Knoxville, TN, USA).

identified. Inappropriate diet and stress are hypothesized to play roles. It seems that gastrointestinal problems have decreased in number in recent years (see Chapter 16).

Studies of red panda nutritional requirements have resulted in improvements in captive red panda feeding husbandry. The decreased feeding of gruel diets that had large amounts of soluble carbohydrates and fats, and the increased provision of bamboo, regardless of geographical location, has improved the overall nutrition of captive red pandas. The prevalence of dental disease, especially periodontitis, seen in middle-aged pandas also seems related to the feeding of gruels or porridge diets. Periodontitis has become much less common in red pandas in the last decade (see Chapter 16).

A phenomenon of red and giant pandas is a periodic lethargy and passing of mucoid stools [12]. In red pandas, these bouts usually last only one day and can occur at various intervals. Individual red pandas may have mucoid stools as often as once every two weeks but most animals have episodes at monthly or greater intervals. Repeated efforts to identify an aetiology for this syndrome have been made in red pandas and giant pandas, but the cause remains unclear [12].

Other important diseases of adult red pandas include heart disease and osteoarthritis. Congestive heart failure, hypertrophic cardiomyopathy [13], and left ventricular myohypertrophy have been reported in red pandas [2], and cardiomyopathies were



FIGURE 15.2 A captive adult red panda with hair loss. The cause for this condition remains undetermined (Photo courtesy of the Mill Mountain Zoo, Roanoke, VA, USA).

reported in over 9% of adult red pandas in a recent pathology review (see Chapter 16). Mild to moderate ankylosing spondylitis and degenerative arthritis of joints have also been seen [1]. Palliative treatment of the latter typically includes oral chondroitin sulphate/glucosamine compounds and non-steroidal antiinflammatory drugs.

Hyperostotic bone disease is an unusual pathology observed in several collections. The Knoxville Zoo and one other collection each had a single animal affected [14], while another zoo had three middle-aged red pandas with lesions [15]. Primary lesions in one of the single animals [14] and the group of three involved the elbow joints and legs. Pathology in these animals resembled hypertrophic pulmonary osteopathy seen in dogs. The other single animal had multiple exostoses of the ribs, especially dorsally and near the spine. Several of the affected animals had either concomitant renal disease or eventually succumbed to renal disease. While kidney disease can cause changes in calcium metabolism, the lesions in the red pandas did not resemble renal secondary hyperparathyroidism. An aetiology for these conditions has not been identified but hypervitaminosis A was postulated as a contributing factor in the group of three cases [15].

Hair loss over the caudal body and tail, or general patchy hair coats, is common in captive red pandas (Figure 15.2). Endocrinopathies can cause symmetrical hair loss and hypothyroidism has been reported occasionally in red pandas [1]. Thyroid function is

TABLE 15.1 Baseline haematological values for healthy male and female red pandas of all age groups

Haematological parameter	No. of samples	Range	Mean \pm SEM
Haematocrit (%)	219	29.0–54.0	41.5 \pm 0.34
Haemoglobin (g/dl)	214	9.6–17.4	13.5 \pm 0.10
RBC ($\times 10^6/\mu\text{l}$)	213	4.8–12.8	8.8 \pm 0.07
MCV (fl)	210	39.0–55.0	47.0 \pm 0.17
MCH (pg)	210	13.0–18.0	15.0 \pm 0.05
MCHC (%)	210	23.0–52.0	33.0 \pm 0.16
Total protein (g/dl)	226	5.8–9.5	7.2 \pm 0.05
WBC ($\times 10^3/\mu\text{l}$)	218	3.1–14.2	6.75 \pm 0.15
Neutrophils ($\times 10^3/\mu\text{l}$)	216	0.8–11.6	3.1 \pm 0.13
Relative (%)	216	13.0–87.0	44.3 \pm 1.10
Bands ($\times 10^3/\mu\text{l}$)	216	0.0–0.2	0.003 \pm 0.001
Relative (%)	216	0.0–2.0	0.03 \pm 0.015
Lymphocytes ($\times 10^3/\mu\text{l}$)	216	0.6–11.1	3.3 \pm 0.10
Relative (%)	216	9.0–82.0	49.6 \pm 1.10
Monocytes (/μl)	216	0.0–792.0	203.0 \pm 10.7
Relative (%)	216	0.0–13.0	3.2 \pm 0.16
Eosinophils (/μl)	216	0.0–675.0	78.0 \pm 6.19
Relative (%)	235	0.0–8.0	1.3 \pm 0.10
Basophils (/μl)	235	0.0–700.0	97.0 \pm 8.49
Relative (%)	235	0.0–11.0	1.5 \pm 0.12

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usually normal in most animals showing hair loss or patchy coats, and the cause of these cases remains unclear. Many have observed a seasonal hair loss, especially at the base of the tail, occurring when the temperature rises in spring and loss of winter coats begins. A perineal dermatitis has also been observed in yearling female red pandas during the spring. Increased amounts of oestrogen have been proposed as a cause of this syndrome (D. Rost, personal communication).

Chronic renal disease occurs with some frequency in older red pandas. Affected individuals have poor body condition and rough hair coats. Clinical pathology shows azotaemia and urinalyses indicate proteinuria. Animals may survive for years with renal compromise and treatment is usually restricted to limiting the amount of concentrates in the diet and allowing feeding of bamboo *ad lib*. Pathology shows end-stage kidneys with both glomerular and tubular lesions. No aetiology has been identified and this is presumed to be a degenerative disease of old age. Oxalate nephrosis has also been described in a red

TABLE 15.2 Baseline serum chemistry values for healthy male and female red pandas of all age groups

Serum chemistry	No. of samples	Range	Mean \pm SEM
Albumin (g/dl)	103	2.0–6.6	4.23 \pm 0.07
Alkaline phosphatase (IU/L)	108	1.0–102.0	26.6 \pm 2.1
BUN (mg/dl)	109	12.0–55.0	25.0 \pm 0.63
Calcium (mg/dl)	109	6.9–11.8	9.2 \pm 0.09
Cholesterol (mg/dl)	54	169.0–472.0	281.0 \pm 11.4
Creatinine (mg/dl)	108	0.4–1.8	1.1 \pm 0.02
Fibrinogen (mg/dl)	210	100.0–500.0	200.0 \pm 6.2
Glucose (mg/dl)	108	51.0–281.0	115.9 \pm 3.34
Phosphorus (mg/dl)	109	2.0–8.9	4.9 \pm 0.13
Potassium (mEq/l)	85	4.1–6.9	5.1 \pm 0.05
AST (SGOT) (IU/L)	109	34.0–183.0	61.5 \pm 2.07
ALT (SGPT) (IU/L)	108	9.0–165.0	54.1 \pm 2.99
Sodium (mEq/L)	86	126.0–150.0	138.2 \pm 0.48
Total bilirubin (mg/dl)	109	0.1–1.0	0.24 \pm 0.01

[17] Table reprinted with permission of the editor of the *Journal of Zoo and Wildlife Medicine*.

panda [1]. This animal had no known exposure to agents or plants that traditionally cause oxalate toxicity but had been treated with an aminoglycoside antibiotic which is known to cause nephrosis in other species.

Neoplasms are relatively rare in red pandas. A granulosa cell (ovarian) tumour [16], an anaplastic hepatic neoplasm which resembled a histiocytic sarcoma, a hepatocarcinoma (see Chapter 16), a squamous cell carcinoma (see Chapter 16), a thyroid carcinoma (see Chapter 16), and a “lung sarcoma” [2] have been reported. Three haemopoietic system neoplasias have been described, which seems a large number considering the few neoplasias observed in red pandas, overall. Lymphoma [17], a myelogenous leukaemia [18], and a chronic lymphoid leukaemia have each been reported [1].

The clinical pathology of red pandas is generally similar to that of domestic carnivores (Tables 15.1 and 15.2) [17]. A few biochemical parameters differ from domestic dogs. Normal red panda serum sodium concentrations may range slightly lower than those seen in dogs and normal serum urea nitrogen concentrations typically range a bit greater [17].

PARASITES

Several zoos have reported dirofilariasis in red pandas, either definitively or presumably, caused by the canine heartworm *Dirofilaria immitis* [19]. Red pandas in regions of the USA where this parasite is endemic are routinely given prophylactic anti-microfilaria treatment.

Ivermectin, at a dosage of 0.05 mg/kg p.o. q.30 days, therapy is started at 6 months of age and continued throughout the animal's life. In regions with severe winters, treatment may be suspended during the winter months. In the southeastern USA, heartworm prophylaxis is given year-round. In most European countries where red pandas are kept in zoos, *Dirofilaria immitis* is not endemic, although dirofilariasis has been reported in a red panda in southern France (D. White, personal communication).

An occult canine heartworm serological test can be used to identify infection and many zoos do this test as part of routine health exams. Successful treatment of heartworm infection has not been described, to the authors' knowledge. Treatment of dirofilariasis with melarsomine, at the approved canine dosage, should *not* be attempted as at least one red panda has died following melarsomine therapy. If a red panda is not symptomatic but occult heartworm test-positive, long-term, prophylactic dosage ivermectin therapy may be a more prudent therapeutic approach.

Few enteric parasites have been identified in red pandas. The fox whipworm, *Trichurus vulpis*, has been found at necropsy in a Knoxville Zoo juvenile. Trematodes in the small intestine and nematodes in the lung have been described in an animal imported from India [16]. Dermatitis caused by *Filaria taxidaea*, has been described in red pandas in California [20]. It was presumed the panda acquired this parasite from local, wild mustelids, the known hosts for this nematode. Lungworms have been associated with pathology in red pandas and were identified in one survey as a major cause of morbidity in northwestern European countries (D. White, personal communication). Clinical signs of lungworm infections may be subtle and the infection may only be recognized at necropsy. Infections have been variously attributed to *Troglostrongylus* spp., *Angiostrongylus* spp., *Crenosoma* spp., and *Metastrongyloides* spp. [21].

Fleas, presumably domestic carnivores' fleas, are also occasionally found on captive red pandas in North America and Europe. This usually occurs during warm weather, when other animals in the collection are infested. Red panda infestations may be quite severe and deaths due to anaemia secondary to flea infestations have been observed, particularly in mother-raised cubs still in the nest boxes. The pattern of hair loss on the lower back and tail resemble those seen in flea-hypersensitivity in domestic animals, although fleas or flea faeces are not always found. It is recommended that keepers caring for red pandas are not in contact with animals which are commonly infected with fleas. Where this is unavoidable, measures should be taken to avoid contamination of red panda nest boxes. It is also advisable to change red panda bedding regularly. When birth is imminent, treatment of the nest boxes with some anti-flea preparation helps to avoid infant infestations. A number of anti-flea treatments have been used and, generally, those products which are safe and approved for use in domestic cats are effective. Domestic feline dosage regimens for imidacloprid, selamectin, nitenpyram, and fipronil have all been used in red pandas at the Knoxville Zoo without adverse side effects. Caution must be used as at least one zoo killed a panda cub by putting it in a flea bath.

BACTERIAL AND FUNGAL DISEASES

There are early reports of tuberculosis in red pandas [3,16,22]. At least one of these animals was a recent importation from Asia [16]. One was identified as having bovine

tuberculosis but it was unclear if cultures were performed [3]. These cases occurred when tuberculosis in zoos and importations of red pandas from the wild were much more common.

There are two reports of Tyzzer's disease, caused by *Clostridium piliformis*, in captive red pandas [23,24]. Both these animals had short clinical presentations with clinical pathology suggestive of hepatic disease. Both infected animals died and had necrotic lesions of the liver and other organs. One of these red pandas had a concurrent *Trypanosoma cruzi* infection, which appeared to have been the primary cause of death [23].

Other bacterial infectious conditions which have been reported in red pandas include haemorrhagic septicaemia, due to *Pasteurella multocida* [25], salmonellosis, and septicaemia and pneumonia caused by *Klebsiella pneumoniae* [3]. Pneumonia in red pandas has also been attributed to *Pneumocystis carinii*, now considered a fungus [26]. Leptospirosis was diagnosed in a red panda which presented with an acute haemolytic crisis [27].

VIRAL DISEASES AND VACCINATION

Canine Distemper Virus

Although little published information exists on the prevalence and significance of infectious diseases on the red panda, the most significant infectious agent appears to be canine distemper virus (CDV). The red panda has high susceptibility to natural infection with CDV [22,28–31] and serological surveys have shown natural exposure to this virus [32,33]. Interestingly, since the 1970s, a similar number of outbreaks have been attributed to prophylactic vaccination with modified-live virus (MLV) vaccines [34,35].

Canine distemper virus is a morbillivirus (closely related to measles virus), which has a world-wide distribution, and a very broad host range: species in all families in the order Carnivora (Canidae, Mustelidae, Procyonidae, Hyaenidae, Ursidae, Viverridae, and Felidae) are susceptible to CDV infection, and it is one of the most significant diseases in many of these species.

Clinical signs of distemper vary depending on species, viral strain, environmental conditions, and the age and immune status of the host. In red pandas, the clinical presentation includes depression, anorexia, (oculo-) nasal discharge (serous to mucopurulent), tachypnoea, central nervous signs (convulsions/seizures, paresis/paralysis, incoordination, myoclonus), hyper- or hypothermia [28]. Affected individuals may also have skin lesions similar to those present in seals with morbillivirus-associated dermatitis [36].

The most significant lesions – catarrhal pneumonia and acute necrotizing inflammation with inclusion bodies in several visceral organs and lymph nodes – are very similar in both naturally infected animals and those with vaccine-induced distemper [28,34]. On gross pathology, the lesions have included consolidation and oedema of the lungs with frothy fluid and mucopurulent exudate in trachea and bronchi, splenomegaly, and congestion of the gastrointestinal tract and liver [35]. Histopathological lesions include catarrhal bronchopneumonia, degeneration of epithelial cells of the bronchi, and passive congestion and fatty degeneration of the liver. Eosinophilic cytoplasmic and intranuclear inclusion bodies have been detected in epithelial cells of bronchi, bronchial glands, bronchioles, alveoli, oesophagus, stomach, small intestine, bile duct, pancreatic duct,

urinary bladder, epididymis, and uterus [28]. Lesions of the central nervous system (CNS) (cerebral lesions with intranuclear inclusion bodies in nerve cells) have only been found in naturally infected animals [31].

A problem faced in the prophylaxis against distemper in exotic carnivores is the variation between and within species in their reaction to MLV vaccines, with possible lethal consequences. MLV vaccines have been designed to be minimally virulent, while retaining maximal immunogenicity in their domestic counterparts. When used in highly sensitive species or delivered by another route, the residual virulence may cause disease [37]. There are two widely used attenuated CDV vaccine strains: the Onderstepoort strain, attenuated in avian, and now more commonly co-cultivated in Vero cells; and the Rockport strain, attenuated in canine cells. Although the avian-attenuated CDV vaccines are generally safer when used in mammals, neither is safe for use in non-domestic species, as both types have caused fatal disease in a variety of species [38]. Published vaccine-induced distemper in red pandas has been caused by the Rockport strain [34,35]. While MLV vaccines are not recommended for use in non-domestic species, currently MLV canine distemper vaccines continue to be used in Chinese facilities, despite questionable efficacy and safety [32], and reports indicate that vaccine-induced disease and mortality is common [33].

A safer alternative is an inactivated vaccine, which cannot cause an infection, but the efficacy of inactivated vaccines has long been questioned [39,40]. An experimental, adjuvanted, inactivated, CDV vaccine has been used in red pandas and giant pandas in several zoos, and appeared to be safe, but produced low titres with inadequate durability, requiring booster vaccinations two to three times annually [41]. This vaccine is no longer produced. At present, there are no inactivated CDV vaccines commercially available, due to their low immunogenicity – and therefore low demand – in domestic dogs, and the market for non-domestic animals being too small [42]. In Germany, a small amount of inactivated vaccine is produced for use in zoos (Geyer and Matern, personal communication, 2002).

An experimental subunit vaccine incorporating the CDV fusion (F) and haemagglutinin (H) surface proteins into immunostimulating complexes (ISCOM) has been developed, and proven to be capable of producing humoral and cellular immunity in dogs and seals [43,44]. Vaccination protected seals against a lethal challenge infection, although the immunity achieved was not sterile: upper respiratory tract infection occurred in vaccinated, experimentally infected animals [44]. The CDV-ISCOM vaccine has since been shown to be safe in several species in European zoos (W. Schaftenaar personal communication) [45,46]. Red pandas reacted to vaccination with higher antibody titres when the total antigen concentration of the CDV-ISCOM was increased from 5 µg/ml to 10 µg/ml, suggesting a positive dose-response [45], although the concentration should not exceed 10 µg/ml to minimize local reactions to the vaccine. Three vaccinations with a 10 µg/ml vaccine are recommended with a 3-week interval, e.g. young animals at 8, 11, and 14 weeks of age, with one annual revaccination [45].

Recently, a monovalent canarypox-vectored vaccine (Purevax™, Merial, Duluth, USA) expressing the H and F surface antigens of CDV has become commercially available in the USA. Its safety and immunogenicity (in terms of antibody response) in giant pandas [47], European mink (*Mustela lutreola*) [46], and black-footed ferrets (*Mustela nigripes*) × Siberian

polecat (*Mustela eversmanni*) hybrids has been documented [48,49] and vaccination of Siberian polecats has protected them from experimental challenge infection [50]. This vaccine is registered for use in domestic ferrets in the USA, but its off-label use in susceptible species in zoos is recommended by the American Association for Zoo Veterinarians [51] and the Veterinary Specialist Group of the IUCN [52]. However, in the European Union, its use is not permitted as it uses a non-registered genetically modified organism [45,53]. Three vaccinations are recommended with 3–4-week interval, e.g. young animals at 8, 11, and 14; or 8, 12, and 16 weeks of age, with annual revaccinations.

The main advantage of Avipox-vectored vaccines like Purevax™ is their safety. The Avipox-vector is an avian virus with a host-restriction to avian species. Virus replication in mammalian cells is blocked at a late stage, importantly leaving the synthesis of viral proteins unimpaired [54]. Protective cellular and humoral immunity is induced in the absence of the complete virus, therefore eliminating the possibility of infection with CDV. Due to the host restriction, there is no dissemination of the vector virus within the vaccinated mammal and therefore no excretion of the vector virus to non-vaccinated contacts or the environment [55].

Rabies Virus

Rabies virus belongs to the genus *Lyssavirus* in the family *Rhabdovirus* and causes an acute fatal encephalomyelitis in an extremely broad host range of mammals. Red pandas have been diagnosed with rabies virus infection, and rabies virus has been isolated from red pandas [56]. Clinical signs are not definitive or species-specific beyond acute behavioural alterations. Wildlife may lose their apparent wariness and caution around humans and domestic species, alter their activity cycles, seek solitude, or become more gregarious. Head tilt, head pressing or butting, “stargazing”, and altered phonation may be observed [57].

Vaccination recommendations depend on location, risk of exposure, or possible outbreak [51,58,59]: in areas where the incidence of rabies in local wildlife (skunks, raccoons, foxes) is high, vaccination is recommended. In certain countries, local veterinary authorities should be contacted regarding the legal aspects of extra-label vaccination, as some areas may have restrictions [53]. Red pandas can be vaccinated with a commercially available, inactivated rabies virus vaccine approved for ferrets (Imrab™, Merial, Inc.) [60], at 3–4 months of age, with a booster-vaccination after one year, then triannually [61]. The use of modified-live rabies virus vaccines is contraindicated, due to documented vaccine-induced rabies infections in several species.

Parvovirus

Recently, a novel parvovirus has been isolated from red pandas in China [62]. No clinical signs were seen in the infected red pandas, nor is the pathophysiology of the disease and epidemiology of the infection known for this species. There is also a necropsy report of a red panda having feline panleukopaenia in the 1960s, but this infection has not been reported in recent times (see Chapter 16). Vaccination is not recommended in the USA and Europe at this time, as infection with this novel strain occurred without any clinical signs.

Other Viruses

Published reports of other virus infections in red pandas are rare, with low prevalences. A Reo-like virus was seen in one red panda with enteritis [1]. During an outbreak of West Nile Virus (WNV) disease in a zoo, one red panda had serum antibodies to WNV [63]. Serological surveys have shown low prevalence and low or “suspect” antibody titres to canine adenovirus, canine coronavirus, and influenza A virus in red pandas in China [33]. The detection of virus-specific antibodies indicates possible susceptibility to these viruses, although no clinical disease was observed in these pandas.

IMMOBILIZATION

Several drugs and drug combinations have been used to chemically restrain red pandas for short procedures or for the induction of general anaesthesia. Neonates are usually “masked down,” by placing a face mask over their face, and having them breathe 5% isoflurane in oxygen. Alternatively, an induction chamber (an opaque plastic box with a tight top) can be used in all age groups. Anaesthesia is induced by flowing 5% isoflurane in oxygen into the box. The animal is removed from the induction chamber when recumbent, and a face mask or endotracheal tube can be applied to maintain anaesthesia. With either induction method, when the animal is recumbent the percentage of isoflurane is reduced to 1.5–3% isoflurane in oxygen for maintenance of anaesthesia. The chamber inductions are relatively slow but recoveries are rapid and animals are quickly able to be returned to their exhibit. Other new inhalant agents, such as sevoflurane, should work comparatively well.

A combination of ketamine HCl, a dissociative anaesthetic (6.6 mg/kg i.m.), and medetomidine, an alpha-2 adrenergic agonist (0.080 mg/kg i.m.), works well in red pandas for short, non-noxious procedures, such as blood collection, teeth cleaning, or radiology [64]. Typically, the animal is transferred from a crate to a small squeeze cage and the drugs are given intramuscularly, via hand injection. The effects of the medetomidine can be reversed with atipamezole (0.4 mg/kg i.m.), and recoveries are usually rapid and smooth.

Other drug combinations that have been used in juvenile and adult red pandas are: ketamine (6–9 mg/kg i.m.) and xylazine (0.2–0.4 mg/kg i.m.); ketamine (10–15 mg/kg i.m.) with xylazine i.m. and followed by i.v. diazepam (0.2–0.5 mg/kg); and tiletamine/zolazepam (4.5–6.0 mg/kg i.m.) [17]. They are sufficient for non-invasive procedures (i.e., obtaining blood samples or cultures) of 10 to 25 minutes' duration. The effects of xylazine can be reversed with yohimbine (0.125 mg/kg s.c., i.m., or i.v.).

If surgery or long procedures are to be performed, an endotracheal tube should be placed and the animal maintained on an inhalant agent. Isoflurane in oxygen is the most commonly used agent at this time. Anaesthetic monitoring is similar to that used in anaesthetized domestic carnivores and red pandas do not have novel problems during anaesthesia.

CONCLUDING COMMENTS

Captive red pandas' health has benefited greatly from improved husbandry and nutrition. More routine veterinary care and better preventive medicine programmes, such

as vaccination and parasitology surveillance, have also contributed to red pandas living longer. One can anticipate that more attention will be paid in the future to the treatment of geriatric diseases of red pandas. Poor captive reproduction and infant survival are challenges we still face with this species and must do more to address. Better techniques to evaluate reproductive soundness are something that veterinarians and reproductive physiologists need to develop for this species. Continued efforts are also needed, by managers and health care staff, to improve mothering of cubs, with the aim of reducing the number of cubs that need to be hand-reared.

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