Standards, Guidelines and Protocol on Disease Diagnosis and Cure of Wild Animals in Indian Zoos

D Swarup
A Das
M Saini
Pankaj Kumar
A K Sharma
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INDIAN VETERINARY RESEARCH INSTITUTE
IZATNAGAR- 243 122 (U.P.)
and
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Disclaimer: Every possible effort has been made in the collection and presentation of facts regarding doses and administration of vaccines and drugs. However, knowledge and best practices in the field of wild animal medicine are constantly changing. The changes are likely to occur in therapeutic and other veterinary practices. Zoo veterinarians are advised to check the most current information provided on procedures, drug development and availability of new drug molecules, the method and duration of administration, and contraindications etc and use their practical experience and knowledge of the patient to make diagnosis, determine course of the best treatment for each individual zoo animal. The authors, or CZA or IVRI assume no liability for any injury or untoward effects

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केन्द्रीय चिड़ियाघर प्राधिकरण
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(STATUTORY BODY UNDER THE MINISTRY OF ENVIRONMENT & FOREST, GOVT. OF INDIA)

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FOREWORD

The species richness of mammals, birds, reptiles and amphibians contained within the country is recognized to be of global significance. However, the loss and fragmentation of habitat, poaching, construction of dams and other anthropogenic activities have severely strained the faunal ecosystem. Consequently, many species face the threat of extinction. Modern zoos contribute significantly to *ex-situ* conservation of endangered species. There can be little doubt, however, that captive animal healthcare is one of the crucial components of modern zoo management to attain the larger goal of successful conservation breeding. Despite the tremendous progresses made in the field of veterinary sciences and medicine, zoo medicine and wildlife healthcare still rely on symptomatic treatment and empirical individual experience of zoo veterinarians and managers. There is lack of information on prophylactic and preventive measures including deworming and immunization for containment of infectious diseases. Zoo vets often face problem in management of emergency health problems that they have never handled before. Under this perspective, CZA decided to request Indian Veterinary Research Institute to develop *Standards, Guidelines and Protocol on Diseases Diagnosis and Cure of Wild Animals in Indian Zoos*.

Indian Veterinary Research Institute, the premier institute of veterinary sciences has made significant contribution in different aspects of wild animal management including surveillance and management of wildlife diseases, development of diagnostics for important diseases, studies on feeding behaviour and nutrition of wildlife and use of biotechnology in developing wildlife forensics and molecular medicine and I was confident that the project awarded to the institute will be completed successfully. The team of scientists including Dr M Saini and Dr A Das under the leadership of Dr D Swarup has done a commendable job to accomplish the goal envisaged by the CZA. I am happy to learn that the present publication provides guidelines and protocol on important aspects of wildlife healthcare including diagnosis, vaccination and deworming schedules, tranquilization of captive animals, management of routine and emergency clinical cases, and disinfection of enclosures and surroundings and management of zoonoses. I hope the publication will be useful and would serve as a ready reference for the zoo veterinarians and will contribute to better health management of captive animals in Indian Zoos.

New Delhi
August 25, 2009

(B. R. Sharma)

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Principal Investigator

PREFACE

The management and veterinary care of wild animals vary greatly according to their phylogenic needs, habitat ecology, nutritional and physiological status and the prevailing and emerging disease conditions in a particular region. Animals in zoos differ from their wild counterparts in several ways. The captive animals may be under some kind of physical and physiological stress and are dependent on man for food, water, mating, veterinary care, etc. Although, wild animals in their habitats are prone to various diseases, there are fewer deaths from diseases among free-ranging wild population than captive animals, except at times when population number becomes excessive. Despite modern scientific developments in veterinary practices, the overall scenario of planned wildlife health management either for free-ranging or captive animals is gloomy in India. In this backdrop, the initiatives taken by Central Zoo Authority to award a project to Indian Veterinary Research Institute to develop *Standards, Guidelines and Protocol on Disease Diagnosis and Cure of Wild Animals for Indian Zoos* is praiseworthy.

The idea to develop the project was conceptualized during a meeting with the CZA Member Secretary Dr BR Sharma and the concept note was discussed and finalized at a meeting of experts subsequently held at CZA. It may not be out of place to mention that Dr Sharma has introduced many innovative ideas while sharing the responsibilities as Member Secretary, CZA and initiation of this particular programme underlines his scientific vision for betterment of health, management and care of animals in Indian zoos. I along with my project team express deep sense of gratitude to him for keen interest and constant support to complete this programme. I also thank the other members and the officials of CZA, especially Dr Naim Akhtar and Dr BK Gupta Scientific Officers and Shri PS Negi, Finance Officer of CZA for their valuable support.

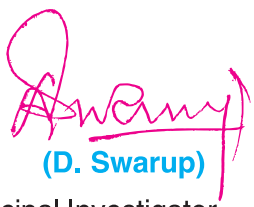
The administrative support and technical guidance received from the former and present Directors, and the Joint Directors (Research) of IVRI, are highly acknowledged. During the entire duration of the project, I have been most fortunate to have knowledge based scientific support from the Joint Director (CADRAD), Heads of Divisions of Pathology, Bacteriology and Mycology, Parasitology, Virology, and Animal Nutrition and I wish to express my gratitude to them. Timely help received from Finance and Administrative wings of IVRI, and the staffs of the Centre for Wildlife Conservation, Management and Diseases Surveillance and the Division of Medicine, IVRI is highly appreciated. I especially acknowledge the assistance received from Shri Raj Kumar, Shri Jitendra Khare, Shri Rajendra Kumar and Shri Mohan Chandra Bhatt.

The project team is equally grateful to the wildlife experts from all over the country notably including Dr LN Acharjyo, Dr PK Malik, Dr AB Srivastava, Dr JL Singh, Dr Parag Nigam and Dr Vibhu Prakash for providing their technical inputs as and when needed to prepare this document. I fully appreciate all help and cooperation extended by the Directors and Veterinary officers of the zoos visited by our team to collect necessary information. The work could not have been completed without their kind help and cooperation. In this context, I am personally grateful to Shri DN Singh, Director, National Zoological Park New Delhi, Dr AK Pattnaik, Ex-Director, Nandan Kanan Zoological Park, Bhubaneshwar, Dr Utkarsh Shukla, Dy Director Lucknow Zoo, Dr LK Sanwal, VO Nainital Zoo, Dr Atul Gupta, VO Van Vihar Bhopal, Dr KK Jadhav, VO SOS Bear Rescue Center and other senior veterinary officers for their help and experience based crucial inputs .

I wish to place on record my appreciation for the excellent spirit of work by the entire project team who have offered every technical help in completing the project. Senior Research Fellows of the centre Mr Swatantra Prakash Gupta, Dr Puneet Kumar, Dr Mahipal Choubey, Mr. Rahish Ahmed, Mr Vineet Kumar, Dr D Das, Dr YD Bhutia, and Dr Somesh Singh deserve due acknowledgement and appreciation for their dedication and sincere efforts. A special acknowledgment is being rendered to Dr. Mohini Saini, Dr A Das, Dr Pankaj Kumar and Sri Kundan Singh for meticulous editorial and publication job and Shri Satish Chandra Joshi for typing and setting the manuscript.

Since the wild animal medicine is yet in infancy and there are fewer drugs exclusively licensed for use in wild animals; difference of opinion about the veterinary practices and drug uses and doses may likely to occur. But with the imitative of CZA an attempt has been made to provide standards and guidelines on various aspects of veterinary care of zoo animals in India. Efforts have been made to maintain accuracy of drugs, their doses and preferred routes. However, veterinarians are advised to use their own experience and follow manufacturers' instructions while using a drug in wild animals.

I hope that the document would be useful to the zoo vets, zoo managers and other stakeholders.



(D. Swarup)
Principal Investigator

Izatnagar

August 25, 2009

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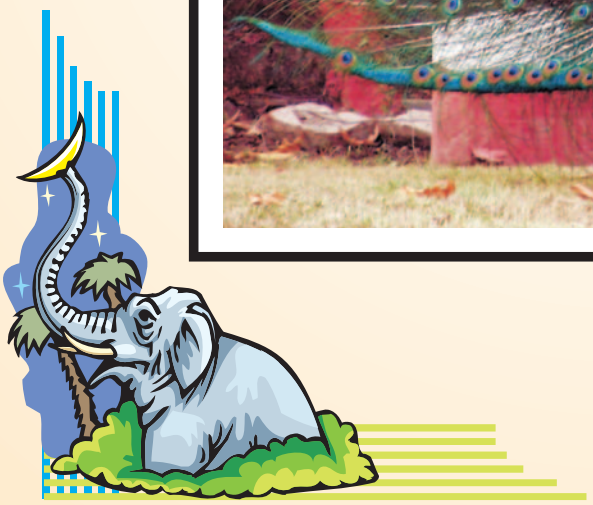
CHAPTERS 01

INTRODUCTION



1. Introduction

India is one of the bio-diversity rich countries of the world, standing 6th in the list of 12 mega-biodiversity countries. It is estimated that our country possesses over 81,000 known species of animals, representing over 6.3% of total global animal species. Unfortunately, many of these species are threatened and facing fear of extinction. Once lost, we lose them forever. The zoo movement, which received an impetus in India after independence with the constitution of Indian Board of Wildlife, was an important attempt for conservation of wildlife. The zoological parks and gardens were established in the country with the basic objective to act as repositories of species threatened with extinction, to evolve and carry out breeding programme for the propagation of rare and endangered species, to act as a place for dissemination of biological information to educate visitors and to conduct research on behaviour, reproduction, nutrition and diseases of wild animals. In this perspective, wild animal health management plays a vital role. However, there are certain issues related to wild animal health management that need immediate attention, especially in zoo animal medicine in India.

The zoological medicine is comparatively a new branch of veterinary medicine dealing with the health problems of all species of animals not classified as companion animals or livestock. It is a more complex subject than medicine of domestic animals. Until recently, the zoo animal medicine was primarily concerned with specific disease conditions and emphasis was on cure, not prevention. Moreover, no formal training was given to veterinarians due to lack of formal courses on wildlife diseases management in veterinary curriculum. Self taught veterinarians or those attending specialized Post-Graduate programme were looking after the health of wild animals in zoos. However, during the past 3 decades, interest in the clinico-medical problems of wild animals has changed significantly due to change in attitude of professionals. Now, courses dealing with wildlife management and health care are being offered in veterinary colleges under VCI regulations and more and more veterinarians are becoming increasingly interested in management of disease problems of both free and captive wild animals. There are, however, still certain issues which need attention for effective zoo animal health management in Indian context. There is lack of information on standard therapeutic and prophylactic medication and their schedule including deworming and immunoprophylaxis programmes that could be adopted uniformly in different zoos across the country. Also zoo veterinarians often face difficulty in getting a reference to make appropriate decision in emergency health problems.

1.1 Zoo animal health challenges in India

Important diseases of wild animals in India have been recognized and listed in the literature. It is observed that the diseases of captive wild animals are diverse in nature. In natural conditions, diseases act as a density depend population regulation measure, and as such cause no threat. However, ever-increasing human population and consequently more contacts between man and wild animals have resulted in emergence of newer diseases posing endemic/ epidemic problems to both man and animal populations. The situation is even worse in zoo animals, primarily because they are completely dependent upon man and secondarily due to introduction of exotic species within the same compound with indigenous species. Further, the stress of captivity may contribute to predisposition of diseases in zoo animals.

Most of the animals in captivity are vaccinated against important viral diseases like FMD, feline panleucopoenia, feline rhinotrachitis and calicivirus. Nevertheless, outbreaks of FMD in ungulates and diseases like Feline panleucopoenia in carnivores do occur and cause mortality in captive animals. Occurrence of such diseases could be attributed to development of numerous new strains of the viruses and also due to faulty or improper vaccination procedure. Research on viral disease of man and domestic animals are taking care of different aspects of disease management, including development of vaccines using recombinant DNA technology. However, such investigations involving wild animals are scarce.

There are number of bacterial diseases which affect zoo animals in India. Regular vaccination schedule is followed in some zoos as prophylactic measure against anthrax, haemorrhagic septicaemia (HS), Black quarter (BQ) and tetanus. Most ungulates and primates are highly susceptible to tuberculosis. Vaccination against tuberculosis is not very successful and prophylactic treatment involves long duration and high cost. Further, with the emergence of multi-drug resistant tuberculosis (MDR-TB), more and more captive animals are under its threat. Similarly, some other bacterial zoonoses such as leptospirosis, listeriosis, brucellosis, anthrax, etc. have also been recognized in captive wild animals.

Parasitic infestations like those caused by tapeworms, round worms and flat worms are known since long. Their control apparently appears easy. However, emergence of drug resistance against anthelmintic hinders the effective control programme. Many zoos in the country have faced outbreaks of haemoprotozoan diseases, particularly in large felids and other carnivores. Since some of the commonly used anti-protozoan drugs are not effective in cats, management of haemoprotozoan conditions in felids is a difficult task. Dermatitis and mange still continue to be major diseases in wildlife, particularly in large cats.

Clinical problems like acidosis, peritonitis, pericarditis and dystocia are common in ungulates. The treatment of many of these diseases is known. However, an early and accurate diagnosis is prerequisite for success in treatment. In most of the zoos veterinarians are not well equipped for early and accurate diagnosis. Thus, treatment schedule they follow is often empirical and symptomatic. Such a method of treatment may result in complications in prognosis and even mortality in critically endangered species. In recent years, numbers of neoplastic conditions have been identified in Indian zoo animals and in most cases the management has not been much fruitful.

1.2 Central Zoo Authority (CZA) initiative to address the challenges

Different aspects of Zoo animal health mangement are covered under Rule-10 of the Recognitions of Zoo Rules-2009 and are available at Annexure-4 of the handbook- Zoos in India: Legislation, Guidelines and Strategies published by CZA (2009). However, considering the above facts, CZA decided to develop basic standards and protocols on wild animal health and awarded a project to **Indian Veterinary Research Institute (IVRI)** in 2006 to develop standards, guidelines and protocol on disease diagnosis and cure of wild animals in order to enable the Indian zoos to adopt the same plan. The project was mandated to provide information in form of a handbook dealing with the following topics.

1. Diagnosis of diseases affecting the wild animals in zoos
2. Carrying out vaccination of different species of wild animals against diseases, their type, dosages and frequency
3. Prevention of zoonotic diseases affecting wild animals and the personnel handling the wild animals
4. Isolation/quarantine of sick and newly arrived animals
5. Chemical and manual restraining of wild animals in captivity including prescribing of drugs and dosage for chemical restraining
6. Checking the parasitic load in wild animals (ecto- and endo- parasites) and prescribe the methods for containment of the prevalence of the parasites including deworming schedules and the type of drug and dosages
7. Disinfection of animal enclosures and the zoo surroundings including the type of disinfectant to be used for these purposes
8. Overall sanitation of the zoo campus including hygienic disposal of all wastes generated in the zoo and the dead carcass of the animals
9. Providing first aid and emergency treatment to critically ill and injured animals

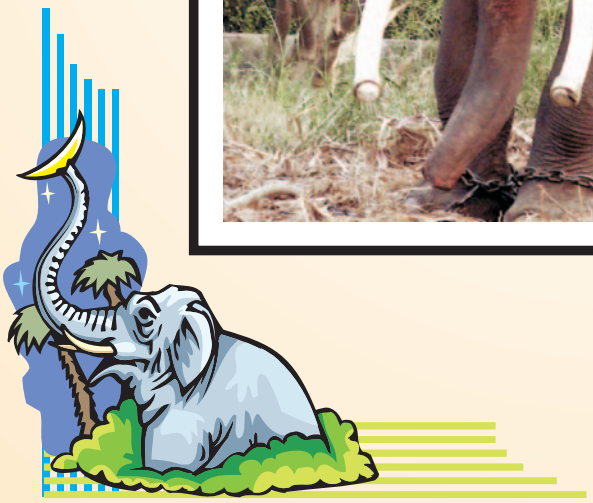
1.3 Technical programme of the project completed by IVRI

As envisaged under MOU, signed between CZA and IVRI, following technical activities were completed to achieve the objectives of the project.

- The team of IVRI researchers visited different zoos representing 5 different regions in the country ***(Annexure-I)*** and collected information from the clinical and pathological records pertaining to selected species over the last ten years on general management, disease prevalence, therapeutic and prophylactic measures and other health related aspects.
- Information on occurrence of important disease conditions reported in zoo animals in India, during the last 25 years (1984-2009) were collected from published reports and records of laboratory findings at IVRI.
- The national and international practices adopted for captive animal health management were also collected from published literature and via internet.
- Interactive meeting was organised involving senior zoo veterinarians, wildlife veterinary experts and other stakeholders to discuss the findings of research team and for developing standards and guidelines.

CHAPTERS 02

PROJECT REPORT: ZOO ANIMAL HEALTH MANAGEMENT IN INDIA



2. Project Report: Zoo Animal Health Management in India

Data pertaining to general management, hygiene, vaccination schedule, feeding schedule, treatment and post-mortem records of 36 species were collected from 35 zoos over the last ten years. The specieswise morbidity and mortality data and prophylactic and sanitary measures undertaken in these zoos are described below.

2.1 Diseases and mortality pattern

2.1.1 Reptiles

Crocodile: Total 14 clinical cases comprising of enteritis (3), wound (3), anorexia (2), haemorrhage (2), hepatitis (2), contusion (1) and pneumonia (1) were recorded in crocodile. No mortality was recorded in crocodiles in the visited zoos.

Tortoise: A total of 4 clinical cases were recorded in visited zoos. These included nasal discharge (3) and dermatitis (1). Total four mortalities were recorded; due to predator bite (2) and pneumonia (1). Cause of mortality in one case could not be ascertained due to putrification of carcass.

Python: Only three clinical cases were recorded for python at Ranchi and Udaipur zoos.These included single case each for wound, anorexia and internal injury.

2.1.2 Aves

Peafowl *(Pavo cristatus):* A total of 215 clinical cases were recorded during the last 10 year period at different zoos and included mainly wound and injury, debility, anorexia, diarrhoea, respiratory distress, limping, fracture, vitamin deficiency, conjunctivitis, parasitic infection, pyrexia, inflammation, enteritis, stress etc. (Fig 2.1). There were 173 mortalities in peafowl among the visited zoos during the period of investigation. The major causes of death were shock, senility, respiratory tract infection, fracture, injury, septicaemia, liver and lung abscesses, non-specific infections, hypovolaemic shock, electrocution, asphyxiation, traumatic pericarditis, etc (Fig 2.2).

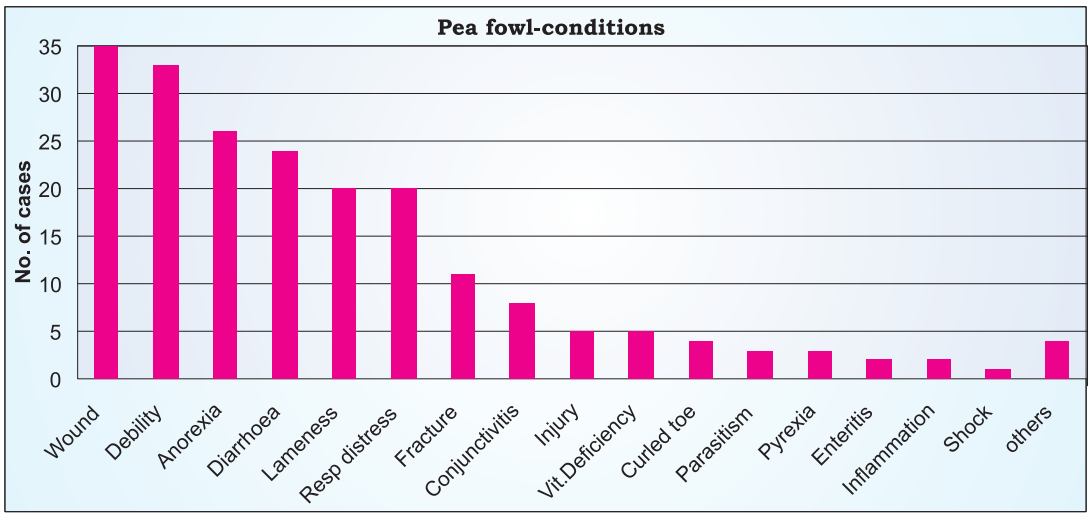


Fig 2.1: Distribution of common clinical conditions in pea fowl

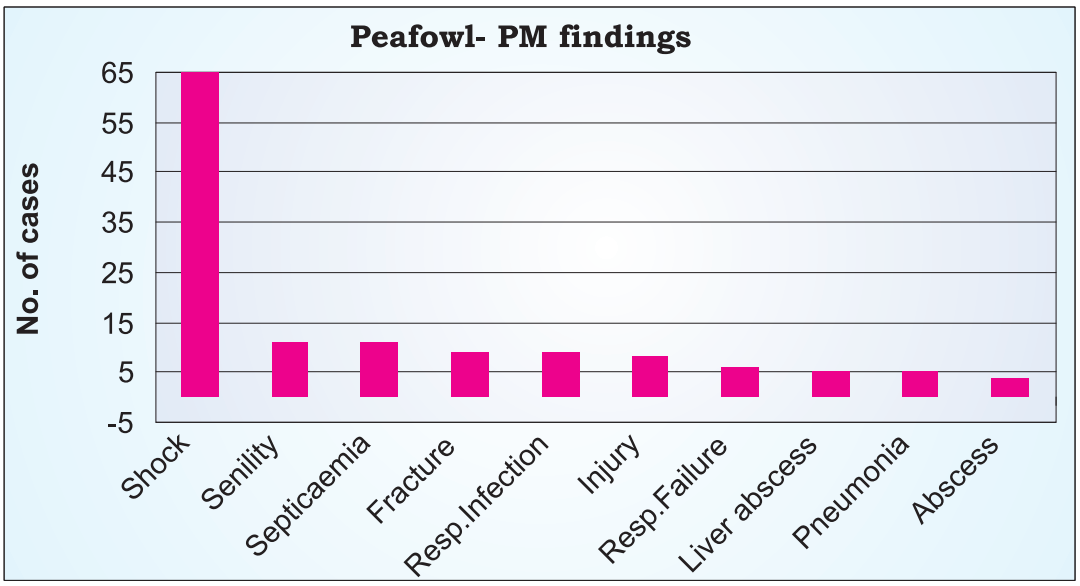


Fig 2.2: Distribution of PM lesions/ causes of mortality in peafowl

Pelican *(Pelecanus sp.)*: Only two zoos (Ahmedabad and Lucknow) were maintaining pelican and there were 8 cases of illness comprising wound (7) and debility (1). No post-mortem record was available to know the cause of death for this species.

Pheasants *(Phasianids)*: Pheasants (44 clinical cases) mainly suffered from asphyxia, enteritis, debility, hepatitis, wound, anorexia, ascites, bronchitis, etc (Fig-2.3). A total of 44 mortality were recorded due to mainly broncho-pneumonia, liver cirrhosis, hepatitis, chronic respiratory diseases (CRD), senility, coryza, enteritis, environmental stress, fracture and ascites.

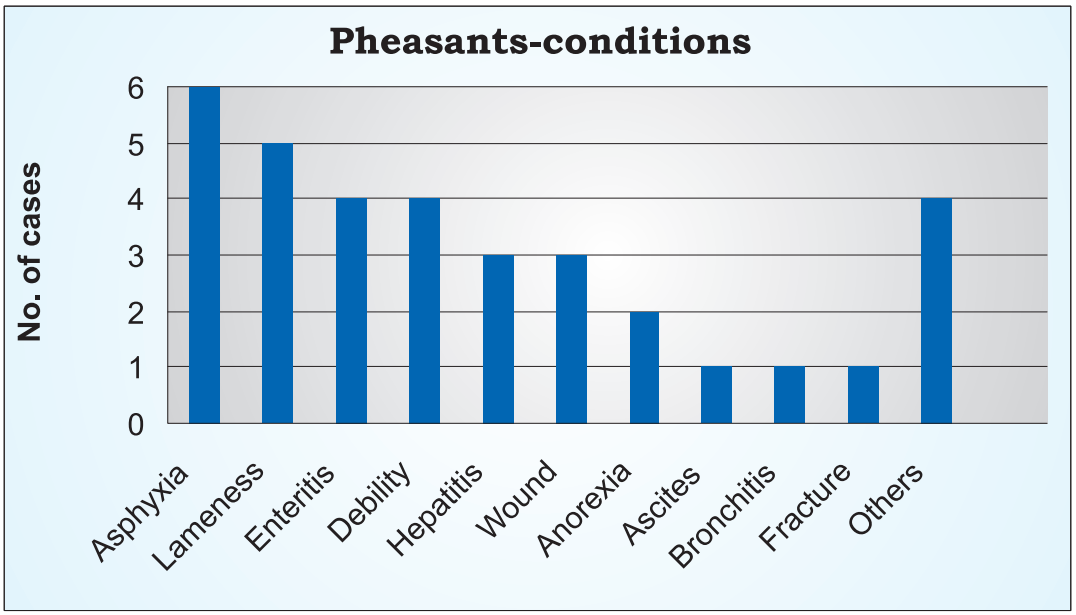


Fig 2.3: Distribution of common clinical conditions in pheasants

2.1.3 Mammals

2.1.3.1 Primates

Bonnet monkey *(Macaca radiata)*: Major clinical conditions (83) treated in bonnet monkey included wound and traumatic injury, mange, diarrhoea, debility, enteritis, anorexia, senility, anasarca, etc. Investigation of post-mortem records revealed that 8 animals died in the visited zoo had traumatic injury, septicaemia, toxaemia, tetanus, and retention of urine (Table 2.1).

Chimpanzee (*Pan* sp): A total of 91 cases were reported for treatment of wound, anorexia, diarrhoea, debility, parasitic infestation, alopecia, cold stress, senility, orchitis, sprain and dermatitis (Table 2.2).

Table 2.1: Distribution of clinical cases and PM findings in bonnet monkey

Conditions	No	PM findings	No
Wound and traumatic injury	38	Traumatic injury	5
Mange	20	Septicaemia	1
Diarrhoea	10	Tetanus	1
Debility	5	Urinary retention	1
Enteritis	2		
Anorexia	2		
Anasarca	1		
Senility	1		
Alopecia	1		
Miscellaneous	3		
Total	**83**	**Total**	**8**

Table2.2: Distribution of clinical cases in chimpanzee

Conditions	No	PM findings	No
Wound	23	Parasitic infection	6
Anorexia	18	Cold stress	4
Diarrhoea	8	Alopecia	4
Debility	5	Dermatitis	3
Lameness	2	Eye infection	3
Orchitis	2		
Senility	2		
Sprain	2		
Shock	1		
Pneumonia	1		
Pyrexia	1		
Miscellaneous	5		
Total	**91**	**Total**	**20**

Langur *(Presbytes entellus):* A total of 19 clinical cases were recorded during period under investigation. These comprised wound, injury, anorexia, debility, cold stress, dermatitis, pyrexia and diarrhoea (Fig 2.4). Post-mortem findings (3) included enteritis (2) and pleurisy (1).

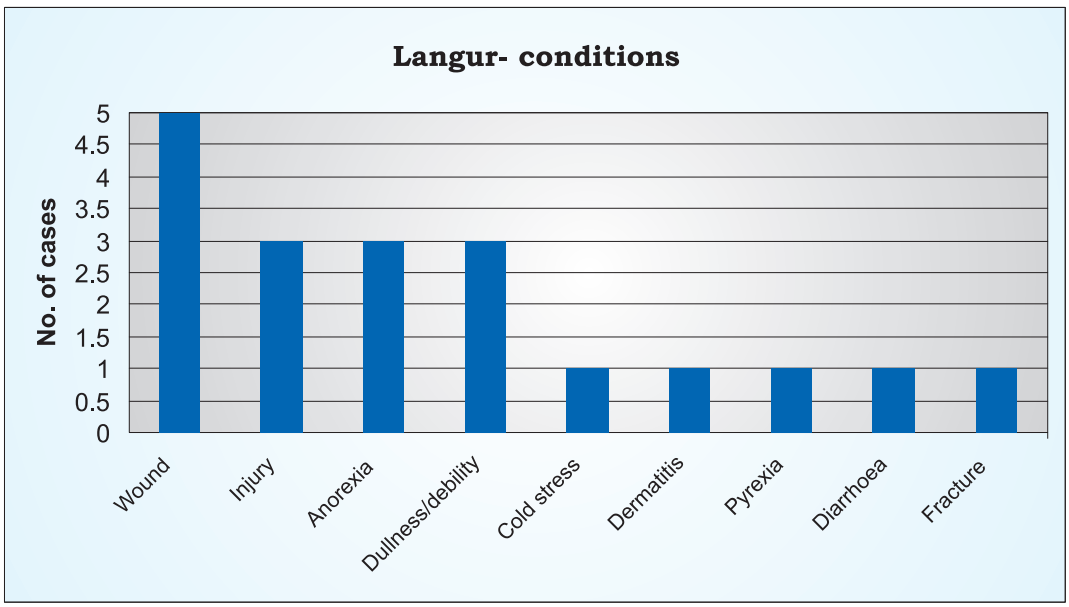


Fig 2.4: Distribution of common clinical conditions in langur

Rhesus Monkey *(Macaqa mullata):* A total of 20 cases of monkeys were treated chiefly for wound, alopecia, debility, dermatitis, injury, posterior paralysis, dystocia (Fig 2.5). Post-mortem findings included death due to senility (3), broncho-pneumonia (1) and injury (1).

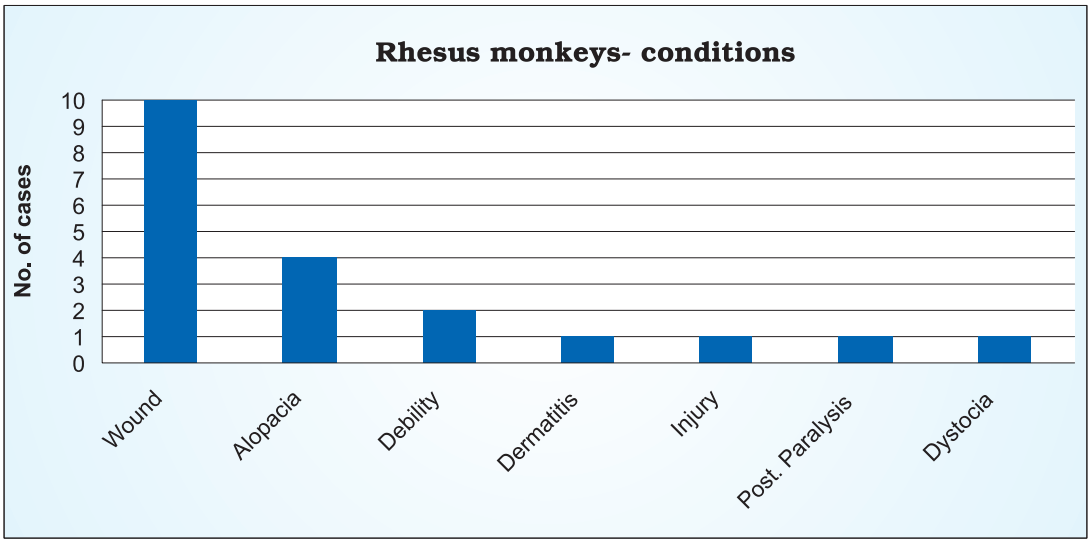


Fig 2.5: Distribution of common clinical conditions in monkey

Porcupine: Only 9 clinical cases of porcupine were recorded. These included wound (8) and debility (1). No record for mortality was available.

2.1.3.2 Carnivores

Common palm civet *(Paradoxurus hermaphroditus):* Data pertaining to disease conditions and mortality pattern in common palm civets is presented in Table 2.3. Wound and injury were the major conditions followed by anorexia, gastrointestinal (GIT) disorders, pyrexia, pneumonia, and alopecia. Animals were also treated for specific conditions, such as ascariasis and tapeworm infections. Major PM findings in 39 cases were traumatic injury, stress, senility, debility, pulmonary infection, GIT infections, nephritis, septicaemia, liver cirrhosis and paralysis (Table 2.3)

Table 2.3: Distribution of clinical conditions and PM lesions in palm civet

Condition	No	PM findings	No
Wound and Injury	73	Traumatic Injury	10
Anorexia	12	Stress	10
GIT infection	9	Senility	3
Pyrexia	7	Debility	2
Ascariasis	4	GI infection	2
Eye Infection	3	Pulmonary infection	2
Alopecia	2	Septicaemia	2
Pneumonia	2	Others	8
Others	7		
Total	**119**	**Total**	**39**

Sloth bear *(Melursus ursinus):* A total of 205 clinical cases were recorded mainly with symptoms of anorexia, diarrhoea, wound, alopecia, enteritis, pyrexia, weakness, broncho-pneumonia, dermatitis, ecto-parasitism, capture stress, etc. PM findings indicated pneumonia, respiratory tract infections including pulmonary septicaemia, hepato-splenomegaly, enteritis, tuberculosis, hypovolaemic shock, renal failure, etc. as common cause of death (Fig. 2.6 and 2.7).

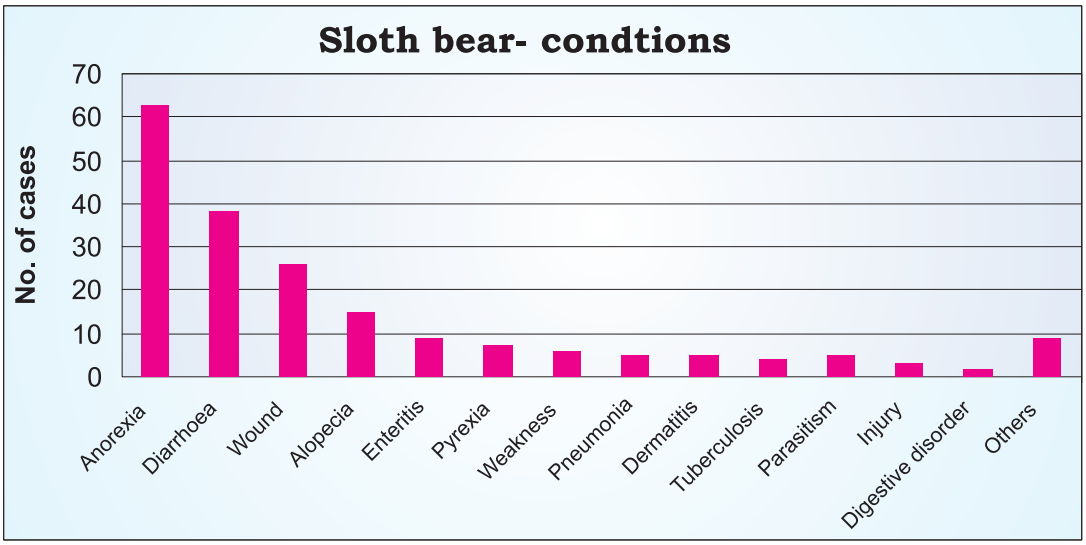


Fig 2.6: Distribution of common clinical conditions in sloth bear

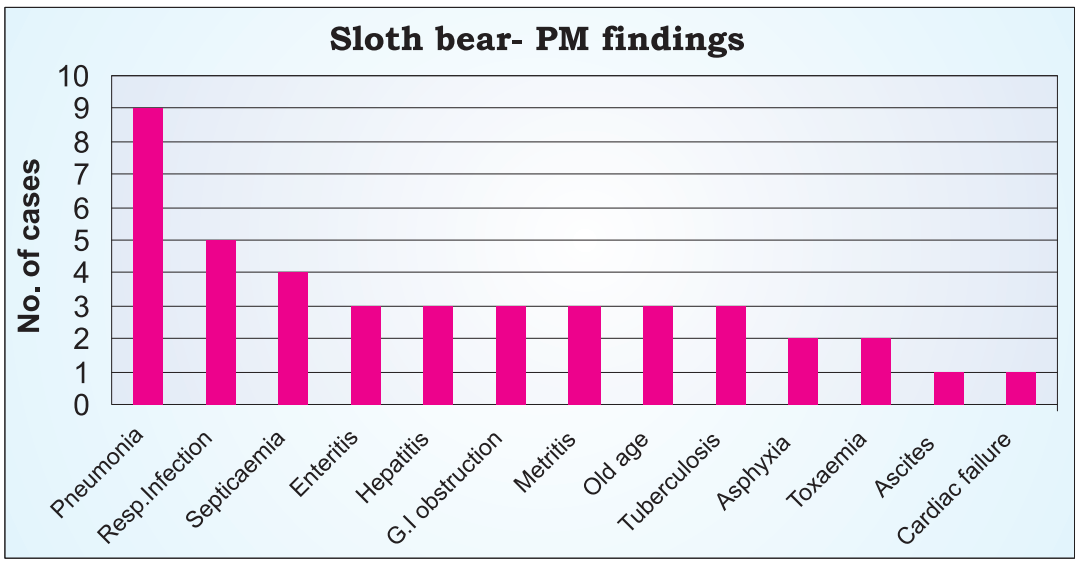


Fig 2.7: Distribution of PM lesions in sloth bear

Himalayan black bear *(Ursus/ Selenarctos thibetanus)*:A total of 472 clinical cases were reported mainly for treatment of wound and injury , anorexia, diarrhoea, dermatitis, laminitis, debility and dullness, injury, paralysis, alopecia, dysentry, vomiting, fever, mange, constipation, conjunctivitis, parasitic

infections, common cold, enteritis, dermatitis, colic, scabies, sclerosis, nasal bleeding, corneal opacity, post parturient peresis, lameness and anaemia. Major PM findings in 39 animals that had died during the period included sudden heart failure, multiple infection, senility, traumatic and hemorrhagic shock due to injury, respiratory infection, diarrhoea, enteritis, ascites, etc (Fig 2.8).

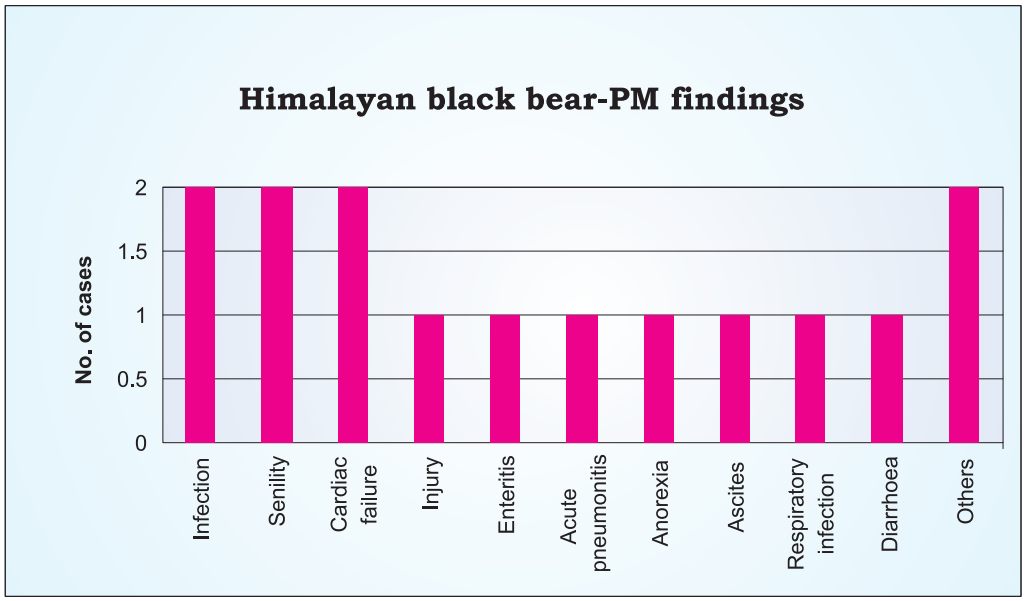


Fig 2.8: Distribution of common PM lesions in Himalayan black bear

Leopard cat *(Felis bengalensis)*: Seventy six cases were treated mainly for wound and injury, anorexia, GIT infection, debility, conjunctivitis, stress, lameness, coma and pyrexia (Table 2.4). Mortality occurred mainly due to traumatic injury, senility, GIT infection, hepatopathy, respiratory tract infection, haemorrhage, cardiac failure and tuberculosis (Fig. 2.9).

Table 2.4: Distribution of clinical conditions in leopard cat

Conditions	Total
Wound and injury	20
Anorexia	15
GIT infection	13
Debility	5
Conjunctivitis	4
Diarrhoea	4
Stress	3
Lameness	2
Toxocariasis	2
Abscess	1
Coma	1
Other	8
Total	**76**

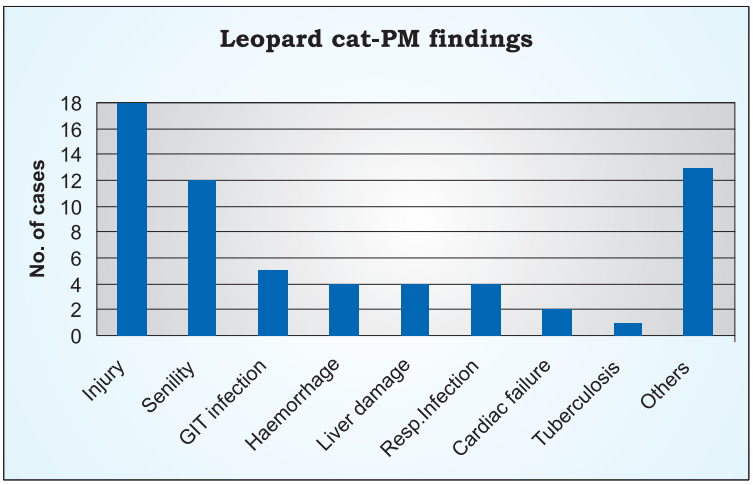


Fig 2.9: Distribution of common PM lesions in leopard cat

Fishing cat *(Felis viverminus):* Most of the 54 cases reported for treatment were due to wound, fracture, debility, diarrhoea, lameness, alopecia, helminthosis, sprain, conjunctivitis, gastroenteritis, and infighting. (Table 2.5). Major causes of death included liver abscess, senility, septicaemic shock, infighting injury, pleurisy, haemorrhagic nephritis and cyst in urinary tract.

Table 2.5: Distribution of clinical conditions and PM lesions in fishing cat

Conditions	No	PM findings	No
Wound	12	Liver abscess	3
Fracture	10	Senility	2
Debility	10	Cyst in urinary tract	1
Diarrhoea	6	Haemorrhagic nephritis	1
Lameness	5	Infighting injury	1
Alopecia	4	Pleurisy	1
Helminthosis	2	Septicaemic shock	1
Sprain	2		
Others	3		
Total	**54**	**Total**	**3**

Jungle cat *(Felis chaus)*: The jungle cats (50 cases) were mainly treated for diarrhoea, infighting injury, anorexia, fungal infection, conjunctivitis, lameness, helminthosis, weakness, fever, dehydration, epistaxis, wound, dermatitis, transportation stress and eczema (Table 2.6). Major causes of death (24) included senility, cardiac failure, septicaemia, stress, traumatic injury, vital organ dysfunction, ascites, hepatitis, gastro-enteritis, nephritis, etc. (Fig 2.10)

Table 2.6: Distribution of common clinical conditions in jungle cat

Conditions	No	Condition	No
Diarrhoea	11	Dehydration	2
Injury	6	Epistaxis	1
Anorexia	5	Wound	1
Fungal infection	4	Dermatitis	1
Conjunctivitis	3	Transportation and stress	1
Lameness	3	Eczema	1
Helminthosis	2	Inflammation	1
Weakness	2	Miscellaneous	6
Total			**50**

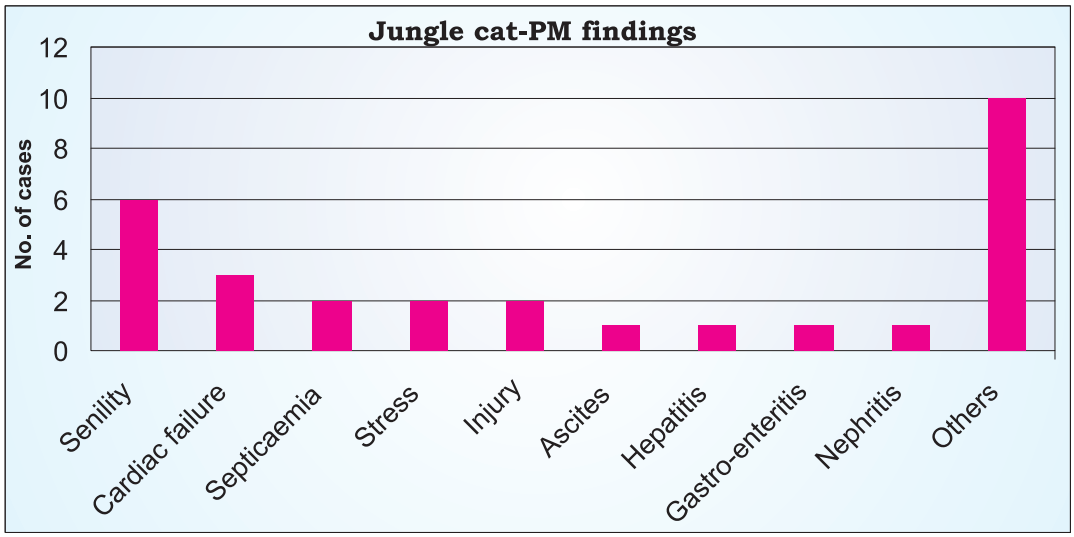


Fig 2.10: Distribution of common PM lesions in Jungle cat

Golden cat: Main clinical conditions recorded in golden cats were anchylostomiosis, ascariasis, ecto-parasitic infestation, weakness, haematuria and anorexia (Table 2.7). Two cases of death were reported one each due to senility and hepatonephropathy.

Table 2.7: Distribution of clinical conditions and PM lesions in golden cat

Conditions	No	PM findings	No
Anorexia	5	Senility	1
Haematuria	3	Hepatonephropathy	1
Weakness	2		
Anchylostomosis	1		
Ascariasis	1		
Ectoparasitic infestation	1		
Miscellaneous	1		
Total	**14**	**Total**	**2**

Leopard (*Panthera pardus*): A total of 628 clinical cases were reported during the period under investigation. Major clinical conditions were anorexia, wound, lameness, injury, alopecia, diarrhoea, debility, vomiting, conjunctivitis, pyrexia, rectal prolapse, infestation of ticks and other ectoparasites including mange, dermatitis, polyuria/urinary infection, endoparasitism, swelling and inflammation, metritis, gastritis, arthritis, constipation, etc. (Fig. 2.11). The major causes of death in leopards

(105) in different zoos included old age, traumatic injury, haemorrhage, pneumonia, shock, respiratory failure, cardiac arrest, asphyxia, stillbirth, urinary tract infection, gastro-enteritis, septicaemia, dehydration, snake bite, toxaemia, pleurisy, urinary infection, hepatitis, etc (Fig 2.12).

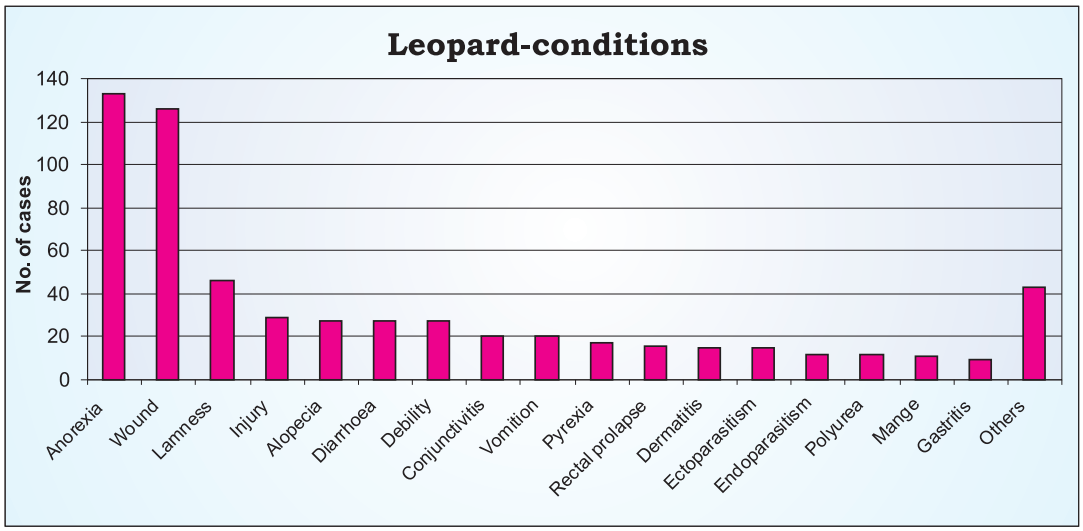


Fig 2.11: Distribution of common clinical conditions in leopard

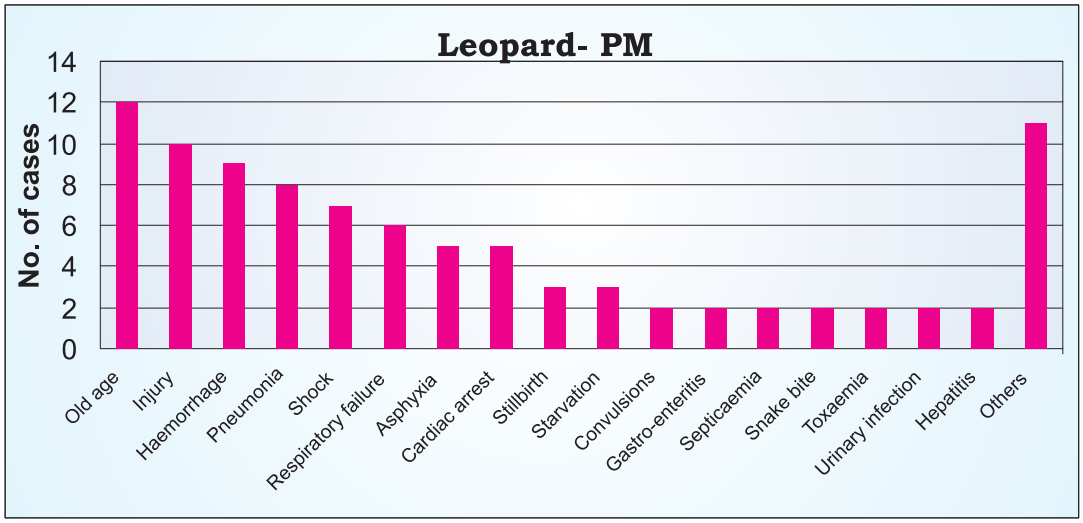


Fig 2.12: Distribution of common PM lesions in leopard

Lion *(Panthera leo persica)*: Large number (1379) of lions were reported for the treatment in zoos across the country. The major clinical findings were wound and infighting injury, anorexia, diarrhoea, vomiting, constipation, pyrexia, weakness, conjunctivitis, lameness, endo-and ectoparasitism including

mange, swelling and inflammation, in-coordination of gait, babesiosis, common cold, lack of libido etc (Fig 2.13). Mortality (103 cases) occurred mainly due to senility, respiratory failure, shock, dehydration, anorexia, septicaemia and severe toxaemia (Fig 2.14).

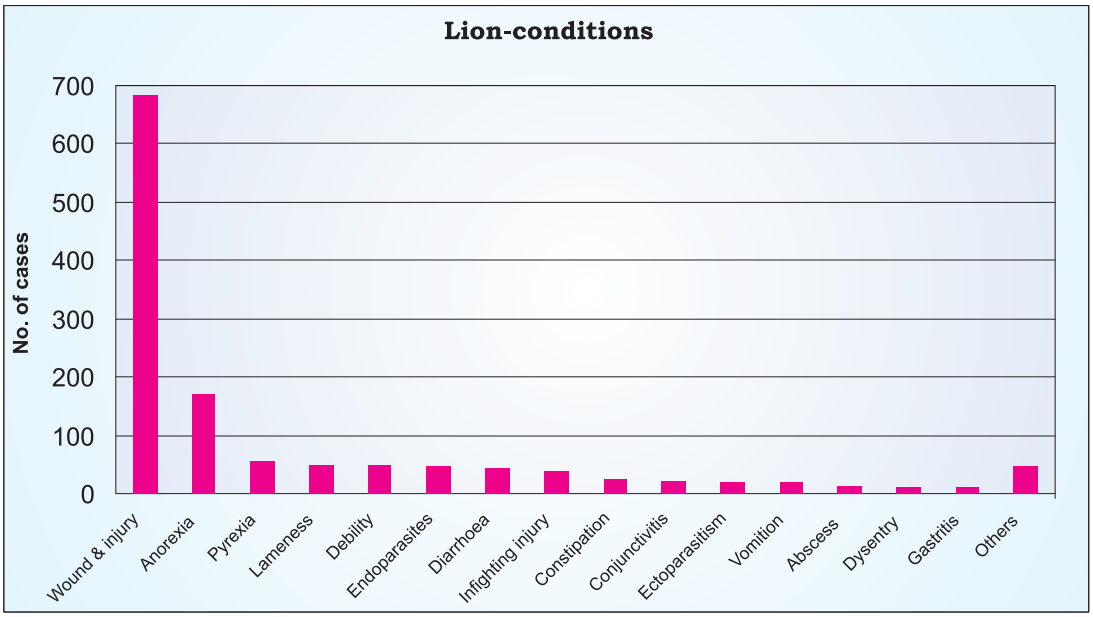


Fig 2.13: Distribution of common clinical conditions in lion

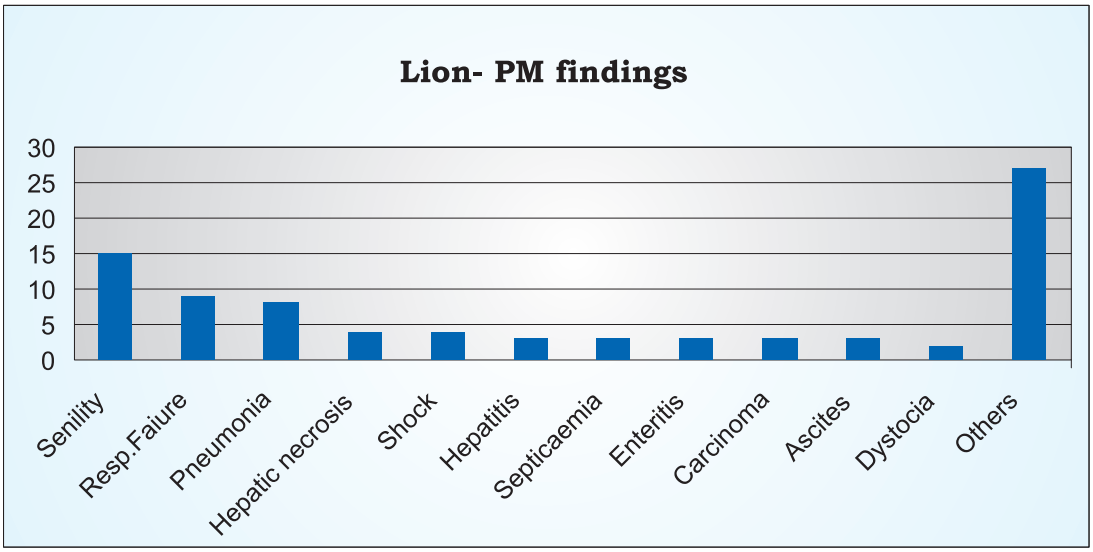


Fig 2.14: Distribution of common PM lesions in lion

Tiger *(Panthera tigris tigris)*: A total of 1184 cases were treated in different zoos during the last 10 years. The main conditions were wound, anorexia, constipation, diarrhoea, lameness, vomiting, debility, pyrexia, alopecia, senility, inflammatory swelling and contusion, epistaxis, pneumonia, jaundice, nasal

fistula, rheumatic pain, abscess, posterior paralysis, sprain, fracture, urinary infection, bursitis, synovitis, corneal opacity, conjunctivitis, dystocia, post- parturient stress, dyspnoea, pica, sloughing of skin, dermatitis, parasitic infection including hookworm and mange, fungal and streptococcal infection, and babesiosis (Fig 2.15). Post-mortem (114 cases) findings included cardiovascular shock, respiratory failure and asphyxia, pneumonia, senility, septicaemia, renal failure, indigestion, carcinoma, haemorrhagic gastro-enteritis, internal haemorrhages dystocia, poisoning and ascites (Fig 2.16).

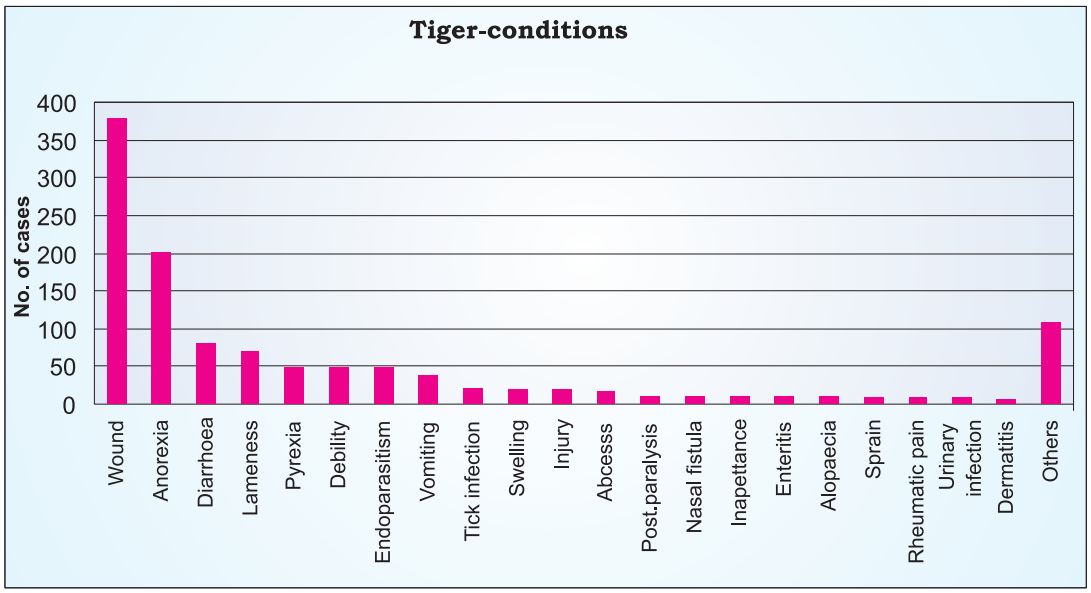


Fig 2.15: Distribution of common clinical conditions in tiger

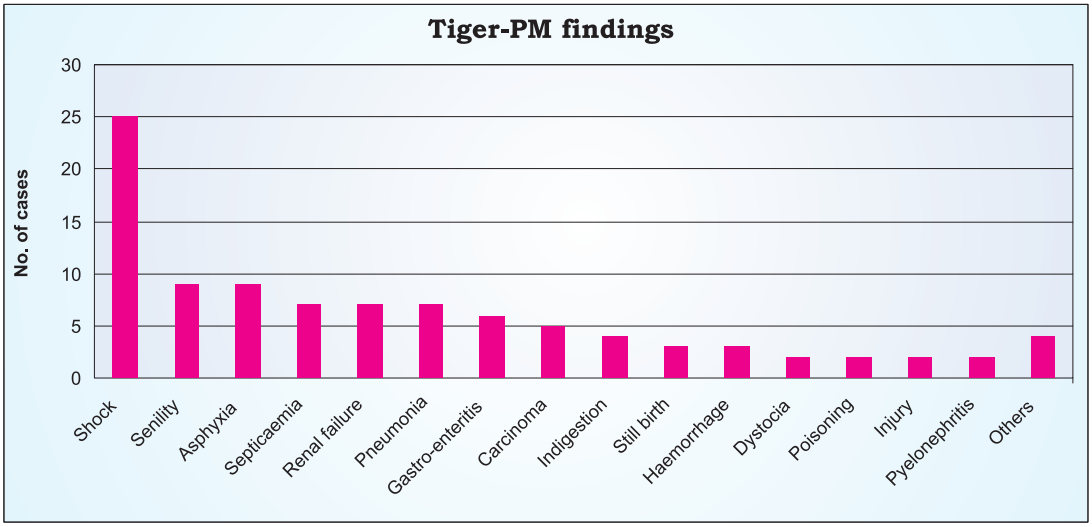


Fig 2.16: Distribution of common PM lesions in tiger

Hyena *(Hyena hyena)*: A total of 329 cases were treated for different conditions including wound, anorexia, debility, vomiting, fever, rickets, fracture, abscess, parasitic infection, alopecia and stress (Table 2.8). Main post mortem findings in 53 dead animals were senility, asphyxia, injury, hepatic disorders, toxaemia, ascites, carcinoma, tuberculosis, etc. (Fig. 2.17).

Jackal (*Canis sp*): Major clinical findings in 146 cases were wound and injury, anorexia, diarrhoea, pneumonia, debility, lameness, swelling, tumour, dermatitis, mange and alopecia (Fig 2.18). Analysis of post-mortem (49) records revealed that major causes of death were traumatic injury, stress and shock, respiratory failure, abscess, hepatopathy, senility, internal haemorrhage, cardiac arrest, gastro-enteritis, tuberculosis and impaction (Fig. 2.19).

Table 2.8: Distribution of clinical conditions in hyena

Conditions	Total	Diseases	Total
Wound and injury	128	Enteritis	5
Anorexia	42	Parasitism	5
Fracture	33	Alopecia	3
Lameness	25	Diarrhoea	3
Vomiting	20	Stress	3
Debility	11	Conjunctivitis	2
Pyrexia	10	Hepatitis	2
Abscess	7	Rickets	2
Oedema	10	Haemorrhage	1
Dermatitis	9	Others	4
Total			**329**

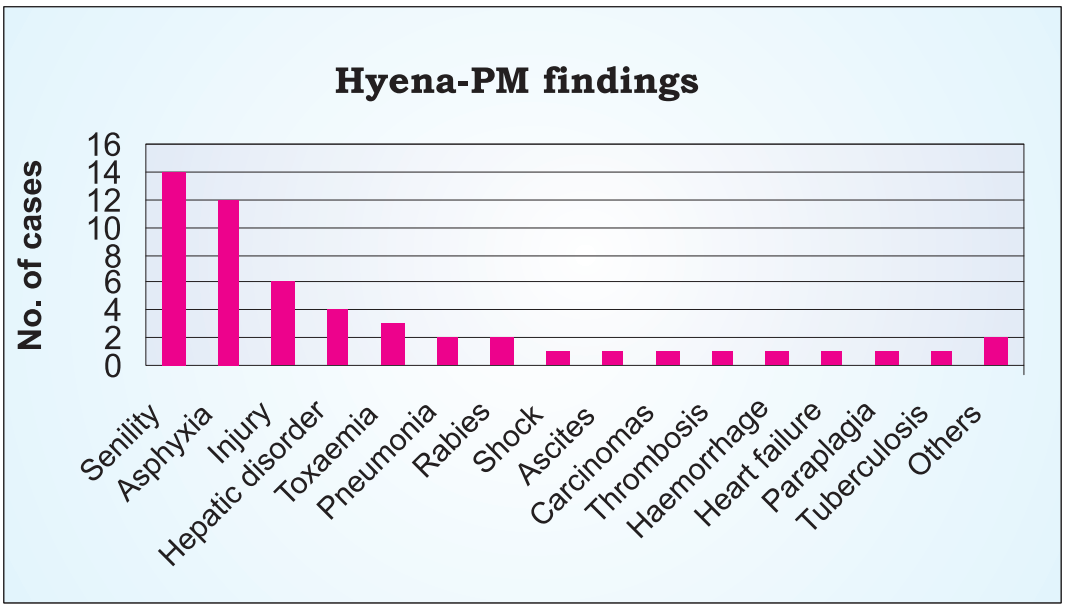


Fig 2.17: Distribution of common PM lesions in hyena

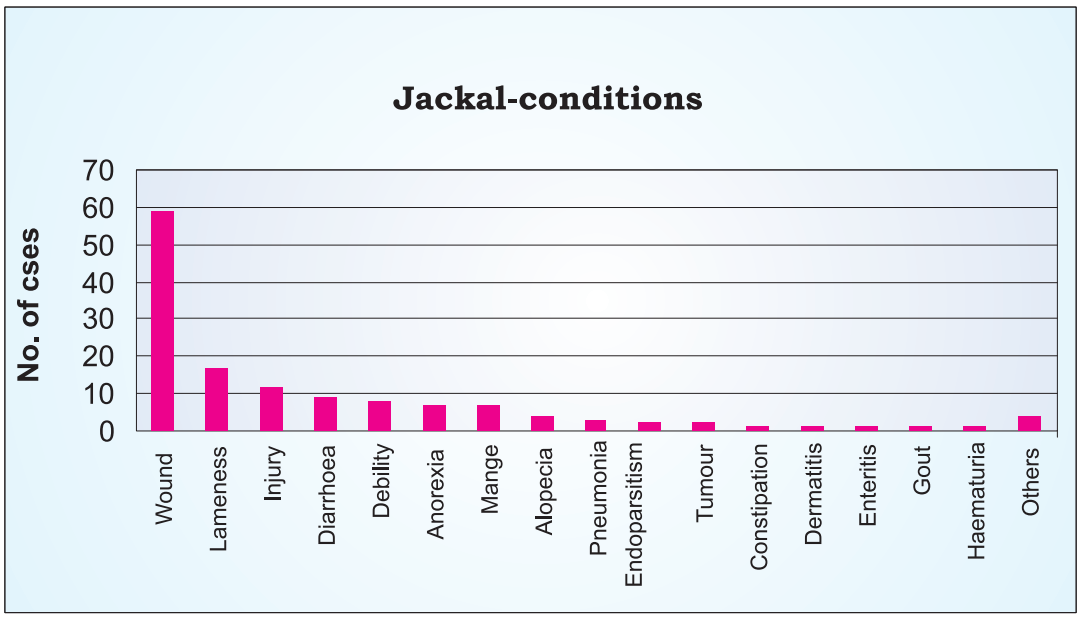


Fig 2.18: Distribution of common conditions in jackal

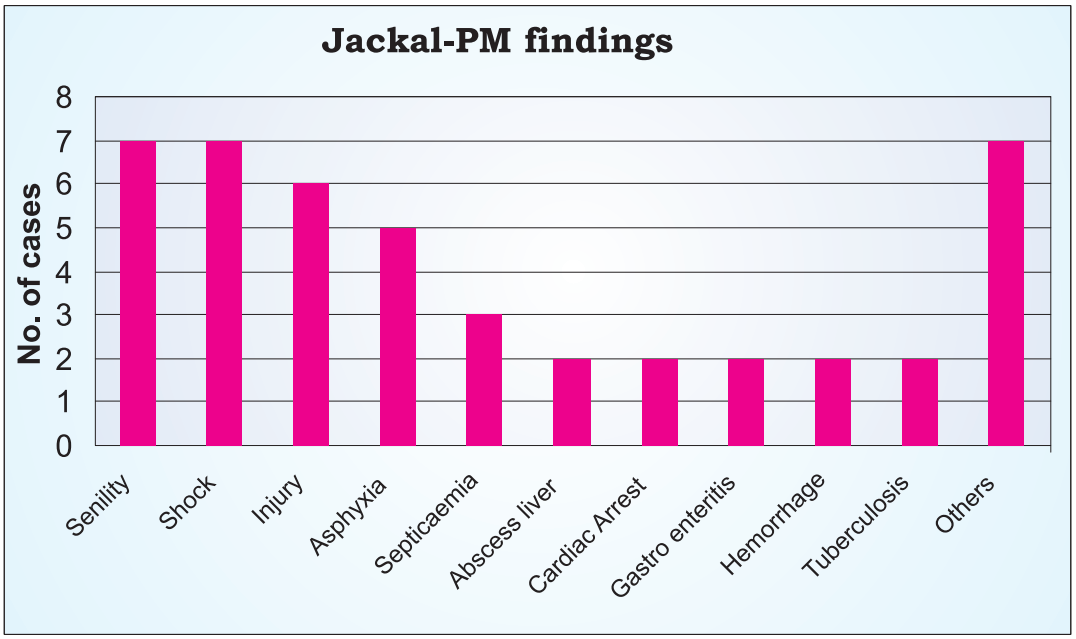


Fig 2.19: Distribution of common PM lesions in jackal

Wolf **:** *(Canis lupus)*: Total 38 clinical cases were recorded for the investigation period. The main conditions included wound, diarrhoea, debility, lameness, swelling, abscess, alopecia, anorexia and fracture (Fig 2.20). Only 3 post-mortem reports were available indicating cirrhosis, senility and dehydration as the causes of death.

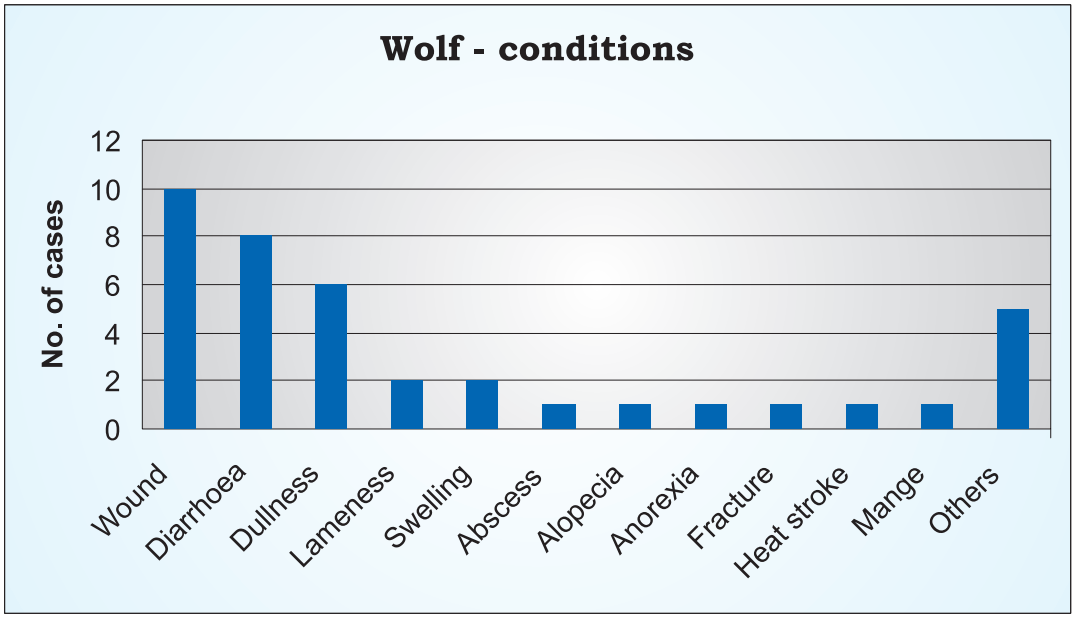


Fig 2.20: Distribution of common conditions in wolf

2.1.3.3 Proboscidea

Asian elephant *(Elephus maximus):* Elephants (579) mainly suffered from wound, debility, anorexia, diarrhoea, tympany, conjunctivitis, pyrexia, ascites, abscess, lameness, footrot, strongylosis, fasciolosis, tick infestation, tuberculosis, dermatitis and stress (Fig. 2.21). Solitary case of death was due to bloat in the Bannerghatta National Park.

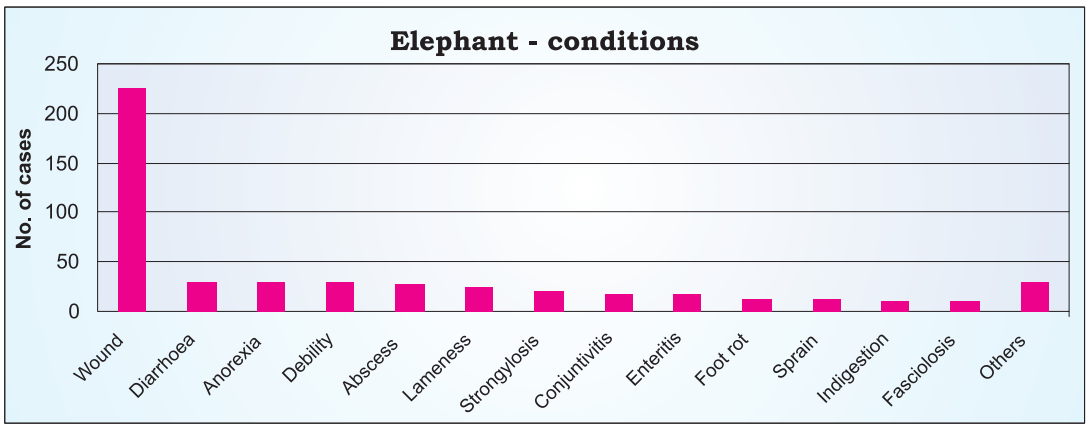


Fig 2.21 Distribution of clinical conditions in elephant

2.1.3.4 Perissodactyla

Zebra *(Equus burchelli):* The common clinical conditions identified in 38 cases were anorexia, diarrhoea, debility and weakness, anaemia, fever, wound and injury, lameness, worm infestation and alopecia Pneumonia, tuberculosis, tympany, heart failure, osteomyelitis and septicaemia were identified as the causes of death of 6 animals.

Rhinoceros *(Rhinoceros unicornis):* Rhinoceros (358 cases) suffered mainly due to wound and infighting injury, anorexia, diarrhoea, conjunctivitis, debility, stress, nephritis, GIT infection, tympany, endoparasitic infection, rectal prolapse, lameness, sprain, abscess, dermatitis, and Johne's disease (Fig 2.22). Post-mortem findings (9) revealed cardio-respiratory failure, pneumonia, dehydration, pyaemia, still birth, cardiac tumour, toxaemia, peritonitis and senility as the causes of death.

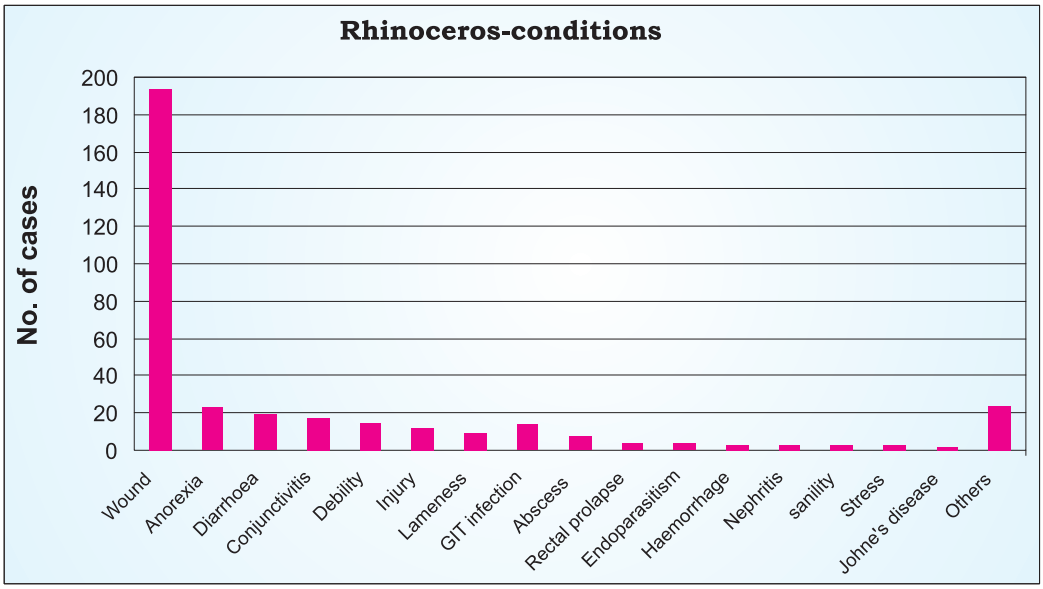


Fig 2.22: Distribution of clinical conditions in rhinoceros

2.1.3.4 Artiodactyla

Hippopotamus *(Hippopotamus amphibius):* Major clinical conditions identified in 176 cases included anorexia, indigestion, debility, vesicular stomatitis, wound and infighting injury, lameness, parasitic infection and geriatric problems. Major post-mortem findings were emphysema, acute hemorrhagic enteritis, abortion, strangulation of intestine, congenital defect and haemorrhage (Table 2.9).

Table 2.9: Distribution of clinical conditions and PM lesions in hippopotamus

Conditions	No	PM findings	No
Wound	62	Strangulation of intestine	2
Anorexia	32	Congenital defect	1
Sprain	19	Emphysema	1
Indigestion	18	Haemorrhagic enteritis	1
Infighting injury	15	Abortion	1
Debility	11	Haemorrhage	1
Diarrhoea	3		
Abscess	3		
Lameness	2		
Others	11		
Total	**176**	**Total**	**7**

Giraffe *(Giraffa camelopardalis):* Data collected from Alipore, Assam, Delhi and Thiruvananthpuram zoos revealed that 64 clinical cases were treated mainly for wound and abscess, debility, stress, pyrexia, dermatitis, lameness and sprain, conjunctivitis and tuberculosis. Senility, pneumonia and infighting injury were the major causes of death (Fig. 2.23).

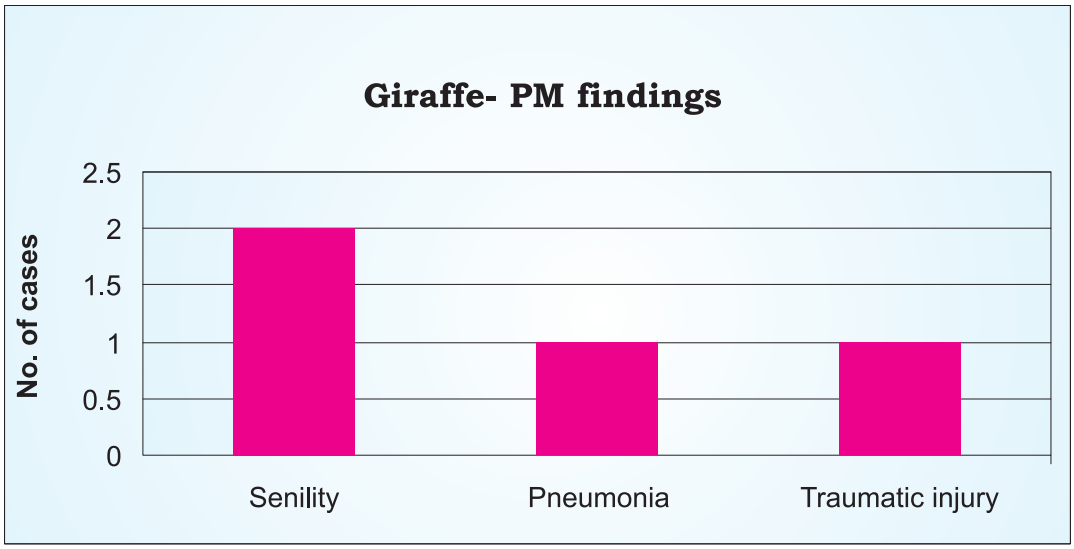


Fig 2.23: Distribution of common PM lesions in giraffe

Swamp deer *(Cervus duvauceli):* In different zoos, 111 cases of swamp deer were treated for wound, anorexia, lameness, alopecia and debility. Cases of diarrhoea, Tuberculosis, abscess, rectal prolapse and parasitic infection were also recorded. Common causes of death were traumatic injury, septicaemia, tympany, senility, haemorrhages, gastrointestinal tract infection, lung infection and acute impaction (Table 2.10).

Table 2.10: Distribution of clinical conditions and PM lesions in swamp deer

Conditions	No	PM findings	No
Diarrhoea	79	Traumatic injury	11
Wound	13	Capture stress	2
Anorexia	5	Debility due to senility	2
Lameness	2	Tympanitis	2
Alopaecia	2	Haemorrhages	2
Debility	2	Septicaemia	1
Fracture	2	GIT infection	1
Tuberculosis	1	Lung infection	1
Abscess	1	Acute impaction	1
Constipation	1		
Others	1		
Prolapse	2		
Total	**111**	**Total**	**23**

Spotted deer *(Axis axis):* A total of 584 cases were reported for treatment at different zoos. Major clinical conditions identified were wound, tuberculosis, debility, lameness and digestive disorders. Cases of dystocia, anal fistula, tympany, metritis, abortion, HS, dermatitis, helminthosis and tetany were also recorded. PM findings revealed respiratory failure, infighting injury, wound, old age and shock as the main causes of death. Specific diseases such as tuberculosis, rabies, HS, FMD, tympany, asphyxia, liver cirrhosis, toxaemia, peritonitis, acute lymphoma and impaction were also reported on PM examination (Table 2.11).

Table2.11: Distribution of clinical conditions and PM lesions in spotted deer

Conditions	No	PM findings	No
Wound and injury	253	Respiratory failure/Infection	100
Tuberculosis	80	Injury and wound	88
Debility/dullness	69	Shock	52
Lameness	52	Senility	23
Diarrhoea	21	Tuberculosis	21
Fracture	16	Septicaemia	19
Abscess	14	Hepatitis	13
Swelling	14	Tympany	7
Anorexia	13	Abscess	4
Pneumonia	8	Toxaemia	4
Dystokia	7	Capture myopathy	3
Helminthosis	7	Dystocia	3
Septicaemia	7	FMD	3
Metritis	3	Fracture	3
Pyrexia	3	Acute lymphoma	2
Gangrene	3	Anaemia	2
Haemorrhage	2	Haemorrhage	2
Rectum prolapsed	2	Peritonitis	2
Broken jaw	1	HS	1
Cold stress	1	Neonatal death	1
Umbilical infection	1	Nephritis	1
FMD	1	Parturition stress	1
Heat stress	1	Rabies	1
Others	5	Others	13
Total	**584**	**Total**	**369**

***Sambar** (Cervus unicolor):* Common clinical cases treated and causes of death have been described in table 2.12. Common clinical conditions included wound, infighting injury, anorexia, indigestion and tuberculosis. Major causes of death were traumatic injury, respiratory infections, dystocia, GIT infection, cardiac failure, etc.

Table 2.12: Distribution of clinical conditions and PM lesions in Sambar

Conditions	No	PM findings	No
Wound and Injury	322	Traumatic injury	61
Anorexia	29	Resp. infection	32
Debility	28	Debility/Senility	18
Tuberculosis	22	Dystocia	13
Indigestion	26	Cardiac failure	9
Fracture	11	GIT infection	9
Oedema	9	Paralysis	9
Diarrhoea	9	Tuberculosis	9
Abscess	8	Haemorrhage	8
Endoparasitism	7	Septicaemia	8
Alopecia	5	Shock	7
Conjunctivitis	6	Stress	6
Sprain	5	Metritis	4
Dystocia	4	Tympany	4
Pyrexia	4	Hepatitis	3
Lameness	4	Pyaemia	3
Ectoparasitism	3	Retension of urine	3
Haemorrhage	3	Anthracosis	2
Hypothermia	3	Myocarditis	1
Pneumonia	3	Still birth	1
Mange	2	Tetanus	1
Hernia	2	Others	17
CBPP	1		
Dermatitis	2		
Haematuria	1		
Tumor	1		
Others	10		
Total	**530**		**228**

Barking deer *(Muntiacus muntjak):* Barking deer (307cases) were treated mainly for wound, abrasion, anorexia, diarrhoea, debility, pyrexia, lameness, ascariasis, dystocia, stress, indigestion, dog-bite and FMD. Traumatic injury, respiratory failure, haemorrhage, renal failure, pyemia, cardiac failure, senility, shock, wound, urinary retention, hip joint dislocation and tetanus were the major causes of death (Table 2.13).

Table2.13: Distribution of clinical conditions and PM lesions in barking deer

Conditions	No	PM findings	No
Wound and injury	173	Traumatic injury	36
Abrasion	41	Resp. failure and Pneumonia	22
Anorexia	15	Haemorrhage	11
Diarrhoea	19	Pyemia	9
Pyrexia	8	Shock	9
Debility	7	Cardiac failure	8
Lameness	7	Senility	7
Abscess	4	Renal failure	6
Ascariasis	4	Wound	5
Dystocia	3	Attack/bite by animal	5
Ectoparasitism	3	Stress	3
Stress	3	Liver abscess	2
Oedema	3	Tetanus	2
TB	2	Rejected by mother	2
FMD	2	Capture myopathy	1
Mange	2	Dystocia	1
Alopacia	1	Dystocia	1
Colic	1	Hypothermia	1
Respiratory distress	1	Impaction	1
Tetanus	1	Infant mortality	1
Vaginitis	1	Posterior paralysis	1
Colitis	1	Toxaemia	1
Others	5	Tympanitis	1
Total	**307**	**Total**	**137**

Chinkara: *(Gazelle gazelle)*: A total of 13 clinical cases were treated during the period of investigation. Endoparasitic infestation, wound, pyrexia, ocular infection, tendon rupture, abscess and corneal opacity were the main conditions (Fig 2.24). No post-mortem record were available to note the causes of death.

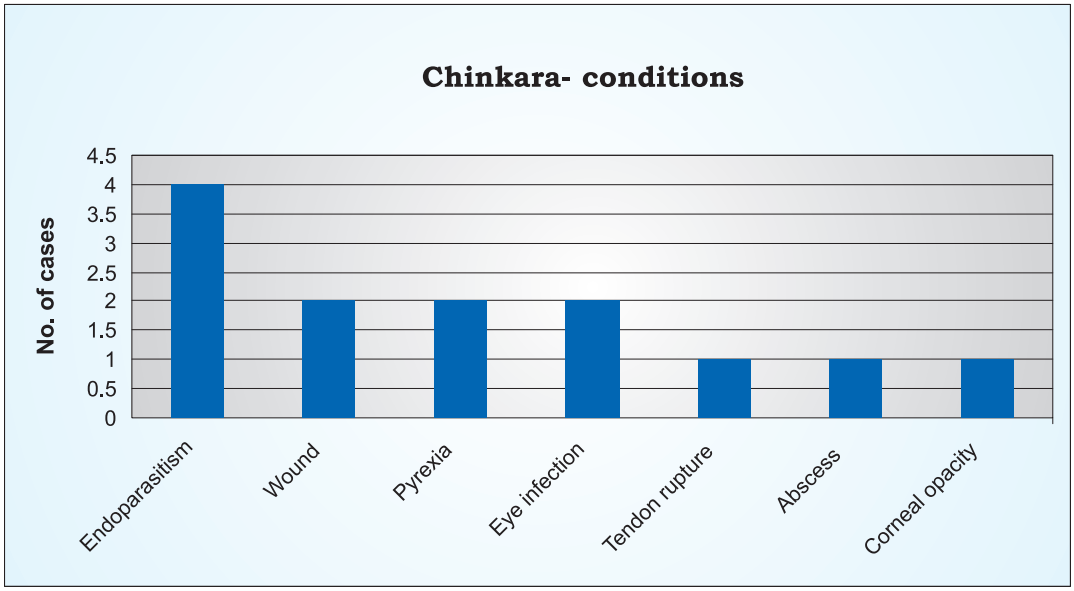


Fig 2.24: Distribution of common clinical conditions in chinkara

Hog deer *(Axis porcinus):* Total 325 clinical cases were treated for wound and injury, diarrhoea, lameness, anorexia, fracture, debility, abscess, tuberculosis, oedema, deformed bones, senility, parasitic infection and dystocia. Post-mortem record of 92 hog deer showed acute frothy bloat, intestinal obstruction, cardiac and respiratory failure, still birth, old age, haemorrhages and shock as the major causes of death (Table-2.14)

Table 2.14: Distribution of clinical conditions and PM lesions in hog deer

Conditions	No	PM findings	No
Wound and injury	166	Pneumonia/respiratory failure	10
Diarrhoea	33	Acute frothy bloat	9
Lameness	29	Still birth	8
Anorexia	21	Shock	7
Fracture	17	Septicaemia	7
Abscess	12	Senility/ debility	7
Debility	10	Haemorrhage	6
Oedema	7	Cardiac failure	4
Tuberculosis	7	Toxaemia	4
Distocia	5	GI obstruction	4
Pyrexia	3	Injury	4
Alopecia	2	Metritis	3
Parasitic infection	2	Tuberculosis	2
Senility	2	Others	16
Others	8		
Total	**325**	**Total**	**92**

Blackbuck *(Antilope cervicapra):* Common clinical conditions for which blackbuck were treated included wound and injury, tuberculosis, debility, diarrhoea, respiratory distress, septicaemia, pyrexia, naval ill, etc. The PM lesions included bloat, tuberculosis, septicaemia, toxaemia, snake bite, enteritis, hepatopathies, respiratory failure, shock and traumatic injury (Table 2.15).

Table 2.15: Distribution of clinical conditions and PM lesions in Black buck

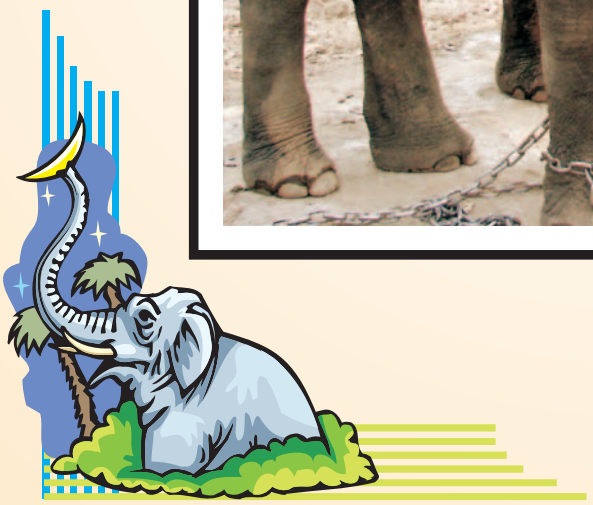
Conditions	No	PM findings	No
Wound and injury	116	Respiratory failure/pneumonia	39
Debility	33	Wound and injury	30
Diarrhoea	31	Shock	28
Tuberculosis	19	Bloat	17
Septicaemia	14	Senility	14
Stress	11	Cardiac failure	13
Respiratory distress	10	Hepatopathies	12
Sprain	10	Tuberculosis	11
Pyrexia	9	Killed by wild animals	9
Pica	6	Septicaemia	8
Rectal prolapse	6	Respiratory stress	8
Paralysis	5	Haemorrhage	7
Lameness	4	Enteritis	5
Navel ill	4	Foreign bodies	4
Oedema	7	Toxaemia	4
Impaction	4	Paramphistomiosis	3
Indigestion	5	Snake bite	3
Inflammation	3	Impaction	3
Fracture	2	Still birth	3
Abscess	1	Peritonitis	2
Parasitic infestation	3	Traumatic pericarditis	2
Anaemia	1	Anaemia	2
Anorexia	1	Dystocia	1
Dermatitis	1	Myopathy	1
Others	3	Paresis	1
		Parturition stress	1
		Others	17
Total	**309**		**248**

2.2. Summary findings

- Introspection into clinical records of the surveyed zoos for the last 10 year indicated that rabies, FMD, tuberculosis, HS, tetanus, helminthosis and haemoprotozoal infections were the most commonly encountered infectious conditions in zoo animals.
- There were also published reports of occurrence of FPL in large felids in Delhi, Kanpur, Mumbai, Chhatbir, Trichur, Bhopal and Bhubaneshwar zoos.
- Commonly reported non- infectious conditions included wound and infighting injuries in almost all species of animals, tympany (in herbivores), hepatopathy, nephritis, and cardiac failure. Occurrence of carcinomas was reported in carnivores. Based on PM findings, cardiac and respiratory failures were also mentioned as the major causes of death.
- Deaths due to snake-bite and poisoning were reported in a leopard, tiger, and barking deer. Nitrate-nitrite toxicity was responsible for death of black bucks and spotted deer in two zoos.
- Injury due to infighting appeared to be the main health concern in zoo animals, irrespective of species and type of the zoos.
- Most of the zoos practiced regular deworming schedule. However incidence of parasitic infection in different species was quite common. Hence, it is necessary to develop a species and area specific deworming schedule.
- Vaccination schedule followed at different zoos varied from one zoo to another. Most of the big cats are vaccinated with Fel-o-Vex. Other conditions for which vaccination is being practiced included FMD, Rabies, HS, BQ, Leptospirosis. Birds were vaccinated for RD, Fowl Pox and Gumboro Diseases in some zoos.
- Most of the treatments were symptomatic and disease diagnosis was tentative, necessitating suitable disease diagnostic protocols.

CHAPTERS 03

DISEASE CONDITIONS IDENTIFIED IN WILD ANIMALS IN INDIA



3. Disease Conditions Identified in Wild Animals in India

Information on occurrence of important disease conditions in wild animals in the country during the last 25 years (1984-2009) were derived from published literature, records of laboratory examination conducted at the Indian Veterinary Research Institute and also the findings of survery of the present project. The same are being presented in Table 3.1.

Table-3.1 Important diseases reported in zoo and wild animals in India

Class/Species	Disease/ Infection	Remark
A- Infectious diseases		
REPTILES		
Chamaeleon	Tuberculosis	
Gharial	Septicaemia*, infectious pneumonia (*Klebsiella pneumoniae)*, necrotic dermatitis (*Aeromonas sp),* salmonellosis, infections due to *Pseudomonas and E. coli, Klebsiella sp*., *Streptococcus* (Haemolytic) and *Staphylococcus*, *Proteus* sp. Candidiasis, and *Goussia* sp** and Pentastomes,**	* 19 animals died at Zoological Park, Jaipur (1998)** From animals that died in Chambal river (2007-08)
Muggar	*Klebsiella sp.*and *E.coli infection and* Aspergillosis (in hatchlings)	
Tortoise/Turtles	Parasitic gastroenteritis* Coxiellosis	*31 turtles died at Kukrail Breeding Centre Lucknow (2004)
Star tortoise	Mycoplasmosis	
Python	Coxiellosis	
Cobra	Salmonellosis	

Class/Species	Disease/ Infection	Remark
AVIAN		
Pea fowl	Ranikhet disease*, Marek's disease, IBD, avian leucosis sarcoma virus (ASLV), septicaemia, colibacillosis, coccidiosis	* Heavy mortality occurred at National Zoological Park, Delhi (1986)
Pigeon	Ranikhet disease, *Actinomyces sp.,* colibacillosis, trichomoniasis	
Pheasants	Ranikhet disease, ASLV, staphylococcosis, colibacillosis*	* Outbreak at IVRI, Mukteshwar (1985)
Pelican	Staphylococcosis	
Pin tailed duck	Staphylococcosis	
Vulture	Colibacillosis, avian malaria*	*At Vulture Conservation Project Gadchiroli (MS)
Crane/ Duck	Colibacillosis, *Campylobacter jejuni* and *Plasmodium* infections	
Parrot	Aflatoxicosis*, IBH	* Caused large scale mortality at Alipore Zoo (1988)
Mynah	Fowl Pox	
Flamingo	Helminthiosis (*Railletina, Davainia* and *Cotugnia*)	
Emu	Tuberculosis,* colibacillosis	* Tuberculosis has also been reported in wide range of other birds (cranes, silver pheasant, and whistling teal)
MAMMALS		
Marsupials		
Kangaroo	FMD, tuberculosis, *anthrax , Haemorrhagic septicaemia (HS)	*Reported in1974
Primates		
Common Langur	Hepatic tuberculosis, coccidiomycosis, *Plasmodium*	
Bonnet monkey	Septicaemia, tetanus, tuberculosis	
Chimpanzee	Tuberculosis, helminthosis	

Class/Species	Disease/ Infection	Remark
Carnivores		
Sloth bear	Rabies*, infectious canine hepatitis (ICH), tuberculosis, leptospirosis	*14 animals died at Bear rescue centre, Agra were confirmed at IVRI, (2003)
Himalayan black bear	Scabies, helminthosis	
Common palm civet	Rabies, tuberculosis, echinostomosis	
Jackal	Rabies, tuberculosis, trypanosomosis, dirofilariasis, lung worm, *Spirocerca lupi*, trichomoniasis	
Hyena	Rabies, tuberculosis	
Wolf	Rabies, ICH, tuberculosis, trichomoniasis	

Beware of babesiosis in big cats

- *Babesia cati*, *B. felis, B. harpailuri* and *B. pantherae* are known to infect domestic and wild cats. Babesiosis has been reported in cheetah, tiger, lion and panther. It is characterized by inappetence, lethargy, weakness, rough hair coat, anaemia, shallow respiration, listlessness and constipated yellow faeces. Tachycardia, tachypnoea, and laboured breathing are observed in severely anaemic felids.
- Primaquin is the drug of choice in feline babesiosis.
- Diminazene aceturate may cause fatal damage to kidney, liver and brain in felines and should be used cautiously.
- Imidocarb has been demonstrated highly curative and prophylactic against all *Babesia* species. In felids, good response is obtained, when it is administered @2 mg/kg b.wt.
- Adopt appropriate tick control measures in the enclosure and surroundings.

Class/Species	Disease/ Infection	Remark
Red panda	Panleucopoenia, septicaemia	
Fishing cat	Chlamydiosis, entamoebiasis, giardiasis	
Leopard cat	Tuberculosis, toxoplasmosis, *Toxocariasis,* diphyllobothriosis	
Tiger	Rabies, feline panleucopoenia, feline infectious peritonitis**, tuberculosis, salmonellosis, colibacillosis, leptospirosis, pasteurellosis, babesiosis ehrlichiosis, trypanosomiasis*, anchylostomiosis and other hookworms, toxocariasis, paragonimosis and other roundworms, mange	*12/56 died within 2 weeks at Nandankanan zoo (2000) ** Without specific virological confirmation
Asiatic lion	Rabies, ICH, parvovirus*, tuberculosis, staphylococcosis, colibacillosis, leptospirosis, anaplamosis, dermatophytosis, ehrlichiosis, GI helminthosis, toxocariasis, Schistosomosis, dirofilariasis (*D. immitis*)	*A prevalence rate of 15% has been reported from Gir National Park
Leopard	Rabies, feline panleucopoenia*, ICH, anthrax, colibacillosis, babesiosis, *Hepatozoon felis,* toxocariasis sarcocystitis, paragonimosis, diphyllobothriosis	*Reported death of 3 animals
Jaguar	Anthrax*	*Confirmed in Trichur Zoo (1982)
Snow leopard	ICH, septicaemia	

Trypanosomosis in wild cats

- *Trypanosoma evansi* infection has been reported in several wild animal species including felids and in Indian Zoos.
- Contaminated meat may be the source of infection to carnivores.
- Clinical symptoms in felids include inappetance, dullness, dyspnoea, lateral recumbency, bilateral corneal opacity, serous ocular discharge and photophobia, anaemia and death.
- Diminazene aceturate may be toxic to big cats and should be used with caution.
- Quinapyramin (Triquin) is effective to manage Trypanosomosis in big cats.

Class/Species	Disease/ Infection	Remark
Proboscidea		
Elephant	Rabies, FMD, pox, tuberculosis, anthrax, HS, tetanus, BQ*, foot rot, actinomycosis, colibacillosis, trypanosomosis, fasciolosis, amphistomosis, anoplocephalosis, strongylosis, stephanofilariasis	*Single case report from Assam State Zoo (2005)
Perisodactylids		
Rhinoceros	Rabies*, tuberculosis, anthrax, HS, staphylococcosis , colibacillosis, sarcocystitis, entmoebiasis, balantidiasis, anoplocephalosis	*Died at Zoo. Park Lucknow (1992) and Kanpur (2001). Confirmed by IVRI
Wild ass	Rabies, streptococcosis, strangles, *Cl. perfringes type* 'D', microfilaiasis Trypanosomosis*	*In free range conditions
Zebra	Tuberculosis, staphylococcossis	
Artiodactylids		
Giraffe	TB, *Cl. perfringes* 'D' infection*	*Reported in 1981
Spotted deer	FMD, rabies*, blue tongue, HS, tuberculosis, anthrax, colibacillosis, leptospirosis, nocardiosis, staphylococcosis dermatophytosis (Trychophyton), anaplasmosis, theileriosis, trypanosomosis, coccidiosis, fasciolosis, strongylosis, oesophagostomosis and paramphistomosis**	*Negri bodies demonstrated in 7/11 dead animals at Chital farm, Chennai (1997) ** Heavy mortality reported at Ranthambor National Park (1986)
Hog deer	Blue tongue, tuberculosis, nocardiosis	
Serow	Tuberculosis	
Chinkara	Haemorrhagic septicaemia	
Nilgai	FMD, blue tongue, tuberculosis, anthrax, dermatophycosis, theileriosis, amphistomosis, fasciolosis, coccidiosis	
Black buck	FMD, anthrax, tuberculosis, actinomycosis, pneumonic pasteurellosis (*Past. haemolytica*), salmonellosis, paramphistomosis, fasciolosis, bunostomosis	Black quarter is also reported (1978)

Class/Species	Disease/ Infection	Remark
Sangai deer	Rabies, actinomycosis	
Barking deer	Blue tongue, anaplasmosis, stephanofilariasis	
Sambhar	Rabies, FMD, haemorrhagic septicaemia, tuberculosis, anthrax, tetanus, CBPP, salmonellosis, colibacillosis, leptospirosis, dermatophytosis, candidiasis, trypanosomosis, sarcocystitis, filariasis	
Swamp deer	*E. coli* Type 099*, *Pseudomonas aeruginosa, Leptospira canicola, L. australis*, fasciolosis, amphistomosis	* Assumes zoonotic significance
Bison	FMD, Johne's disease *(Mycobacterium paratuberculosis)*	
Pigmy hog	*Salmonella typhimurium, S cholerae suis*, and *S. enteritidis*	
Rodents		
Porcupines	Tuberculosis*	* Reported in 1974

B. Non–infectious diseases

REPTILES

Gharial	Gout*	*From animals that died in Chambal river (2007-08)
Muggar	Infighting injuries and trauma	

AVIAN

Pea fowl	Wound, fracture, hypovitaminosis, pesticide poisoning*	* Free range birds
Gyps vultures	Visceral gout, fracture, diclofenac toxicity	
Emu	Impaction of gizzard	

MAMMALS

Primates

Bonnet monkey	Traumatic injury and wound	
Chimpanzee	Traumatic injury, haematuria	

Carnivores

Sloth bear	Capture myopathy, articular haematoma, traumatic injury	
Himalayan black bear	Epistaxis, corneal opacity, sclerosis, abscess, injury	

Class/Species	Disease/ condition	Remark
Common palm civet	Nephritis, liver cirrhosis, stress, traumatic injury	
Fishing cat	Liver abscess, Pleurisy, Infighting injury	
Leopard cat	Wound injury, lameness, stress	
Jungle cat	Epistaxis, wound, transport stress, splenomegaly, ascites, paralysis	
Golden cat	Hepato-nehropathy	
Tiger	Dehydration and shock, epistaxis, renal failure, carcinoma, posterior paralysis, ascites, splenomegaly, umbilical hernia	
Asiatic Lion	Dehydration and shock, infighting injury, lameness, nephritis, cataract	
Leopard	Rectal prolapse, injury, wound, lameness, arthritis	

Hind-quarter paresis in large cats

- Occurrence of hindquarter paresis is quite common in leopard and tigers.
- Chronic traumatic injury, generally due to falling of trap door upon tail or hindquarter is the main cause.
- Nutrition deficiency may also contribute to this problem.
- Regular supplementation of multi-mineral vitamin may show some ameliorative effect.
- Possible correlation of hindquarter paresis and inbreeding cannot be ruled out.

Proboscidea

Elephant	Osteomyelitis, lameness, traumatic wound, tympany, ascites, intussusceptions, impaction of colon, OPC poisoning*	*Reported from National Parks

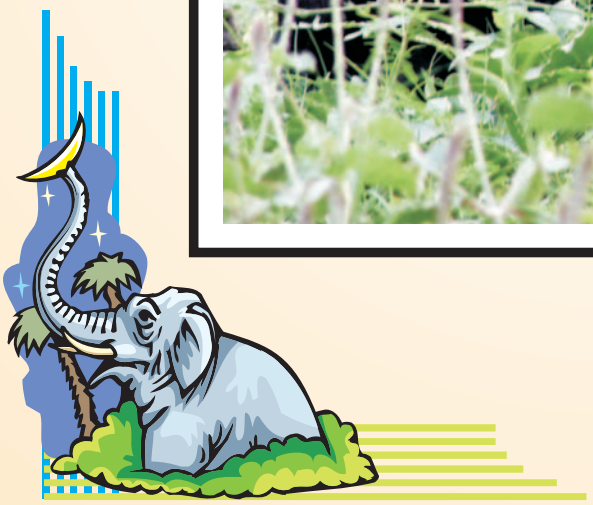
Perisodactylids

Rhinoceros	Dehydration and shock, nephritis, tympany, arthritis, biliary carcinomas	
Zebra	Tympany, cardiac failure	

Class/Species	Disease/ Infection	Remark
Artiodactylids		
Giraffe	Lameness and sprain	
Spotted deer	Infighting injury, capture myopathy, shock, wound, tympany, liver cirrhosis, *nitrate-nitrite poisoning	* Caused mortality at Kanpur Zoo (2008)
Black buck	Injury, tympany, snake-bite, liver cirrhosis, *nitrate- nitrite poisoning	*Caused mortality at Kanpur Zoo (2008)
Sambhar	Traumatic injury, dystocia, cardiac failure, uterine torsion	
Barking deer	Snake bite, cardiac failure, shock, wound, hip dislocation	
Swamp deer	Tympany, wound	
Hog deer	Wound and abscesses, lameness, frothy bloat, cardiac and respiratory failure	
Hippopotamus	Intestinal strangulation, congenital defects	

CHAPTERS 04

DIAGNOSIS OF DISEASES AFFECTING WILD ANIMALS IN ZOOS



4. Diagnosis of Diseases Affecting Wild Animals in Zoos

Establishing diagnosis is the most crucial aspect of disease investigation and accurate diagnosis is vital to decide specific therapeutic and appropriate control measures. Diagnosis is the identification of disease affecting animals. In simple terms, disease is an inability to perform physiological functions at normal levels even though nutrition and other environmental requirements are adequate. The cardinal signs of disease include:

- Changes in behaviour (separation from group, sluggish, dull or indifferent response, anxiety, restlessness, hyper-excitation, cannibalism)
- Voice abnormalities (hoarse, soundless bellowing, yawning and continuous bellowing)
- Changes in appetite (partial to complete anorexia), prehension, mastication or swallowing
- Changes in color, volume, frequency of urine/faeces
- Abnormal posture, gait (movement), bodily condition
- Changes in skin and its abnormalities (alopecia, discolouration of hair or wool, itching, trauma, bleeding)
- Altered vital signs: Temperature, pulse and respiration (TPR)

A sick animal can be identified on the basis of above cardinal signs. However in peracute conditions, animal may be found dead without any clinical signs are noted.

The complete diagnosis includes- identification of the specific cause, determining abnormality of structure and function (produced by the causative agent) and associated clinical manifestation. Establishing correct diagnosis of disease in wild animals is a difficult task and diagnosis is generally tentative, and uncertain, and the treatment is empirical based on clinical findings. The diagnostic uncertainty is thus the crux of all veterinary problems in wildlife health management.

4.1 Types of diagnoses

Depending on the available information and circumstances, diagnosis is described using following types of diagnostic possibilities

- **Differential diagnosis:** It is the initial stage wherein plausible diagnostic possibilities (mostly 3-5) are made on the basis of clinical signs and laboratory findings. For example, signs of polydypsia and polyuria in a canid can occur in hyperthyroidism, renal failure, diabetes mellitus or liver diseases. A veterinarian should consider all these diagnostic possibilities for further investigation of the case.
- **Tentative diagnosis**: It is suspected diagnosis based on history and initial clinical examination and experience of the veterinarian. Under certain circumstances, it may not be necessary to proceed for further tests and therapeutic strategies can be decided based on tentative diagnosis.
- **Presumptive diagnosis:** It is usually made after considering several differential diagnoses and the collection of further clinical and laboratory examinations. It can also be made by exclusion of possibilities after detailed clinical examination
- **Definitive and etiological diagnosis:** It is the final diagnosis wherein specific cause of diseases is precisely identified on the basis of thorough clinical examination and laboratory tests. The diagnosis includes description of abnormality of structure or function produced by causative agent. Definite diagnosis also includes cause of the disease. Example: *paediatric gastroenteritis* due to *feline panleucopoenia* virus. However, many a times aetiological diagnosis can not be made because of lack of confirmatory laboratory assistance and definitive diagnosis is described without mention of aetiological factor. Example: *canine colitis* or *canine granulomatous meningo-encephalitis*
- **Patho-anatomic diagnosis:** This is based on pathological findings in the affected body organ or system and the morphological description of the lesion. Example: *Granulomatous encephalitis*
- **Open diagnosis:** When the clinical abnormalities are detected but their cause can not be ascertained the diagnosis is made as open diagnosis. The open diagnosis should be processed further by continuous clinical examination, history and laboratory test to establish definitive aetiological diagnosis.
- **Undetermined diagnosis:** It is the most usual type of diagnosis and required to initiate symptomatic therapy or treatment of the clinical abnormalities. This type of diagnosis is common in zoo and wild animals because of difficulty in animal handling and collection of biological samples for definitive and etiological diagnosis.

4.2. Diagnostic protocol and veterinary record keeping

A readily recognizable course for clinical case management consists of three steps: Collection of database, generation of diagnostic hypothesis and development of management plans. The outline to be adopted for completing the course is mentioned below

A. Collection of database

- **History:**
  - *Patient data:* Identification number, species, sex, age, date and place of birth, physiological status, transaction history (if any)
  - *Disease history:* Present disease (clinical findings, and morbidity, case fatality and mortality), previous exposure/ treatment and prophylactic measures
  - *Management history:* Nutrition/ diet (any change), breeding and reproductive history, general management
  - E*nvironment*: Surroundings including housing (change if any), types of the own and nearby enclosures, waste disposal, disinfectant used, introduction of potential environmental/ social stressors
- **Examination of patient:**
  - *General inspection* (individual, group, herd, flock, pack). Note any sign of change in behaviour, feed intake, general appearance, overt clinical sign, etc
  - *Physical examination* of individual animal (after proper restraint)
  - *Special physical examination of system or organ*
- **Paraclinical tests (that can be used to support the history and clinical findings)**
  - Medical imaging, endoscopy, radiology, biopsy
  - Haemogram and blood biochemistry
  - Stool, blood, skin and other tissue/fluid examinations
  - Serology, histopathology, tuberculin tests, etc
  - Feed and water analysis, toxicological assays

B. Generation of diagnostic hypothesis

- Create short list of diagnostic possibilities by relating key clinical signs. Generate hypothesis for plausible diagnosis
- Consider each diagnostic possibility using both inductive and hypothetico- deductive reasoning to arrive at a tentative diagnosis

C. Developing disease management plan

On arriving at a tentative diagnosis, additional clinical examination and recommended specific laboratory tests need to be considered. Decision on the therapeutic measures to be undertaken and making a rational prognosis should be taken at this stage. The database, diagnosis and treatment plans can be revisited on the basis of new information or developments.

The standards of professional conduct, etiquette and code of ethics for veterinary professionals in India are regulated under Veterinary Council of India (Standards of Professional Conduct, Etiquette and Code of Ethics for Veterinary Practitioners) Regulations, 1992. The veterinarian is authorized to make a diagnosis, provide a prognosis, recommend rational treatment and control procedure. At the same time he/she can explain treatment options, including prognosis and euthanasia along with the cost of treatment and probable outcome to zoo authorities. Advice of Health Advisory Committee, constituted as per the provisions under Rule 10, Sub Rule (31) of Recognition of Zoo Rule-2009, may be sought of on all matters related with sanitation, hygiene, prophylaxis, nutrition and management of sick animals.

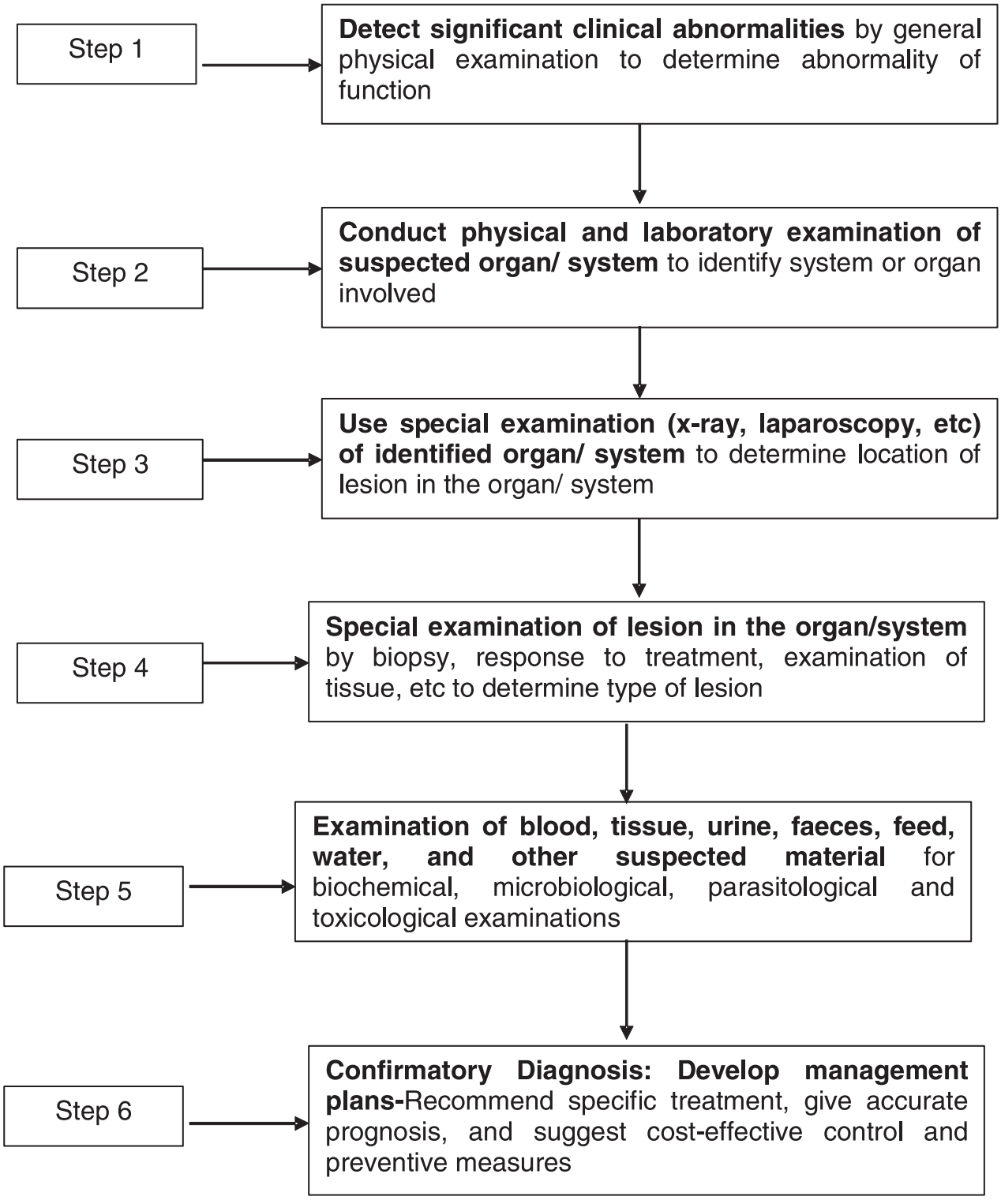
Wild animals can mask signs of illness

Clinical signs of sickness are important for early detection of disease, but it is often difficult to make clinical assessment of sick wild animals as they may not exhibit overt clinical signs so frequently until near death. Daily rapport is therefore, necessary between the attendant, veterinary staff and animal keepers. Being in close contact, keepers can detect subtle abnormalities in animals they are attending. However, do not use technical terms while questioning the animal keepers. The ailing animal should be captured carefully for detailed investigation and treatment.

Fig 4.1 Characteristic bicorneal opacity in Trypanosomosis in a wolf (courtsey Dr. U. Shukla)

Fig 4.2 Dead Gharial floats on water surface

4.3. Steps for making a diagnosis



4.4. Necropsy and specimens for laboratory examination

Post-mortem (PM) examination is an important investigation to aid and establish disease diagnosis in zoo animals, where overt clinical signs of illness are less frequently observed. For example, evaluation of nutritional status is often difficult in wild animals. However, a thorough PM examination of an emaciated animal can help in confirming malnutrition on the basis of patho-morphological changes in fat depots, bones, and other internal organs. The procedures for necropsy in zoo animals can be adopted from the techniques used for closely related domestic species.

The necropsy examination should be initiated with recording of clinical history and close examination of external body parts for injury or fang marks and skin lesions. A close screening of tissue reaction identified as lesions is required while conducting necropsy. There are many diseases where pathognomic lesions are present in the internal organs. The striking lesions occur in heart (tiger heart) and mouth in FMD, in lungs in pneumonic tuberculosis, and in visceral organs (extensive haemorrhages) in haemorrhagic diseases.

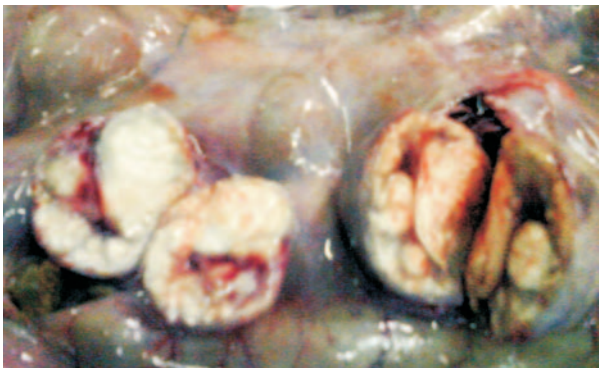


Fig 4.3 Tuberculus nodules in liver of nilgai

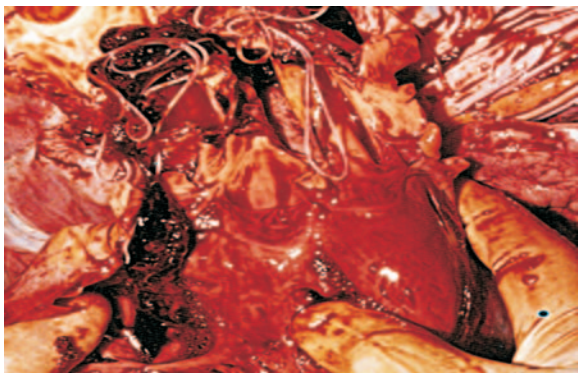


Fig 4.4 Heart worms (D. immitis) in a tiger

Knowledge of normal anatomical features of wild animals and morphological structures of visceral organs helps in interpretation of the necropsy findings. For example, a normal lung is pink in colour with spongy texture. An animal died of pneumonia may reveal red, purple or grey areas in lungs with firm texture. If pneumonic condition is older than 10 days, there may be firm adhesion of lung with the rib cages. The adhesions may require a knife to cut a part or remove the lung from thoracic cavity. Presence of worms in pneumonic lungs indicates lungworm infection. Animal with tuberculosis and mycotic pneumonia are usually in poor conditions. It should be noted that in adult elephants (*Elephus maximus)*, pleural space is absent and the lungs adhere to the chest wall by fibrous connective tissues. The Manual 'Basic Post-mortem Requisites for Zoo Veterinarians' published by Central Zoo Authority can be consulted for detailed anatomical features for important wild animal species and to understand basic requirements for proper conduct of necropsy.

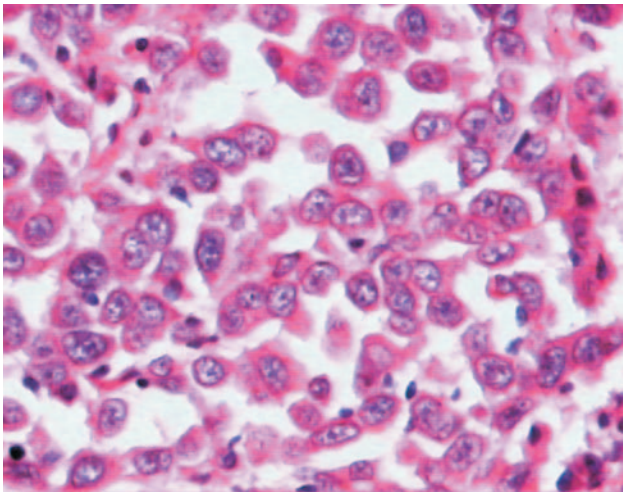


Fig 4.5 Histiocytic cell sarcoma (Lion)

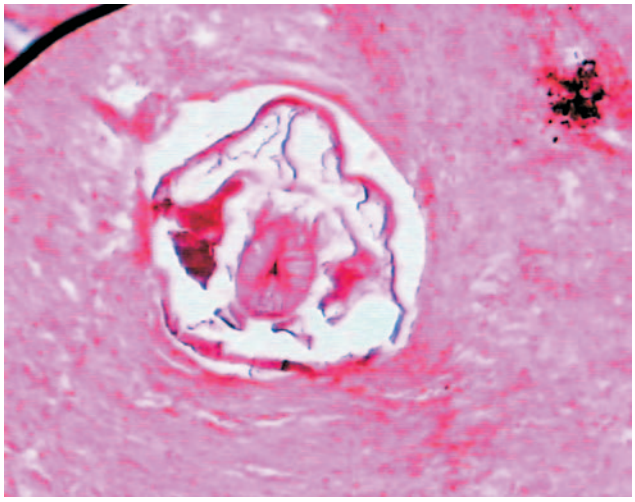


Fig 4.6 Gnathostoma spinigerum in tiger intestine

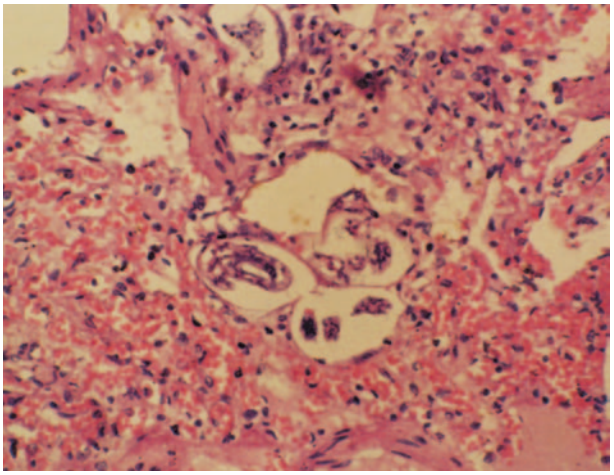


Fig 4.7 Lung worms in a panther

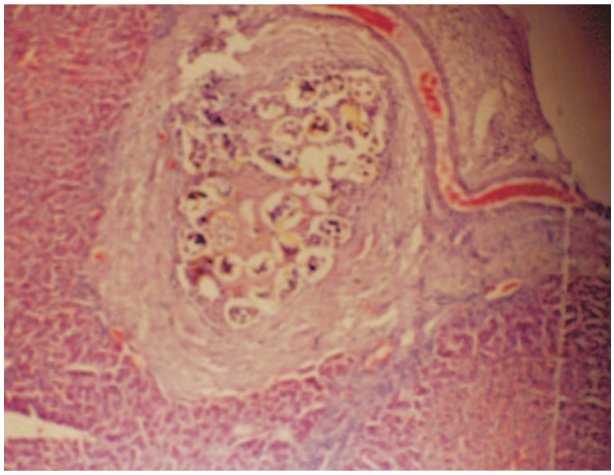


Fig 4.8 Fasciola eggs in liver of black buck

Fig 4.9 Ulcerated Nodular growth in stomach mucosa of gharial

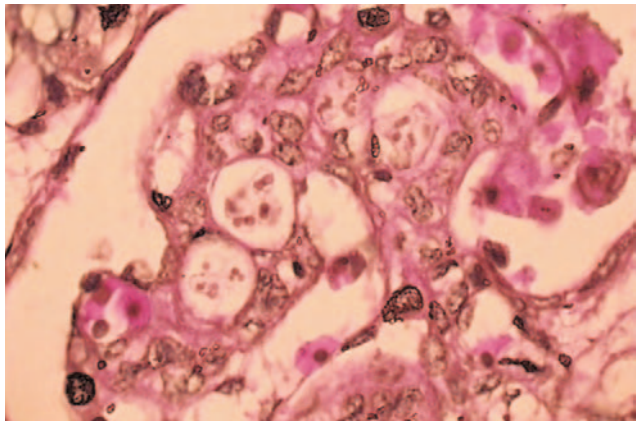


Fig 4.10 Goussia oocysts in kidney glomerulus of gharial

In addition to tissues having gross lesions, pieces of liver, stomach, small intestine, spleen, heart, lung, kidney, brain, etc. should be submitted invariably for histopathological examination. The tissue specimens should be collected in 10% formal saline for histopathological examination. For cultural examination, tissue should be placed in a sterile petridish or wide mouth jar. The specimen should be refrigerated if delay of more than an hour is expected in culturing. Tissue that cannot be taken aseptically should be removed as a large chunk and labelled 'non-sterile' and such specimen can be processed in laboratory before culturing. Impression smears of organs for Giemsa and Gram stains are more beneficial. Parasites recovered from necropsy should be placed in physiological saline until they can be fixed.

For chemical analysis, fresh specimen should be frozen immediately before submission to laboratory. Heparinized whole blood (10ml) and/or 10g (multiple pieces) each of kidney, liver, brain, muscles in ice-packed wide mouth bottle should be submitted for analysis of toxic heavy metals. About 50ml stomach/rumen content may also be submitted for diagnosis of poisoning. Special consideration is needed while sending specimen for chemical analysis. Do not use any preservative. If a preservative has been used, separate sample of the preservative should be submitted along with the specimen. For detection of cyanide, forage should be sent together with liver and muscle in 1% mercuric chloride. For diagnosis of nitrate-nitrite poisoning, samples of urine (frozen), suspected forage (dry) or other potential source of poisoning and 100g ingesta (after adding chloroform or formalin) should be submitted to laboratory. Whole blood under mineral oil for ammonia and urea, and bones and urine for fluoride should be submitted to the laboratory with proper labelling and details.

4.5. Veterinary medical records

Maintaining a veterinary medical record is mandatory for individual animal/herd/flock in each zoo. The record should contain information about

- The patient (patient data) including signalment or description of animal for identification purpose and; name of patient (if given), species, breed, sex, age (date of birth), colour, physiological status, body weight
- Disease history- previous health problem, diagnosis and treatment given, immunization and prophylactic medication, transaction status, current problem or clinical signs
- Daily record entries must include daily observations including diagnostic and therapeutic plans. Drugs and methods used for restraint and recovery must also be noted.
- Patient evaluation and case note including laboratory test reports
- Discharge instructions and case summary

To maintain a complete health record of an individual animal, it is recommended that the veterinary medical records should be supplemented with the information about samples collected and submitted to laboratory for specific test, the reports received from laboratory, and necropsy findings including gross and histopathological report (in the event of death).

4.6. Standards for veterinary record keeping

The formats for history sheet, treatment sheet, treatment register to be maintained in the zoo hospital and post-mortem data sheet have been published in the Indian Zoo Year Book (Vol-V, 2008) and these can be used by the zoo veterinarians. More informative formats to maintain veterinary medical record and post-mortem are given in **Annexure- II a & b.** These formats should be followed uniformly by all recognize zoos.

MedARKS: The standard Computer Programme such as The Medical Animal Records Keeping System **(MedARKS)** is a DOS based software, which supports veterinary medical records keeping and collection management. It can be used for maintaining the veterinary medical records of zoo animals uniformly in zoos. **MedARKS** is distributed to ISIS members upon request. The programme includes: MedARKS Controlled Drug Module, **MedARKS** Anaesthesia and Prescription Modules, Parasitological Examination Records, Prescription Records, Diagnostic Test and Sample Storage Records, Clinical Notes, Pathology Records, Inventory, History Reports, Problems List.

4.7. Retention of health records

No definite guideline was available to define exactly how long the veterinary records should be maintained. There appears to be no guideline/regulation provided by the Veterinary Council of India in this regard. In general, it is recommended that active veterinary records should be maintained according to the life expectancy of animals and inactive records should be maintained for a minimum period of 5 years. Some foreign universities recommend 10-20 year retention period.

4.8. Guidelines for diagnosis of selected infectious diseases of zoo animals

ANAPLASMOSIS

History and epidemiological features	Tick infestation with signs of fever, anaemia, weakness. Mainly reported from domestic and wild ruminants including cattle, buffalo, black buck, deer, antelopes and bison. Incidence are also reported in large felids.
Clinical Indicators	Anaemia, debility, icterus. Depression, staggering gait and muscle tremors are seen in large cats.
Clinico-pathological (antemortem) tests and differential diagnosis	Haematology for anaemia and microscopic examination of blood smears for presence of organisms (*Anaplasma* spp) in red blood cells.
PM findings	Emaciation, pallor tissues, mild jaundice and watery blood.
Specimens for lab	Blood smears and serum.
Diagnostic confirmation	Detection of organisms in blood smear and serological tests.

ANTHRAX

History and epidemiological features	Often occurs in form of outbreaks in climatic extremes and following ingestion of infected feedstuffs including infected carcasses. Reported mainly in artiodactylids, proboscidea, and raptor birds. Carnivores are considered resistant but can be infected by consuming anthrax infected meat.
Clinical Indicators	Sudden death with high fever, subcutaneous oedema and painful swelling. Bleeding from natural orifices. Elephant show profuse salivation, dropping of head and trunk and pendulous penis.
Clinico-pathological (antemortem) tests and differential diagnosis	Clinico-haematological tests are not advisable. Blood or subcutaneous fluid may be examined for presence of bacilli. Rule out possibility of lightening stroke, peracute blackleg, and acute fasciolosis.
PM findings	Carcass not to be opened. Exudation of tarry blood from natural orifices of carcass, failure of blood to clot and absence of rigor mortis are diagnostic indicators.
Specimens for lab	Unopened carcass, blood or oedematous fluid in sealed leak proof container. Formalin fixed spleen and lymph nodes (in case carcass has been opened).
Diagnostic confirmation	By identification of bacilli in blood or tissues using polychrome methylene blue stain of smear, or by culture.

AVIAN POX (FOWL POX)

History and epidemiological features	Slow spreading infection affecting at least 60 species of 20 avian families. Pigeons, passerines and birds of prey are usually affected. Predisposed by stress and other immunosuppressive infections.
Clinical Indicators	Presence of proliferative lesions on the un-feathered skin (head, neck, legs and feet) in cutaneous form. Lesion in upper respiratory and digestive tract in diphtheric form.
Clinico-pathological (ante-mortem) tests and differential diagnosis	Characteristic gross lesions that progress from proliferative lesions to thick scabs. Small white nodules in mouth and GI tract in diphtheric form.
PM findings	Necrotic lesions surrounded by proliferative lesions.
Specimens for lab	Tissue specimen with lesions.
Diagnostic confirmation	Presence of intra-cytoplasmic inclusions and virus isolation.

AVIAN INFLUENZA

History and epidemiological features	History of outbreak of bird flu in poultry, ducks, turkeys or other birds in the surrounding areas. Ducks, geese, pheasants, partridge, psittacians, gulls, shorebirds, emu, eagles, and many other bird species can be infected. Also reported in felids including tiger. Pigs play vital role in the interspecies transmission.
Clinical Indicators	Mild to severe respiratory distress, ruffled feathers, depression, decreased feed and water intake in low pathogenic avian influenza (LPAI). High pathogenic avian influenza (HPAI) infection is characterized by respiratory signs, depression, sinusitis, watery diarrhoea, oedema of comb and wattle with cyanosis and haemorrhages, neurological signs and heavy mortality. Wild felids show sneezing, nasal discharge, malaise and pyrexia.
Clinico-pathological (ante-mortem) tests and differential diagnosis	Differentiate from botulism, Ranikhet disease, duck viral enteritis, pasteurellosis, and other septicaemic infections.
PM findings	Variable lesions; include haemorrhages in epicardium, pectoral muscle and mucosa of proventriculus and ventriculus in poultry. Necrotic foci in pancreas, spleen and heart. Severe lung congestion with haemorrhages, pleural effusion and serosanguineous exudates in tracheal and bronchiolar lumen are found in infected tigers.
Specimens for lab	Cloacal and oropharyngeal swabs or fresh faeces in virus transport medium. Visceral organs stored at -80°C or fixed in 10% formalin.
Diagnostic confirmation	Detection of virus by egg inoculation, virus isolation methods and by RT-PCR. BSL-3 lab facilities are essential for testing.

BABESIOSIS

History andepidemiological features	Tick transmitted disease mainly affecting domestic and wild ruminants (cervids), horses and pigs. Also reported in felines (domestic cats, caracal, lion and tigers). Caused mortality in tigers in India.
Clinical Indicators	Anaemia, haemoglobinuria, jaundice and fever. Anorexia, dullness, anuria. Haemoglobinuria and pyrexia reported in tigers.
Clinico-pathological (ante-mortem) tests and differential diagnosis	Haemogram and blood smear examination for piroplasm. Differentiate from theileriosis, PPH, bacillary haemoglobinuria, leptospirosis, equine infectious anaemia.
PM findings	Thin watery blood and jaundice.
Specimens for lab	Whole blood and smear, serum.
Diagnostic confirmation	Parasites in blood smears and presence of tick vectors on host body or in the environment.

BOTULISM

History and epidemiological features	Ingestion of stored food with preformed toxins or food contaminated with toxin containing carrion (dead birds or animals). More common in birds (chicken, geese, ducks, water fowl). Pigs, dogs and cats are relatively resistant. Pica (associated with phosphorous deficiency) predisposes the disease.
Clinical Indicators	Muscle tremors, progressive weakness, restlessness, knuckling, incoordination, stumbling, paralysis and recumbency in large animals. Birds show paralysis of neck, easy removal of feathers and respiratory failure.
Clinico-pathological (ante-mortem) tests and differential diagnosis	Needs to be differentiated from rabies, organophosphorous poisoning and other paralytic conditions of poultry.
PM findings	No specific lesion.
Specimens for lab	Suspected contaminated feed material, liver, gastro-intestinal and rumen contents, serum from live animals for toxin/ bacteriology. Formalin fixed brain for histopathology.
Diagnostic confirmation	Demonstration of toxin/ organism in serum and feed, intestinal content.

BRUCELLOSIS (ABORTION DISEASE)

History and epidemiological features	History of abortion with retained placenta, especially in ungulates. Reported in bison, elk, deer, moose and other wild ruminants. *Brucella canis* causes brucellosis in canine.
Clinical Indicators	Abortion epidemics in susceptible species. Presence of orchitis-epididymitis (enlarged testis, and epididymis), bursitis-synovitis and metritis, abortion with retained placenta syndromes.
Clinico-pathological (ante-mortem) tests and differential diagnosis	Rose Bengal Test in serum can be used for initial screening. Severe placentitis with surface exudates may be used to differentiate from other causes of abortion.
PM findings	Necrotizing placentitis, and inflammatory changes in foetus.
Specimens for lab	Placenta, and foetal stomach contents and lung for bacterial isolation. Formalin fixed placenta, lung, spleen brain, liver, kidney and maternal caruncles for histopathology.
Diagnostic confirmation	Isolation of organism from foetus and positive serological tests in unvaccinated animals.

CANINE DISTEMPER (HARD PAD DISEASE, CD)

History and epidemiological features	Occurs mostly in unvaccinated young carnivores (fox, wolf, jackal dogs, coyote, hyena, mink, ferret, raccoon and civet). Also reported in tigers, snow leopards, lions and jaguars. No confirm report of CD in felids in Indian zoos.
Clinical Indicators	Diphasic fever, conjunctivitis, keratitis, photophobia, blindness, hyperkeratosis of footpads and sometimes pustules on abdomen. Twitching of facial and limb muscles is seen in CNS form
Clinico-pathological antemortem tests and differential diagnosis	Haematological findings characterized by leucopoenia and lymphocytosis in initial stage followed by neutrophilia. Differentiate from spontaneous hyperkeratosis (no fever)
PM findings	Thymic atrophy (consistent lesion in young pups), necrosis of lymphatic tissues, bronchopneumonia and enteritis.
Specimens for lab	Impression smear from conjunctiva, buffy coat from peripheral blood and formalin fixed specimens of brain, spinal cord, lungs, stomach, intestine and urinary bladder tissues..
Diagnostic confirmation	Isolation and identification of virus, demonstration of intracellular eosinophilic inclusions in respiratory, GI and urinary epithelium.

COLIBACILLOSIS

History and epidemiological features	Reported in birds, artiodactylids, proboscids, felids and primates. Newborns, not receiving colostrum or abandoned by mother are more susceptible. Overcrowding and stress predispose the disease.
Clinical Indicators	Weakness and collapse (septicaemia), watery diarrhoea, dehydration, metabolic acidosis (enteric colibacillosis). Vomiting, diarrhoea, dehydration, respiratory distress in cats.
Clinico-pathological (ante-mortem) tests and differential diagnosis	Total and differential leukocyte count, increased blood urea, PCV and total proteins in serum. Should be differentiated from other causes of neonatal diarrhoea and septicaemic diseases.
PM findings	No specific lesions in septicaemic colibacillosis. Fluid filled intestine and dehydration in enteric form
Specimens for lab	Aseptically collected blood and chilled specimens of spleen, lung, liver, and faecal and exudate swabs, (in septicaemic form), segment of ileum and jejunum (in enteric form) for bacteriology and formalin fixed kidney, liver, spleen, lung, brain, jejunum ileum, colon and mesenteric lymph nodes for histopathological examination (HPE)
Diagnostic confirmation	Isolation and characterization (serotyping) of organism from blood (septicaemic form), intestine and faeces (enteric form).

DUCK PLAGUE (DUCK VIRUS ENTERITIS: DVE)

History and epidemiological features	Affects ducks, geese, swans and other ornamental birds. Out breaks are usually associated with breeding and nesting seasons and introduction of birds from known infection area.
Clinical Indicators	Sudden death with soiled or blood stained feathers around the vent. Males may have prolapsed penis. Photophobia, anorexia, ataxia, watery or bloody diarrhoea and brown bloody fluid in mouth.
Clinico-pathological (ante-mortem) tests and differential diagnosis	Differentiated from fowl cholera by absence of bipolar staining bacilli (Wright's stain) in heart blood smears.
PM findings	Small, dark and mottled spleen, patecheal to ecchymotic haemorrhages on heart, lungs, liver, intestinal serosa and mesentery. Enanthematous plaques beneath the tongue, around the cloaca. Longitudinal streaks along the oesophagus are very specific, but inconsistent lesion in DVE
Specimens for lab	Fixed kidney, liver, spleen, heart, lung, oesophagus, intestine and cloaca for histopathology.
Diagnostic confirmation	Virus isolation and inoculation in ducklings, FAT and neutralization tests. Presence of intranuclear eosinophilic inclusion in hepatic parenchymal cells

FELINE PANLEUCOPOENIA (FELINE DISTEMPER)

History and epidemiological features	Most wild felids are affected. Occurrence is greater in unvaccinated population. Cubs and kittens are more severely affected.
Clinical Indicators	Sudden death in peracute cases. Acute condition is marked by biphasic fever, leukopenia, vomiting and diarrhoea. Terminally, hypothermia and shock.
Clinico-pathological antemortem tests and differential diagnosis	Parvo Dipstick test for detection of parvo virus in stool. Physical examination for dehydration and abdominal pain. Blood examination for total and differential leukocyte count.
PM findings	No specific lesion. Dehydration, dark and tarry blood. Hyperaemic gastric and intestinal mucosa and necrotic ulcer in ileum and colon mucosa.
Specimens for lab	Heparinized whole blood and pieces of intestine, lymphoid organs, bone marrow in 10% formal-saline or 50% glycerine saline and on dry ice separately. Faecal swabs or rectal swabs for virus isolation.
Diagnostic confirmation	Virus isolation and demonstration of characteristic inclusions in intestinal epithelial cells and histiocytes.

FOOT AND MOUTH DISEASE (FMD)

History and epidemiological features

Affects all cloven hoofed artiodactylids. Pigs including wild boars are the main source of virus. Unprocessed contaminated meat and meat products, pig food and contaminated feed, fodder and utensils potentially spread the virus, which can survive for a long period and can persist over 1 year in infected premises. Morbidity rate is very high and several animals may be found affected at a time.

Clinical Indicators

Fever, profuse salivation, vesicles in mouth and feet. Sudden death in young animals.

*Fig 4.11 Characteristic salivation in FMD affected Mithun**

Fig 4.12 FMD affected cape buffalo with foot lesion(*Courtsey Dr. C.S. Jayakumar)*

Clinico-pathological antemortem tests and differential diagnosis

Needs to be differentiated from other vesicular diseases. Lead poisoning is marked by salivation without fever. Natural infection of vesicular exanthema of swine is rare in ruminants.

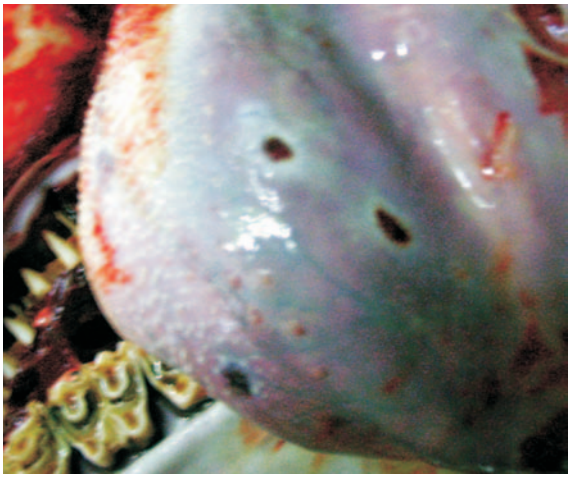


*Fig 4.13 Vesicular lesions of FMD on tongue**

*Fig 4.14 FMD lesions in buccal cavity**

PM findings	Vesicular, erosive /ulcerative stomatitis and oesophagitis. Vesicles and erosion on feet and udder. Tiger heart appearance (patches of yellow tissue interspersed with normal myocardium) in young animals died of FMD.
Specimens for lab	Epithelial suspension, serum, fresh vesicular fluid/tissue in glycerol-saline, blood/serum, throat swabs from pigs, formalin fixed specimens of oral mucosa, heart, mammary gland, and pancreas
Diagnostic confirmation	Virus isolation and typing and positive virus neutralization, ELISA, CFT, RT-PCR tests.

INFECTIOUS CANINE HEPATITIS

History and epidemiological	Dogs, foxes, wolves, and bears are mainly affected. More common in unvaccinated young pups. Other carnivores may harbour infection without overt clinical signs. Solitary case of inclusion body hepatitis reported in panther.

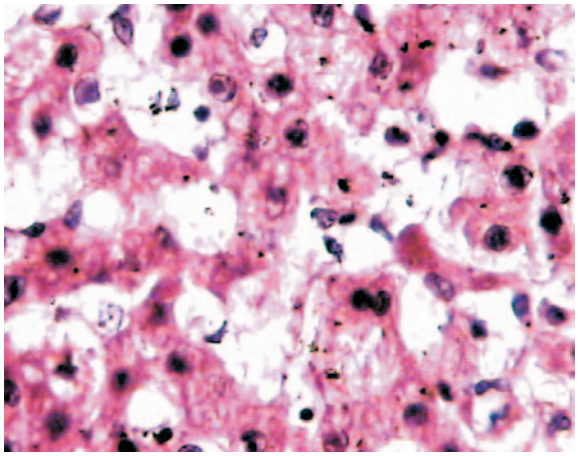


Fig 4.15 Histopathology section of liver showing intranuclear inclusions

Clinical Indicators	Biphasic fever lasting for 1-6 days with leucopoenia. Increased blood clotting time. Bleeding around deciduous teeth. Conjunctivitis and corneal clouding (blue eye).
Clinico-pathological	Signs of abrupt onset and bleeding suggest ICH. Total and differential count and blood clotting time may provide clues. Gross lesion in gall bladder (oedematous and thickened wall) and liver (necrosis) differentiate ICH from CD.
PM findings	'Paint brush´ haemorrhages on the gastric mucosa, lymph nodes, pancreas and subcutaneous tissues.
Specimens for lab	Formalin fixed liver, gall bladder, kidney, lymph nodes and gastric mucosa. Whole blood and sera samples from live animals.
Diagnostic confirmation	Virus isolation, immunofluorescence test and presence of characteristic intranuclear inclusions in hepatocytes.

JOHNE'S DISEASE (PARATUBERCULOSIS: JD)

History and epidemiological features	History of recurrent chronic diarrhoea. *Mycobacterium avium* subsp *paratuberculosis* is the cause of JD in wide range of wild artiodactylids and has also been isolated from faeces of foxes, crows, hares, badger, rats and wood mice, and these may be potential source of infection for susceptible hosts. Predisposed by physical, climatic and transportation stress, and nutritional deficiencies.
Clinical Indicators	Chronic persisting odourless profuse diarrhoea (non-responsive to antibiotic and anthelmintic therapy), emaciation, and rough hair coat. mandibular oedema.
Clinico-pathological (ante-mortem) tests and differential diagnosis	Blood examination suggestive of hypoalbuminaemia and dehydration. Faecal culture, microscopic examination of faeces for acid-fast bacteria by Ziehl-Neelsen stain, and ELISA, CFT, and lymphocyte immuno-stimulation tests for screening. Differentiate from intestinal parasitism (stools negative for ova), copper deficiency, molybdenosis, malnutrition, pyelonephritis, and TRP.
PM findings	Typical lesions of thickened intestinal wall with corrugated mucosa. Pale and swollen mesenteric lymph nodes, sometimes with tubercle like caseation.
Specimens for lab	Distal ileum, colon and ileocaeccal lymph nodes for bacteriology. Faecal smear for acid-fast bacilli. Formalin fixed samples of these tissues.
Diagnostic confirmation	Presence of intestinal lesions and positive faecal and serological tests.

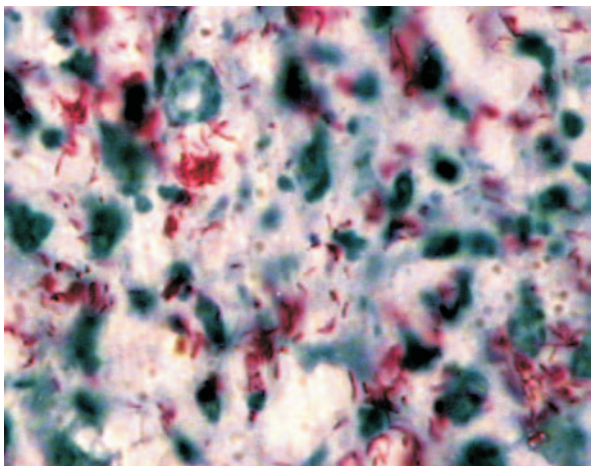


Fig 4.16 Acid fast organizsm with Ziehl-Neelsen stain

LEPTOSPIROSIS

History and epidemiological features	Reported in deer, dogs, bears, rodents, pigs, equines, caprine and ovine.More common in warm, wet climate with possibilities of contamination of water and soil, feed fodder by urine of infected and reservoir hosts (rodents, dogs, jackals). Ground surface moisture is the most important factor for the persistence of infection.
Clinical Indicators	Fever, acute haemolytic oedema, jaundice, still birth, and abortion. Anorexia, weakness, anaemia, haemoglobinuria (in deer), vomiting and haematuria (in dogs).
Clinico-pathological (ante-mortem) tests and differential diagnosis	Demonstration of leptospira in blood or body fluids. Blood examination for evidence of haemolytic anaemia. To be differentiated from anaplasmosis, babesiosis, other causes of abortion, chronic copper poisoning and ICH.
PM findings	Anaemia, jaundice, haemorrhages, haemoglobinuria and cardiac, hepatic and renal congestion.
Specimens for lab	Chilled kidneys, liver and placenta for bacteriology, FAT and PCR. Formalin-fixed kidneys, liver, brain, heart lung and placenta for histopathology. Heart blood serum for serology.
Diagnostic confirmation	Culture or demonstration of the organisms in blood, urine and tissues. Positive serological tests.

MAREK'S DISEASE

History and epidemiological	Affects wide range of bird species. Unprotected birds are more susceptible.
Clinical Indicators features	Progressive paresis and paralysis, depression, and death. Birds may assume characteristic posture of one leg held forward and other held backward.
Clinico-pathological (ante-mortem) tests and differential diagnosis	Differentiate from lymphoid leucosis and other neoplasm associated diseases. Bursal neoplasms are rare in MD and it can develop in very young chickens. Lymphoid leucosis generally occurs in chickens > 14 weeks of age.
PM findings	Enlarged peripheral nerves, visceral lymphomas (in liver, heart, gonads, skin and muscles) in young birds
Specimens for lab	Formalin fixed visceral organs (liver, spleen, gonads, lungs, kidneys and proventriculus) and of tumour lesion.
Diagnostic confirmation	Demonstration of predominant T-cell population and Marek's viral DNA in lymphomas by histochemistry and PCR.

RABIES (HYDROPHOBIA, LYSSA)

History and epidemiological features	Affects all warm blooded animals all over the world, except Australia and New Zealand. Highly fatal; has caused death of several free-ranging and captive wild animals including large felids, bears, deer, elephants, rhinoceros, wild ass, etc in India. History of bite by infected animals (dogs, foxes, jackal, raccoons, bats), provides inital clue to disease diagnosis. Many wild animals act as vector of disease (vampire bats-, South America, foxes- Europe, Canada and North America, skunks- North America, mongoose- South Africa, mongoose, foxes, jackal- Asia).
Clinical Indicators	*Furious form*- anorexia, hiding to isolated dark corner, disobedience to command, involuntary defaecation/ urination, sexual excitement, abnormal behaviour (jumping, bellowing, roaring, chewing or biting and dashing at the objects, catching inanimate objects), drooling of saliva, conjunctivitis muscular incoordination, paralysis and death.*Dumb form*- yawning, bellowing, roaring, barking. No excitement, due to paralysis of masticating muscles. Inability to chew or swallow, generalized paralysis, coma and death.
Clinico-pathological antemortem tests and differential diagnosis	There are no antemortem tests for diagnosis of rabies. Clinical indicators with history of bite by carrier animal may be pathognomic. Do not touch a suspected case of rabies without proper protective clothing and precautions. Differentiate from lead poisoning (circumstantial evidence of poisoning source and blindness in lead poisoning), polio-encephalomalacia (sign of blindness), hypovitaminosis-A (may occur in group of animals not receiving adequate quantity of vitamin-A), trypanosomosis (corneal opacity and presence of parasite) and listeriosis (signs of circling).
PM findings	No specific gross lesions. Non-suppurative encephalomyelitis may be seen.
Specimens for lab*	One half of the mid-sagittally sectioned brain, cervical spinal cord and parotid salivary gland in 10% formal-saline for histopathology; other half of the brain in 50% buffered glycerine-saline for mice inoculation test; corneal smear and saliva for detection of virus antigen
Diagnostic confirmation*	Positive Fluorescent antibody test (FAT) and Negri bodies in impression smears from brain (brain specimens of non-rabid cats are reported to show Lyssa bodies which are morphologically similar to Negri-body). Doubtful cases confirmed by mice inoculation test. Dot-ELISA and immunohistochemical tests are also used.

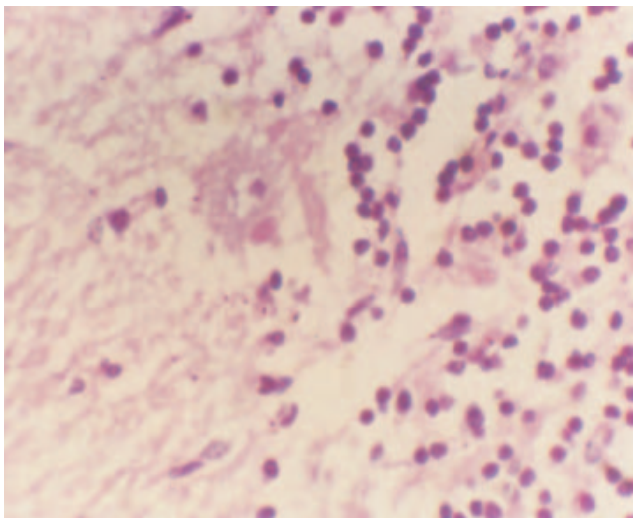


Fig 4.17 Negri body in neuron of rabid sloath bear

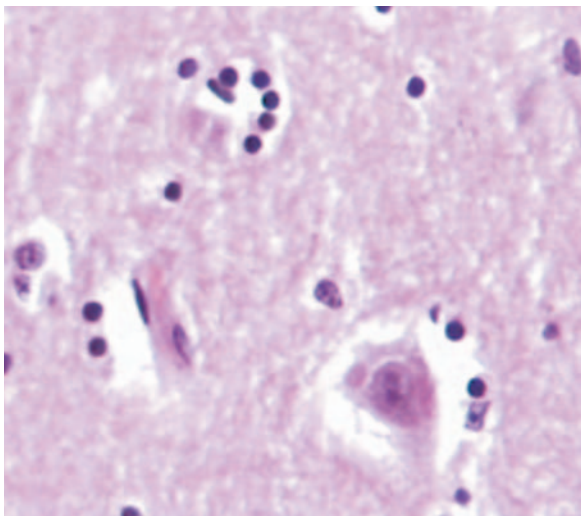


Fig 4.18 Neuronal degeneration in rabies

In view of zoonotic potential of the disease, take appropriate precaution while handling and transporting the samples from rabies suspected animals.

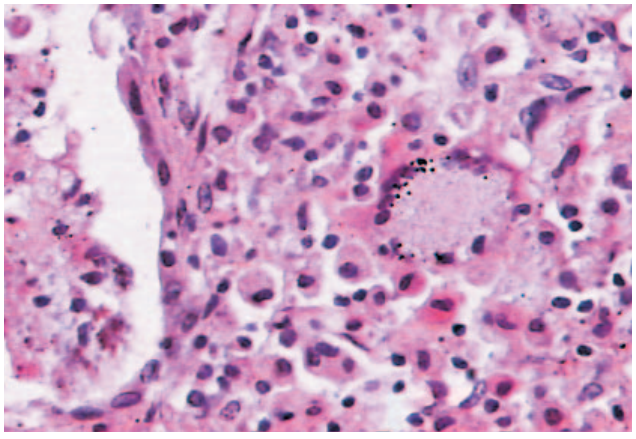


Fig 4.19 Tuberculous pneumonia in a spotted deer

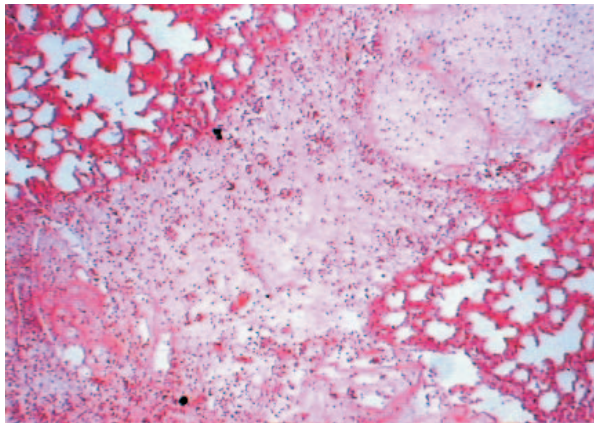


Fig 4.20 Lesions of pasteurellosis in lung of a deer

RANIKHET DISEASE (NEWCASTLE DISEASE, AVIAN PNEUMOENCPHALITIS)

History and epidemiological features	Affects poultry and wide range of wild birds including wild fowl, owl, African white backed vultures, kestrel and buzzard species. More common in young unprotected birds. Spread by respiratory aerosols, faecal contamination of food and water. Whole flock may be affected within 2-12 days.
Clinical Indicators	Virulent form is characterized by depression, anorexia, sneezing, nasal discharge, dyspnoea, conjunctivitis, yellow green diarrhoea and sign of nervous system involvement (paralysis of legs, ataxia, and torticolis). Nervous signs with diarrhoea are typical in pigeon.
Clinico-pathological (ante-mortem) tests and differential diagnosis	Differentiate from other paramyxovirus, HPAI, psittacine proventricular dilatation syndrome and lead toxicity.
PM findings	Hepatomegaly, splenomegaly, petechial or ecchymotic haemorrhages on visceral organs and air sacks.
Specimens for lab	Formalin fixed and unpreserved visceral organs and serum samples.
Diagnostic confirmation	Isolation of virus and Haemagglutitination inhibition test.

SALMONELLOSIS

History and epidemiological	Seen worldwide in all species of animals and man. Dogs and cats are asymptomatic carriers and clinical disease is rare. If it does appear, the severity is more. More common in young age and stress. In large felids, occurs secondary with immunosuppressive diseases.
Clinical Indicators	Septicaemia in neonate ruminants, pigs and foals. Acute to subacute enteritis marked by diarrhoea, dehydration and dysentery, fever. Signs in large felids include jaundice, haemoglobinuria, and dysentery. Young birds exhibit enteritis, and septicaemia. Pullorum disease of birds is marked by whitish faecal paste around the vent,
Clinico-pathological (ante-mortem) tests and differential diagnosis	Faecal and faecal swabs for bacterial culture, haematology for dehydration and electrolyte imbalance.
PM findings	Septicaemic haemorrhages, mucopurulent to marked fibronecrotic haemorrhagic enteritis. Classics greys nodules in liver, spleen and lungs in birds and liver nodules in rodents.
Specimens for lab	Faecal sample, ileocaecal lymph node, ileum, colon, spleen, lung, kidney for bacterial isolation and histopathology (formalin fixed). Blood serum for haemato-biochemsitry and immunology. Meat sample (if suspected as source of infection).
Diagnostic confirmation	Positive bacterial culture, Antigen-capture ELISA, PCR.

TUBERCULOSIS

History and epidemiological features

One of the commonest and fatal zoonosis of wild animals, affecting wide range of reptile, avian and mammalian species. In Indian zoos, mainly reported in non–human primates, bovids, cervids, rhinoceros, elephants and felids. History of progressive weakness, gradual weight loss, non-responsive coughing and prevalence of disease.

Clinical Indicators

Progressive emaciation, enlarged lymph nodes, fluctuating temperature, pharyngeal obstruction, dyspnoea and moist cough.

Clinico-pathological antemortem tests and differential diagnosis

Enlarged superficial (pre-scapular and pre-femoral) lymph nodes, detection of acid-fast bacilli (gold standard test for TB) in body fluids, tissues, sputum, trunk wash and tracheal lavage. Immunohistochemistry of lymph node biopsy, PCR, and detection of antigen–Ag 85 in serum. CBC, and radiography and intradermal tuberculin test as per following protocol;

Animal	*PPD dose and site*	*Reading at*	*Interpretation*
Non-human	0.1ml mammalian /bovine PPD. Intra-palpebral (upper eye lid) or flexor surface (smaller species)	24hr (inspection), 48 hr and 72 hr (Measurement)	Positive reactors show , erythema, swelling or closure of eyelid, purulent discharge and swelling of >5mm in forearm or abdomen (<3 mm negative, 3-5 mm doubtful). Comparative cervical test (CCT) using bovine and avian PPD in doubtful cases
Bison and other bovids	0.1ml bovine PPD in caudal fold	48 hr and 72 hr	≥5mm thickness and painful swelling +ve test
Cervids and giraffe	0.1ml bovine PPD in cervical fold	48 hr and 72 hr	As above. Retesting of suspected cases within 2-3 weeks by CCT
Elephants and Rhinocerous	0.1ml bovine PPD (5000 TU) at the base of ear (eyelid, or caudal fold has also been used in rhinoceros)	48 hr and 72 hr	Positive reactors show hypersensitivity reaction with increase in skin fold thickness >5 mm. It is not sensitive test in elephants; diagnosis is confirmed by positive culture in trunk wash (three samples on 3 separate days), PCR and ELISA. Annual testing by culture is recommended for TB in elephants.

PM findings	Tuberculous lesions in any of the lymph nodes and visceral organs (lungs, thoracic lymph nodes, intestine, mesenteric lymph nodes, and kidneys, liver, spleen and pericardium).
Specimens for lab	Affected lymph nodes and visceral organs for bacteriology and formalin-fixed samples of these tissues for Histopathology
Diagnostic confirmation	Bacterial isolation, PCR and other molecular techniques.

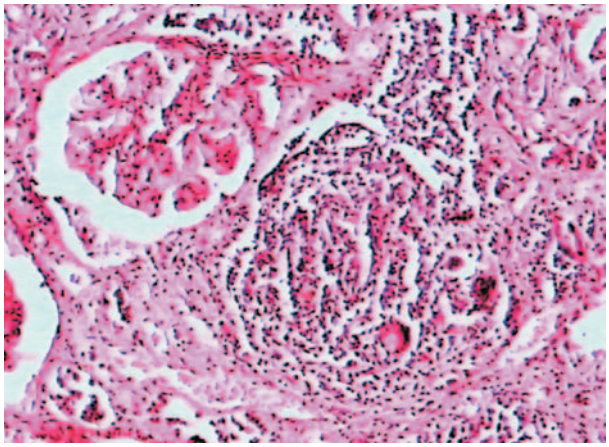


Fig 4.21 Tuberculosis lesion in kidney in a monkey

4.9. Diagnosis of selected non-infectious diseases and organ dysfunctions in zoo animals

HEPATIC DYSFUNCTION

Causes and risk factors	Many causes including hepatotoxins, viral, bacterial and parasitic infections of liver, mycotoxicosis, neoplasia, endocrine disorders feline hepatopathic lipidosis, cholangitis and cholangiopathies, .
Clinical indicators	Abdominal pain, jaundice, hepatic encephalopathies (hyper-excitability, convulsions, dullness, yawning, odema and emaciation, diarrhoea/constipation, prolongation of blood clotting time, photosensitization, anaemia .
Clinico-pathological indicators	Serum bile acid concentration, blood clotting time, albumin, total protein, arginase, gamma-glutamyl transferase, sorbitol dehydrogenase (ruminants) and aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase (felids and canids), bilirubin and urea nitrogen.
PM findings	Pathological lesions and abnormal liver morphology.
Specimens for lab	Whole blood, serum and liver biopsy.
Diagnostic confirmation	Clinical sign supported by laboratory test profile indicating liver dysfunction.

METABOLIC BONE DISEASES (OSTEOPOROSIS, OSTEOMALACIA, RICKETS, SIMIAN BONE DISEASE, CAGE PARALYSIS, PAPER BONE DISEASE)

Causes and risk factors

Can occur in all species of zoo animals including reptiles and birds. Prolonged deficiencies of calcium, phosphorous and/ or vitamin D or improper Ca: P ratio in the diet. Lack of proper solar radiation, protein deficiency, chronic liver and kidney disorders, prolonged anorexia, and long term corticosteroid therapy, and feeding of exclusively muscle meat/red meat diet to felids and reptiles are important contributory factors. More common in young growing animals.

Clinical indicators

Lameness due to painful bones and joints, bone deformities and fracture. Partial to complete reluctance to move, bowing of weight supporting bones, defective mastication and gingivitis, facial deformity, scoliosis, kyphosis, lordosis and collapsed pelvis, cataract and cross-eye in young felids in prolonged calcium deficiency and stunted growth in young animal.

Fig 4.22 Abormal posture in osteo-arthritis affected tiger

Clinico-pathological indicators

Evaluation of diet for protein, calcium, Ca: P ratio and vitamin D. Serum Ca: P ratio, bone ash concentration, bone radiology.

PM findings

Abnormal bones and teeth. Osteoporosis, osteomalacia/ rickets, thinned cortical bones, osteodystrophia fibrosa

Specimens for lab

Whole blood and serum, long bones of dead animals (for ash concentration), and feed for laboratory analysis. Formalin fixed long bones, and parathyroid for histopathology.

Diagnostic confirmation

Clinical findings supported by laboratory results.

RENAL DISORDERS

Causes and risk factors	Pre-renal, intrinsic and renal parenchymal, and post renal functional disorders. Bacterial viral and parasitic infections (Leptospirosis, leishmaniasis, babesiosis,borreliosis, feline infectious peritonitis, septicaemia) haemorrhages, hypertensive shock, hypovolaemic shock, burns, nephrotoxic drugs and non-therapeutic agents, etc.
Clinical indicators	Increased water intake, change in frequency and volume of urine, urinary incontinence, fibrous osteodystrophy in young animals, dehydration, azotaemia, haematuria, etc (all or some of the signs may be found).
Clinico-pathological indicators	Blood urea nitrogen, serum craetinine, creatinine clearance, Routine and microscopic examination of urine, and urinary specific gravity, protein, glucose and conjugated bilirubin.
PM findings	Pathological lesions and/ or abnormal morphology of kidney and urinary bladder.
Specimens for lab	Whole blood, serum (for biochemical tests and serology for leptospirosis in acute renal failure), renal biopsy/ formalin fixed specimens of kidneys, urinary bladder, heart and liver.
Diagnostic confirmation	Clinical sign supported by laboratory test profile indicating renal dysfunction.

ORGANOPHOSPHOROUS COMPOUND (OPC) - PESTICIDE POISONING

Causes and risk factors	Accidental ingestion or overdosing of OP compounds, use of oil based OPC preparations formulated for non-animal surface and contaminated feed and fodder.
Clinical indicators	Salivation, abdominal pain, diarrhoea, dyspnoea, ataxia, muscle tremors and weakness (acute cases). Anorexia, depression, recumbency, diarrhoea, incoordination, and posterior paralysis (delayed neurotoxicity).
Clinico-pathological indicators	Marked depression in blood cholinesterase activity.
PM findings	No diagnostic lesions in acute poisoning. Degenerative lesions in peripheral nerves in delayed neurotoxicity
Specimens for lab	Suspected feed, fodder and diet samples, whole blood for cholinesterase.
Diagnostic confirmation	Clinical sign supported by depressed cholinesterase level.

NITRATE- NITRITE POISONING

Causes and risk factors	Ingestion of nitrate containing preserved meat, and water with high nitrate content and coliform contamination. Excess nitrate in plants (plants growing rapidly after a long drought and in hot humid weather) causes poisoning in ruminants (also reported in wild cervids).
Clinical indicators	Sudden appearance of signs characterized by subnormal temperature, muscular tremors, weakness, ataxia, dyspnoea, anxiety, frequent urination and brown cyanotic mucous membrane. Vomiting, salivation diarrhoea, abdominal pain in monogastric animals.
Clinico-pathological indicators	Methaemoglobin and nitrate-nitrite concentrations in blood, nitrate content in feed/ fodder (can be evaluated by diphenylamine blue (DPB) test;1% solution is prepared by dissolving 0.5 mg diphenylamine in 20 ml distilled water and making 100ml volume by adding conc. sulphuric acid. Add to serum or urine or water extract of plant material and add diphenylamine solution. An Intense blue colour ring indicate positive test. Nitrate dipstick test can be used for nitrate content in water.
PM findings	Chocolate-brown coloured, un-clotted blood and pinpoint or large haemorrhages on serosal surface.
Specimens for lab	Chloroform/ formalin added whole blood, urine and feed and fodder sample for nitrate-nitrite estimation.
Diagnostic confirmation	Clinical sign supported by laboratory test for nitrate-nitrite.

POISONING BY MYCOTOXINS (AFLATOXICOSIS and OCHRATOXICOSIS))

Causes and risk factors	Toxins produced by *Aspergillus flavus, A parasiticus* (aflatoxin) and *A. ochracius* and other fungi (citrinin, ochratoxin). Spoiled feeds, especially mouldy maize, barley, breads, sorghum grains, harvested peanuts and wheat, (aflatoxins, ochratoxins and zeralenone) are the main sources. Young poultry, turkeys, dogs and ruminants are mainly affected.
Clinical indicators	Blindness, circling, falling, convulsions, grinding, frothing (acute aflatoxins), diarrhoea, polydypsia, polyurea and renal disorders (acute ochratoxin). Slow growth and hepatotoxicosis (subacute aflatoxicosis). Immunosuppression, polyuria and polydypsia, nephropathy (subacute ochratoxins).

Clinico-pathological indicators	Elevated levels of liver enzymes in serum. Presence of aflatoxin M_1 in milk, and aflatoxins in feed (aflatoxicosis). Kidney function tests, presence of ochratoxins in feed (ochratoxicosis).
PM findings	Hepatic necrosis, megalocytosis, fibrosis and jaundice (aflatoxicossis). Peri-renal oedema, enlarged pale kidneys (ochratoxicosis).
Specimens for lab	Specimens of liver, kidney, feed, fodder and ration
Diagnostic confirmation	High concentration of mycotoxins in feed and tissue specimens.

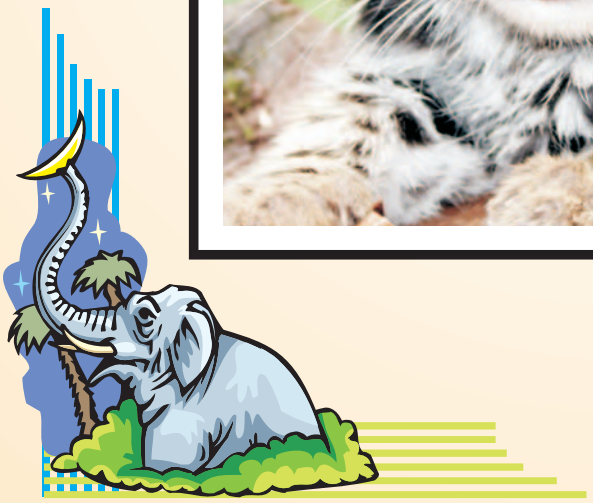
Nitrate-Nitrite toxicity in wild animals

Nitrate-nitrite toxicity has been reported in cervids and antelopes from many zoos/deer parks. Factor contributing to nitrate-nitrite accumulation include:

- Drought, insufficient sunlight or after application of herbicides
- When forage crops are fertilized with heavy dose of nitrogen fertilizer
- More than 0.9% nitrate in feed is potentially toxic.
- Nitrites are 10-15 times more toxic than nitrates.
- Posining manifests by increased respiration and pulse rate, frequent urination staggering gait, froth from mouth, blue coloration of the mucus membrane
- Nitrate oxidizes ferrous haemoglobin to ferric haemoglobin (methaemoglobin) which is not an efficient oxygen transporter. Animal basically suffers from lack of oxygen supply at tissue level. When 3/4th of haemoglobin is converted to methaemoglobin, death occurs.
- A 4% methylene blue solution (in 5% glucose) or 1.8% sodium sulphate solution given @ 10 ml/50kg IV).

CHAPTERS 05

VACCINATION PROTOCOL FOR ZOO ANIMALS



5. Vaccination Protocol for Zoo Animals

Vaccination is a process of active immunization to induce an immune response to the specific antigen. Vaccines can provide effective and generally very specific long term immunity. When used properly, vaccination is highly effective prophylactic measure in controlling infectious diseases. Several factors determine the use of vaccines and vaccination schedule to be followed.

5.1. Vaccine types

In India most of the commercially available vaccines for immunization of animals are either killed (inactivated) or modified live (attenuated) vaccines.

Killed (Inactivated) vaccines: In these vaccines, organism is inactivated usually by chemicals (generally formaldehyde, ethylene oxide, alcohol, ethylamine, beta- propiolactones, aziridine compounds). Killed organisms are commonly less immunogenic than living ones and therefore adjuvant is added to boost their immunogenicity. Thus killed vaccines often contain inactivated organism and adjuvant (aluminium hydroxide, aluminium phosphate, alum, saponin or mineral oils). Inactivated vaccines are generally required to be administered at an appropriate interval to induce a satisfactory immunity. Annual vaccination with inactivated vaccines is usually given to maintain an enduring immunity. These vaccines must always be given by injection at an appropriate site as recommended by the manufacturer.

The killed vaccines are considered safe as they may not cause disease. These are also economical to produce and easy to store. But the killed organisms may contain toxic molecules capable of provoking adverse effects, particularly in a species for which safety of vaccine has not been tested. Further, adjuvants used to increase antigenicity may induce local inflammation and risk of producing hypersensitivity reaction when used in high multiple doses. This aspect of vaccine safety is much important while recommending vaccine for wild animals.

Subunit vaccines: These vaccines are derived by purifying immunogenic fraction of an organism. Tetanus toxoid, used for active immunization against tetanus, is a formalin inactivated purified toxin. The subunit vaccines are safer than whole organism killed vaccines.

Attenuated (Modified Live) vaccines: These are produced by attenuating an organism in a manner that it can replicate, but looses virulence and becomes non-pathogenic. The organisms are adapted to unusual conditions including growth in tissue culture, eggs or in a species to which bacteria or virus are not naturally adapted. The degree of protection afforded by live vaccines varies depending upon the antigen and host. It is generally high and of long duration. The use of attenuated live vaccines in wild animals is viewed with concern.

Other vaccines: Invention of the modern vaccines such as gene deleted vaccines, DNA vaccines, live vectored vaccines, etc have provided hope for wildlife veterinarians for safe and effective vaccination of wild animals. Vectored vaccines have been developed and are commercially available in many countries for avian influenza in birds, canine distemper and rabies in dogs and cats. Recombinant vectored rabies vaccine may be beneficial in providing immunity to rabies in different wild animal species. Also, the Canarypox vectored canine distemper vaccine does not carry live canine distemper virus and has been used in clinical trials in large cats. No adverse reactions were reported and cats did develop detectable antibody titres to canine distemper virus. This vaccine provides the best option available to provide some protection against canine distemper virus in large felids.

5.2. Factors determining use of vaccines

Several factors determine use of vaccine and vaccination for prevention and control of a disease and be considered by zoo vets before opting vaccination.

- Ascertain the actual cause of disease before recommending vaccination of other animals. Vaccinating animals that have disease is not advisable. Antibodies contribute to the disease process in some viral diseases like feline infectious peritonitis and use of even killed vaccine in infected animals may worsen the condition.
- As a guiding principle, assess the risk of vaccination vis-à-vis harm caused by the disease. The risk of vaccination should not exceed the harm caused by disease itself. For example, canine distemper is not a high risk pathogen for large cats. But if an out-break occurs or the risk of exposure is very high, the vaccination with highly attenuated live vaccine may be recommended.
- In general, only inactivated vaccines should be used in wild and pregnant animals.
- Consider the possibility of side effects when vaccines are used. Unhealthy or febrile animals should not be vaccinated. Avoid vaccination of animals for 3-4 weeks of receiving immunosuppressive drugs.

- Occasionally animals may develop hypersensitivity reaction following vaccination. Adrenaline (diluted to at least 100 microgram/ml) should be given (0.5-10 microgram per kg body weight) promptly.
- For wild animals, use of killed vaccine is commonly recommended. Vaccine that confers immunity for longer period without any adverse effects should be preferred, even if it is costly.
- Mixed vaccines are available for immunizing animals against more than one organism. For example, FMD, BQ and HS for cloven footed animals; multicomponent canine distemper, canine adenovirus type-2 (CAV-2), canine parvovirus, canine contagious hepatitis and *Leptospira* vaccine for dogs; Feline Leukaemia, Feline Rhinotracheitis, Calici virus, Panleucopoenia and Chlamydia mixed vaccine (Fel-O-Vax LV-K) and Feline Herpes virus, Feline Calici virus and Feline Panleucopaenia virus vaccine for cats.
- A vibrant immunological system is necessary to achieve optimum immunity after vaccination. The wild animals in zoo are in captivity and exposed to several kinds of stresses or may be fearful of new settings, new groups, diets, odours and human approach, possibly causing stress on their immune system. As such, it is difficult to get desirable effectiveness of the vaccines, especially in newcomers. Vaccinate animals in quarantine once they become accustomed to their new homes.
- It is very difficult to estimate duration of immunity produced by the vaccine because of individual animal and vaccine variability. Considering possibilities of weak immune response in wild animals and that the vaccines are not tested for their potency in different wild animal species, many veterinarians use vaccines at more frequency than recommended by the manufacturer. If you have decided to vaccinate wild animals more frequently than yearly, prefer a killed non-adjuvant vaccine. Administer it by using a small bore needle and small syringe (like tuberculin syringe).
- Chances of vaccination failure are more in wild animals because the vaccines are not tested for their potency in different species of wild animals. A lot of handling stress is imposed on animal during administration of vaccines effectively which may supposedly suppress immune system.
- For inducing better immune response animals should be dewormed at least one week prior to scheduled vaccination and given balanced diet containing essential micronutrients in proper ratio.
- Veterinarian should always assess the need of vaccination on specific circumstance and specific disease basis to determine the need and frequency of vaccinating zoo animals. The experience of veterinarian in zoo animal practice is a guiding force.

5.3. Suggested vaccination schedule for zoo animals

Animal group	Disease/ Vaccine	Dose and route	Frequency	Remark
Non-human primates (Especially LTM)	Diphtheria+ Tetanus+ Pertussis vaccine(Killed vaccine intended for human can be used)	0.5ml IM	At 2-3 month, 5-6 month and 8-9 month of age; followed by annual booster and may be repeated after 3-5 yr	Vaccination to adult may be avoided.
	Tetanus toxoid (Adsorbed)	0.5ml IM	Two 6-8 weeks apart followed by 3rd injection after 6-8 month. Repeat after 3-5 yr	Tetanus toxoid can be used alone because diphtheria and pertussis are not considered health risk to non-human primates.
	Measles, mumps and rubella (human MLV vaccine can be used)	0.5 ml SC	Initial at 4 months of age. Annual booster	To be decided on the basis of disease endemicity.
Ursids (bears)	Leptospirosis	As above	As above	ICH has been reported in bears in certain zoos and multicomponent vaccines containing CAV-2 may be used for protection.
	Rabies Human Diploid cell culture vaccines (HDC inactivated / lyophilized) or Rabies cell culture (inactivated) vaccine for animal use	As for canids	As for canids	

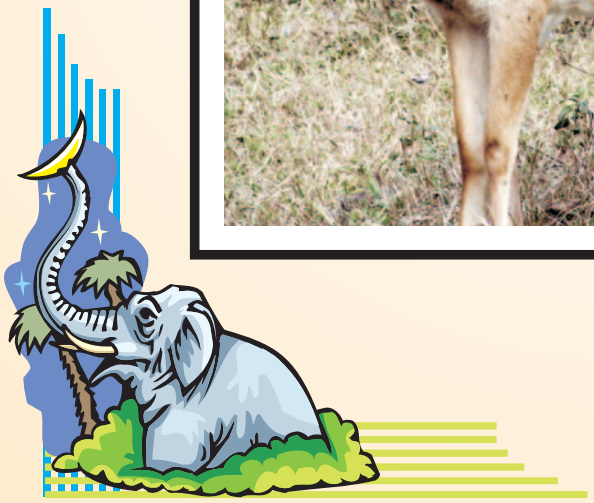
Animal group	Disease/ Vaccine	Dose and route	Frequency	Remark
Canids (Wild dogs, fox, wolves, jackal)	Canine distemper + Canine adenovirus type-2 (CAV-2)+ Canine Parvo virus vaccine (Attenuated live virus)	1 ml IM or SC	Initial- 8-9 weeks followed by second vaccination after 4 weeks. Annual vaccination	Take precaution to vaccinate wild-caught animals as they may be incubating the disease. Recommended only in zoo with history of disease occurrence.
	Infectious canine hepatitis (ICH)	As above	As above	CAV-2 provides cross protection against ICH (CAV-1) virus
	Rabies Human Diploid cell culture vaccines (HDC inactivated/ lyophilized) or Rabies cell culture (inactivated) veterinary vaccines	1 ml deep IM	3-4 months of age, followed by annual vaccination. Post-exposure vaccination on day 0, 3, 7, 14, 30 and 90	MLV vaccines licensed for domestic animals should never be used in wild animals. Care should be taken while vaccinating wild caught animals as they may be in carrier state.
	Leptospira killed vaccine	1 ml SC	At 3-4 months and thereafter annually	Combined vaccines containing CD +CAV-2+ canine Parvo+ inactivated Leptospira are available and can be used in zoos with history of occurrence of diseases.

Animal group	Disease/ Vaccine	Dose and route	Frequency	Remark
Felids	Feline panleucopenia +Feline rhinotracheitis + Feline calicivirus trivalent (killed vaccine)	1 ml SC in hind leg	At 3 months, 4 months and 6 months and one year of age followed by annual vaccination	Use small gauge needle and syringe (Tuberculin syringe and 25 gauge needle) to reduce the risk of vaccine induced sarcomas in cats.
	Rabies cell culture (inactivated) vaccine for animal use	1 ml SC in hind leg	At 3 months of age followed by annual vaccination	Revaccination annually in rabies endemic areas otherwise after first annual vaccination, repeat vaccine after 3-4 years. Human Diploid cell culture vaccine can also be used.
	Leptospira killed vaccine	As for canids	As for canids	Recommended in endemic areas, when animals are exposed to wet-damp environments, contaminated water, and high wild rodent populations.
Bovids and Cervids	Foot and Mouth Disease (FMD) oil adjuvanted inactivated vaccine	2 ml deep IM (large species) 1ml deep IM (small species)	At 6 month age, subsequently annual /half yearly vaccination	Take due precaution to avoid flight stress while vaccinating herd/ flock. Optional in zoo with no past history of disease out-break. Recommended during the out break of disease in livestock in the surrounding area.

Animal group	Disease/ Vaccine	Dose and route	Frequency	Remark
	Haemorrhagic septicaemia (HS) aluminium hydroxide gel adjuvanted inactivated vaccine	2 ml SC (large species) 1ml SC (small species)	At 6 month of age or above. Annual/ half yearly vaccination.	Unprotected animals may be vaccinated during an outbreak in livestock of surrounding area.
	HS + Black quarter (BQ) aluminium hydroxide gel adjuvanted inactivated vaccine	As above	As above	As above. Combined FMD+HS+BQ vaccine is also available and can be used as single shot vaccination against these diseases.
Other Artiodactylids (Giraffe) and Perissodactylids (Rhinoceros)	HS + Black quarter (BQ) aluminium hydroxide gel adjuvanted inactivated vaccine	4 ml SC	As above	Optional. Recommended in highly endemic areas.
Proboscidea (Elephants)	Foot and Mouth Disease (FMD) adjuvanted inactivated vaccine	5-10 ml deep IM	Annual or half yearly vaccination	Recommended in FMD endemic areas and in Zoos following FMD outbreak in livestock of surrounding areas
	HS+ Black quarter (BQ) aluminium hydroxide gel adjuvanted inactivated vaccine	5ml SC	All animals above 6 month of age may be vaccinated. Repeat half yearly/ annually.	
	Tetanus toxoid (Adsorbed)	1-2ml SC	Young calves of 2-3 months age. Booster after 3 months.	

CHAPTERS 06

PREVENTION OF ZOONOTIC DISEASES AFFECTING WILD ANIMALS AND ZOO PERSONNEL



6. Prevention of Zoonotic Diseases Affecting Wild Animals and Zoo Personnel

Zoonoses (*Greek- Zoon*=Animal + *nosos*= diseases) is used to define any infection, which is naturally transmitted between vertebrate animals (wild/ domestic) and man. Such infections may normally exist in animals, but can also infect man. Free-ranging and captive wild animals harbour several zoonotic agents and may be a potential source of transmitting them to man and domestic animals. Wild animals play significant role in transmitting dreaded diseases like rabies and tuberculosis, known to mankind since many centuries. Involvement of wild animals is also suggested in several recently emerging zoonotic diseases such as Ebola virus haemorrhagic fever, Hanta virus complex, Hendra virus, Acquired immunodeficiency syndrome (HIV), Nipah virus, Severe Acute Respiratory Syndrome(SARS), H5N1, dengue, Kyasanur Forest Disease (KFD), etc. Salmonellosis is a major public health problem worldwide and reptiles, commonly being asymptomatic carrier of *Salmonella* spp, pose risk of transmitting infection to susceptible zoo inmates and man. Carnivore species of birds and mammals consuming uncooked meat based commercial diet or whole prey may also harbour *Salmonella* asymptomatically. Infected primates and ungulates are capable of transmitting tuberculosis to other animals and zoo staff. Reversely, infected people can transmit infection to primates, which may harbour the organism as the potential source of tuberculosis. Many other diseases like leptospirosis, toxoplasmosis, histoplasmosis, brucellosis, etc. have also been recognized in zoo animals with potential human health risks (Table 6.1). Institution of procedures and strategies to minimize zoonotic risks to zoo staff and other wild inmates are important component of zoo animal health planning and protocol. Following preventive measures and strategies are recommended for containment of zoonotic infections in zoo animals and premises and reducing chances of exposure and disease development in zoo staff.

- Use of sanitizer and disinfectant foot-bath at all entry point of zoo should be strictly implemented. Restrict the entry of outside vehicles inside zoo premises.
- In the event of any construction work taken up in the zoo, attempts should be made to limit the contact between outside people, zoo personnel and zoo animals.

- Restrict the entry of sick visitors, if possible. Monitoring can be done by installation of Infra Red Thermodevices cameras at the entry points.
- Provide training to the zoo personnel to create awareness about zoonotic diseases so that they strictly follow necessary do(s) and don't(s) for protection of self, visitors and the zoo animals from the diseases.
- All zoo keepers should be given separate disinfected cloth and other dressing materials after entry into zoo. No zoo keepers should be allowed to wear any clothes, shoes or sleepers which have been brought from outside.
- While handling the animals, zoo keepers and veterinarians should use personnel protective clothing (disposable gowns, gloves, face masks) and should wash their hands after handling meat and other food materials.
- Zoo animals, especially primates and carnivore may harbour many zoonotic pathogens asymptomatically, which can be mutually transmitted by aerosol or fomite. As such, a good distance should be maintained between visitors and animal enclosures (particularly primates) to limit chances of exposure.
- Do not open a carcass suspected of anthrax or any other communicable diseases.
- Wild caught animals, especially the foxes, raccoons, wolves, mongooses etc. (even very young) may have been exposed to rabies and harbouring the virus. These animals should be kept in quarantine at least for 6 months before being mixed with other zoo exhibits.
- All susceptible animal species should be vaccinated for rabies, leptospirosis, anthrax, tetanus and other zoonotic conditions, which are endemic to a region. Preferentially use killed vaccines.
- High risk groups including zoo keepers and veterinarians should be provided prophylactic anti-rabies vaccination, under medical supervision, as per the WHO guidelines.
- Observe necessary precautions while handling a suspected case of rabies or other zoonotic conditions. An animal with abnormal mental behaviour and showing involuntary urination, defecation may be looked with suspicion for rabies. Isolate such cases and handle them with all precautions.
- In case of bite or scratch from carrier animals (dogs, foxes, wolves, jackal, mongoose, etc.) or suspected rabies case, immediately adopt post-exposure rabies vaccination as per WHO recommendations.

- The post-exposure rabies vaccination needs to be undertaken as per the category of bite (exposure): Class-I: *(slight or negligible risk*) - Licks on healthy unbroken skin, scratches without oozing of blood; *Class-II (moderate risk or exposure)*- Licks on fresh cut, scratches with oozing of blood, bite except on head, neck, finger and palm, minor wounds less than five in number and *Class-III (severe risk or exposure)*- Licks on mucosa, multiple wounds more than five in number, lacerated wound on any part of the body; all scratches or bites with oozing of blood on face, head, neck, finger and palm. Bites from wild animals are categorized under class III. A minimum of 3 shots of vaccine on day 0, 3, and 7 (without waiting confirmatory diagnosis) may be given to Class-I risk, whereas category -II and III exposure persons should immediately be given a complete course of 6 shots of anti-rabies vaccine (on day 0,3,7,14, 28 and 90) alongwith Human rabies immunoglobulin) if animal is confirmed for rabies.
- Immediate treatment of wound caused by scratch or bite of wild animal is important to reduce chances of rabies. Thoroughly wash the wound with soap and water and apply tincture iodine or 1% cetrimonium bromide or carbolic acid. Delay suturing of the wound. ATS and antibiotic course may also be given under advice of medical professional.
- Zoo personnel should be subjected to health check, at least once in a year, for various important zoonotic diseases like tuberculosis, brucellosis, leptospirosis, parasitic and fungal diseases.
- Periodic tuberculin testing should invariably feature in the health check protocol for animals and high risk people including zoo keepers and veterinarians.
- Bacteriological examination of sputum or body fluids (CSF, pleural fluid, and urine) and chest radiograph are used to confirm tuberculosis in tuberculin (Montoux test) reactor persons. Such persons should immediately be withdrawn from attending animals and be advised for anti-tuberculosis treatment under medical supervision.
- All susceptible zoo animals should be kept free from parasitic zoonoses by regular deworming and ecto-parasiticidal treatment.
- Deworming is recommended at least twice a year. The anthelmintic should be selected on the basis of faecal examination and identification of parasitic ova.
- Zoo personnel or animals showing symptoms of potential zoonoses (see Table) should be immediately referred to medical and veterinary check up with confirmation of disease from a reference laboratory.

Table 6.1- Important zoonotic diseases involving wild animal hosts

Disease	Causative organism	Wild animal Host	Mode of transmission	Characteristic signs	
				Wild animals	Man
Bacterial zoonoses					
Anthrax	*Bacillus*	Mainly artiodactylids, proboscids, and raptor birds	Occupational exposure, insect bites, wounds, food borne and sometimes air borne	Sudden death with high fever, subcutaneous oedema and painful swelling. Bleeding from natural orifices.	Ulcerative skin lesions (cutaneous form) pneumonia and septicaemia (pulmonary form), haemo-rrhagic enteritis (enteric form)
Brucellosis	*Brucella spp.*	Bison, elk, caribou, wild pigs, coyotes, marine mammals	Occupational exposure, contact and sometimes air borne	Still birth, abortion in wild ruminants	Undulant fever arthritis, endo-carditis depen-ding on *Brucella* spp involved
Colibacillosis	*Escherichia coli*	Birds, pigs, young cervids, rabbits	Contaminated food and water,	Depression, weakness, fever and house flies diarrheoa, dehydration	Profuse watery diarrhoea, anorexia, abdominal pain, vomiting, dehydration
Leptospirosis	*Leptospira interrogans serovars*	Wild rodents Canids, felids cervids	Occupational exposure, water and food borne	Fever, icterus, hemoglobinuria, renal failure, infertility, abortion, Many are asymptomatic carriers	Fever, pneumonia, hepatic and renal failure
Melioidosis	*Pseudomonas pseudomallei*	Non-human primates, kangaroos, rodents	Wound infection, contaminated water/ soil	Skin infection	Skin and pulmo-nary lesion, organ abscess and hepatitis

Disease	Causative organism	Wild animal Host	Mode of transmission	Characteristic signs	
				Wild animals	Man
Pasteurellosis	*Pasteurella multocida*	Many species of wild animals	Wounds, scratches, bites	Cellulitis, respiratory infections, meningitis	Wound infections, cellulitis, meningitis
Salmonellosis	*Salmonella enterica*	Carnivorous birds, reptiles, and mammals	Food borne infection	Enteritis and septicaemia (asymptomatic carrier state in some wild species)	Enteritis to septicaemia
Tetanus	*Clostridium tetani*	Turkeys, wild herbivores and many other species	Wound, infection	Locked jaw, raised tail, prolapse of 3rd eye lids, muscular spasm, paralysis and death	Muscular spasm, seizures, death
Tuberculosis	*Mycobacterium spp.*	Non-human primates, artiodactylids, proboscids and many other species	Ingestion, inhalation, occupational exposure	Progressive debility, cough, loss of appetite and weight, non-healing skin wounds, palpable lymph nodes	Skin lesions, adenitis, enteritis, pulmonary disease, organ abscess, meningitis
Viral Zoonoses					
Contagious ecthyma (Orf)	*Orf virus*	Wild ungulates	Occupational exposure	Papules, pustules, crust formation, scab on skin near mouth sometimes on feet	Papules and ulcers on affected hand
Cow pox	*Pox virus*	Felids and ruminants	Contact	Vesicle and papules	Vesicles, pustules on hands

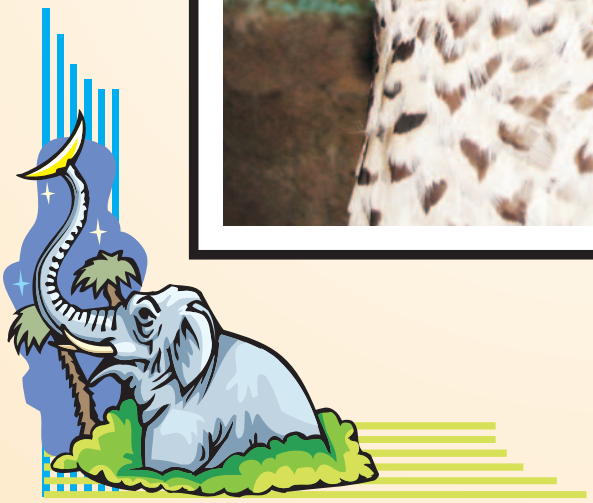
Disease	Causative Organism	Wild Animal Host	Mode of transmission	Characteristic signs	
				Wild animals	Man
Dengue fever	*Flavi virus (DEN Virus)*	Primates	Mosquito bites	Inapparent infection	Sudden fever, chills, depression, myalgia, arthalgia, photophobia, decreased blood platelet count
Japanese encephalitis	*Flavi virus*	Wild birds, pigs and horses	Mosquito bites	Reproductive problems, still births, weak new borne with CNS symptoms, oedema etc.	Fever, GI symptoms, encephalitis, seizures, paralysis
Influenza type- A	*Influenza virus*	Wild mammals, migratory water fowl	Contact exposure	Depression, anorexia, coughing, nasal discharge, high fever, respiratory infection	Respiratory symptoms, influenza, pneumonia
Newcastle disease	*Paramyxovirus*	Wild birds	Occupational exposure	Gasping, coughing, tremors, paralyzed wings, legs and twisted neck, diarrhoea	Self limiting conjunctivitis
Rabies	*Lyssa virus*	Almost all warm blooded animals mainly wild canids bats, mustelids, viverrids	Bite of affected animals, sometimes aerosol	Behavioural changes, nervousness, irritability, hyper-excitability, aggressiveness, paralysis and death	Fever, myalgia, mental changes, paresthesia, paresis, seizures, hydrophobia
Herpes B virus disease	*Herpes virus 1*	Monkeys	Monkey bites and scratches	Rhinitis, vaginitis, prosthitis, still births, abortions	Vesicular skin lesions, encephalitis, seizures, paralysis
Kyasanur forest disease	*Falviviridae*	Rodents and Primates	Tick bites	Coughing, diarrhoea, vomiting, severe fever for more than a week	Fever, rash, bradycardia

Disease	Causative organism	Wild animal Host	Mode of transmission	Characteristic signs	
				Wild animals	Man
Mycotic Zoonoses					
Aspergillosis	*Aspergillus spp*	Wild birds, wild mammals	Environmental exposure	Pneumonia, respiratory distress	Pneumonia, with dissemination in immuno-compromised patient; chronic pulmonary disease
Dermatophytosis (Ringworm)	*Microsporum, Trichophyton, Epidermatophyton* sp.	Rodents and wild carnivores, herbivores	Direct contact	Characteristic skin and hair lesions which is moist	Skin and hair lesions
Parasitic Zoonoses					
Schistosomiosis	*Schistosoma* spp	Rodents, baboons, antelope, monkeys	Skin penetration of larva	CNS disturbance like circling, skin lesions	Fever, chills, cough, diarrhoea, hepatospleno-megaly, kidney and CNS involvement
Taeniasis	*Taenia asiatica*	Wild pigs, monkeys	Ingestion of undercooked meat	Most remain asymptomatic carriers	Non-specific abdominal disturbances
Echino-coccosis	*Echino-coccus* spp.	Deer, foxes, wolves	Ingestion	Space occupying lesion in liver and lungs	Space occupying lesions in lung, liver and kidney, rarely in CNS
Filariosis	*Dirofilaria immitis*	Raccoons, bears	Mosquito bite	Weakness, ataxia, dull, inappetance	Fever, cough, lesions in lung
Trichinosis	*Trichinella spiralis*	Rodents, wild carnivores	Ingestion of flesh of wild animals	Mostly asymptomatic	GI disturbance, severe myalgia, facial swelling, nervous symptoms

Disease	Causative organism	Wild animal Host	Mode of transmission	Characteristic signs	
				Wild animals	Man
Cutaneous larva migrans	*Ancylostoma* spp, *Uncinaria stenocephala*	Wild carnivores	Contact with infected larva which penetrates skin	Anemia, rectal itching, diarrhea	Itching, serpiginous, migrating skin lesions on extremities, utricaria
Visceral larva migrans	*Toxocara* spp.	Wild canids and felids	Accidental ingestion of infective eggs	Poor growth, weight loss, pot bellied appearance, coughing, diarrhoea	Fever, cough, rashes
Kalaazar	*Leishmania donovani*	Wild canids	Bite of sand flies	Skin lesion, loss of weight, lymphoadeno-pathy, renal failure, epistaxis, lameness, anaemia	Fever, hepatospleno-megaly and pancytopenia
Toxoplasmosis	*Toxopalsma gondii*	Wild mammals	Ingestion of oocytes shed in faeces of infected animals or meat	Fever, diarrhoea, cough, icterus, seizures,	Fever and adenopathy, brain abscess
Diphyllobo-thriassis	*Diphyllo-bothrium latum*	Bears, fish-eating animals	Ingestion of raw or half cooked fish	Diarrhea, presence of proglotids in faeces	Usually asymptomatic, mild abdominal pain, pernicious anemia
Giardiasis	*Giardia lamblia*	Porcupines and other wild animals	Infected water and food	Fever, gastrointestinal disturbances	Enteritis
Paragoni-miosis (Lung fluke infection)	*Paragonimus westrmani, P.maxicanus, P. africanus*	Wild carnivores including felids canids	Ingestion of raw uncooked, freshwater crustaceans	Mostly subclincal or inapparent. Cough, dyspnoea, bronchitis	Tuberculosis like pulmonary disease and occasional meningeoence-phalitis and skin nodules

CHAPTERS 07

ISOLATION AND QUARANTINE OF SICK AND NEWLY ARRIVED ANIMALS



7. Isolation and Quarantine of Sick and Newly Arrived Animals

The term quarantine (*quarant* (a)= 40) derives from the practice originally adopted to impose isolation/ detention of ships from port for forty days to check spread of contagious diseases like plague in Europe. In veterinary medicine, it is an important preventive measure, which should be followed strictly in order to check the spread of diseases amongst animals. Quarantine period also provides an opportunity for adapting an animal to the new environment, which is of considerable significance for recently captured wild fauna. According to Recognition of Zoo Rules, 2009 under section 38H of Wildlife (Protection) Act, 1972 (53 of 72) under Veterinary facilities and infrastructure requirements, it is mandatory that every large and medium zoo shall have a quarantine and isolation ward. All new animals, brought to the zoological park should be placed in quarantine upon their arrival for a period generally varying from 14 to 30 days according to the species involved and clinical status of the animals. Retention period in quarantine for large carnivores may be two weeks and for small carnivores 3 to 4 weeks. The quarantine period may be extended even more for primates, but it should not exceed 90 days. Wild caught carnivores may be asymptomatic carrier for rabies and need to be quarantined for a period of 180 or beyond that to rule out possibility of rabies. A separate isolation/ sick ward is always advisable for treatment and care of animals suspected for zoonotic conditions like rabies and tuberculosis.

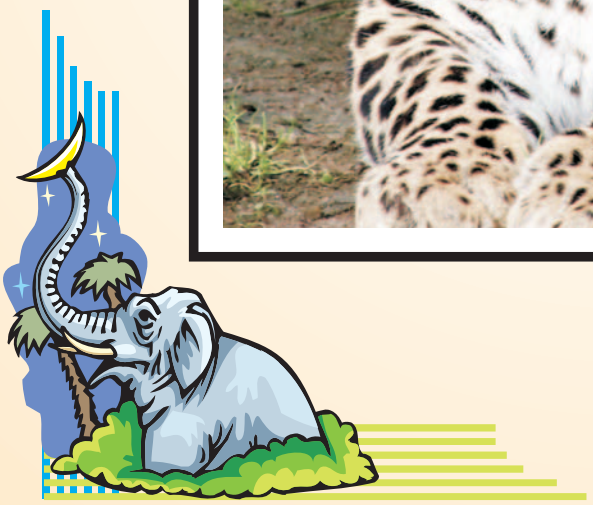
During the quarantine period, newly arrived animals should be looked after carefully and monitored clinically or by laboratory testing for evidence of any infectious condition. Examine stool samples for presence of parasitic ova. Three negative faecal examinations rule out the possibility of helminthic parasites and coccidiossis. Blood should be obtained with minimum stress for haemato-biochemical examinations. Blood smear should be examined for haemoprotozoal infections. Examination of urine and testing of all primates and artiodactylids for tuberculosis is always desirable. The current outbreaks of leptospirosis in bears underline the need for monitoring blood and urine of bears for leptospira during quarantine. Besides quarantine for new arrivals, sick animals should be isolated and treated for specific disease condition till they recover.

Appropriate treatment for prevailing illness and preventive immunization should be carried out during the quarantine period. As a general guideline, animals brought to zoo after a long journey should be given rehydration fluid and palatable feed. A 3-5 day antimicrobial treatment is also recommended. The waste from quarantine facility should be disposed off carefully, preferably by incineration to prevent contamination of zoo surroundings. Besides imposing the quarantine for new entrants, resident zoo animals that are found positive or suspected for an infection should be shifted immediately to isolation ward away from animal display areas, zoo veterinary hospital and animal quarantine facilities.

Let us relax in quarantine (Courtsey Nainital Zoo)

CHAPTERS 08

RESTRAINING AND IMMOBILIZATION OF WILD ANIMALS IN ZOOS



8. Restraining and Immobilization of Wild Animals in Zoos

Restraint is the restriction of movement of an animal which may vary from simply confining the animal in an enclosure, small space, box, or crate, to completely restricting its muscular activity (immobilization). Restraining of animals is generally done for surgical operation, translocation and scientific studies. Most animals, especially those in zoos, require restraining to hold them immobile so that they can not injure themselves or the operator. Although, the basic principles of immobilization apply to all classes of animals, still, a lot of additional factors need to be considered due to differences in behaviour, anatomy and physiology of animals and pharmacokinetics and pharmacodynamics of a drug in a particular species and during a specific physio-pathological condition. The guidelines provided by Central Zoo Authority under Rule 10, Sub Rule (29) of recognition of Zoo Rules-2009 (Tranquilization of Animals in Zoos page 581-582, Zoos in India- 2009) should be followed while tranquilizing zoo animals.

8.1 Restraint techniques

Based on the nature of means used, the restraint techniques are categorized as physical or chemical restraint. Both physical and chemical restraints have their own advantages and limitations. The decision to use physical or chemical restraint depends on the safety and experience of operator alongwith animal factors like behaviour, tolerable degree of stress, feeding nature and size of a particular species, to be restrained.

Physical restraints: Most zoo animals resist handling and manual restraint. Physical restraint is indicated in some species for minor manipulation or close observation and is generally used in mass capture. It has limitation of being less specific with increased chances of stress, injury or causalities due to struggling by the animals. Various devices available for physical restraints include use of snares, traps, nets and other equipment like ropes, gloves, tapes, hobbles, etc.

Squeeze cages (made of steel or aluminium bars) are also a restraint device. These are frequently used for larger species or for animals which are difficult to handle or aggressive. Although aluminium is expensive and less malleable than steel, it produces less noise and should be preferred. A quiet

environment is particularly helpful during training of animals. Many procedures such as limited physical examinations, tuberculin testing, administration of injections or anaesthetics, collection of blood samples, trimming of malformed claws or overgrown hooves and application of topical medications can be performed on so-confined un-anesthetized animals. The dimensions and construction of such cages may vary depending on species under consideration. The cages operate by movement of one wall to restrain the animal against the other. If possible, animals should be trained to enter or be enticed, rather than forced, into the restraint device. Ideally, these facilities are designed as part of the animals' regular quarters and located in an area where the animal is normally shifted as part of the daily routine. From such cages (if made portable), the animal can be transferred to a restraint device, anaesthetic chamber or shipping container and can be weighed also, if facility is available.

Small mammals and birds may be caught and restrained in long-handled hoop nets. These nets must be deep enough so that the animal is confined in the blind end with the upper part of the net twisted to prevent escape. Handler must be aware of the behavioural characteristics and physical abilities of an animal. This is essential to ensure safety of both animal and personnel. Heavy gloves protect handlers from teeth and claws when animals are manually held after capture. Care must be used to avoid excessive pressure on animals, because gloves hinder dexterity and the perception of the pressure being exerted. Gloves are also difficult to clean and can act as fomite for transmitting infectious agents. Physical restraint is acceptable only for short term procedures with a minimum of pain.

Precautions for safe tranquilization

Early morning is the best time to tranquilize an animal. During that time temperature remains moderate and the ambience is quiet. Always try to dart at a perpendicular target and not at an angle. Larger ungulates may be targeted at the back of the leg, on the rump or the shoulder. Smaller ungulates should be targeted at back of the hind leg or rump. Never perform immobilization in enclosure with a deep moat or swimming pool. Immobilize one animal at a time. Never attempt to immobilize an animal with full stomach. An endotracheal tube may be inserted to prevent aspiration if regurgitation occurs. Sternal recumbency in elephant could be fatal but sternal recumbency is desirable in smaller artiodactylids. Never attempt further restraint by applying physical force on the animal. Avoid exposure of animal to low or high temperature. Chemically restrained animal should be kept as comfortable as possible. Do not feed or water till all residual effect of drug is weaned off.

Chemical restraints: Chemical restraint is immobilizing the animal by administration of some chemical agent or drug to induce a state of insensibility by reversible intoxication of central nervous system without loss of vital functions of animal. Chemical restraint is advocated in situations like operational surgery when long duration immobilization is desired. There are many factors such as age, sex, stage of reproductive cycle, general nutritional status, and most especially mental state before drug administration which influence an animal's response to chemical drugs. Absence of knowledge about drug pharmacodynamics and pharmacokinetics, and its administration in wild animals is limiting factor for use of this method.

8.2. Drug delivery system

Oral administration of chemical drugs for immobilization via food and water has shown varied results which are unacceptable. Parenteral routes of administrations are suitable for quick onset and continuous effect of the drug. Use of hand held syringes is generally limited to animals that have already been physically restrained. For larger animals, a large bore needle (16-18 gauges) is used for intra muscular (IM) injections and a smaller needle (18-21 guages) used for intravenous (IV) injections. Pole syringe or Jab stick is a handy extension for a syringe that allows drug/medicament delivery from a safe distance. The main limitation of this method is breaking or bending of needles when trying to administer the drug.

Projectile drug delivery system with blow pipe or darting equipment is preferred depending upon the situation and species. Animal in a cage or enclosure can be immobilised with blow pipe. Free range tiger can also be darted from elephant back if animal is within the range of blow pipe.

Equipments required for proper restraining (chemical or physical) of different type of animals are summarized in the Table 8.1

Table-8.1: List of equipments for restraining different types of zoo animals

Type of animal	Equipments required
Small carnivores	Squeeze cage, traps, crates, nets, gloves, pole syringes, blow dart
Hoofed stock	Crates, nets, ropes, foot snares
Small mammals (primates)	Squeeze cage, crates, nets, gloves, pole syringes, blow dart
Reptiles	Nets, bags, plastic tubes, snake tong, snake hook
Amphibians and fishes	Nets, gloves

8.3. Darting area

Muscular parts like shoulders and thighs are the best darting targets in large animals. The dart should hit these areas at right angle. Sometimes, hair on the skin can deflect the dart striking at an oblique angle and drug may be released subcutaneously. Following factors should also be considered for effective drug response

- Environmental factors such as ambient temperature, relative humidity, wind direction, season, daylight and topography of area.

- Animal factors including sex, age, body weight, feeding status, excitement level, physiological status, temperament and pathological condition.
- Drug factors including drug volume, charge and pH; drug compatibility and the dosage

8.4. Immobilizing/anaesthetizing drugs

Safe immobilization of zoo animals via anaesthesia is of special concern. Anaesthesia records for the individual, other specimens of the same species in the collection, or published references for the species should be reviewed. Consultation with someone knowledgeable in the field is advisable, as there are great differences in effective drugs and dosages in the diversity of species in a zoological practice.

Xylazine (α_2-adrenoreceptor agonist), when used alone produces adequate sedation in some ungulates, mainly bovids, to allow manipulative procedures. The sedative effects can be antagonized by administration of yohimbine or tolazoline. Xylazine should not be used as the sole anaesthetic agent in carnivores because they may appear sedated but can respond aggressively when stimulated. Limitation of use of xylazine in cats is also due to the fact that it produces prolonged sedation with bradycardia and profound cardiovascular depression. Care should be taken when xylazine is used in elderly or debilitated animals. Xylazine is more commonly used as a preanaesthetic agent along with ketamine or thiopentone.

Ketamine @ 5-10 mg/kg (either alone or in combination with tranquilizers or sedatives such as xylazine @ 1-3 mg/kg or medetomidine @ 0.05-0.15 mg/kg in canids and felids) is a common and excellent anaesthetic for small to medium size animals. Ketamine alone is used in cats (11-33 mg/kg preferably intramuscularly) and primates only (as per the dose described by manufacturer). Combining ketamine with a sedative or tranquilizer speeds induction, minimizes excitement, increases muscle relaxation, and provides a smoother anaesthetic induction and recovery than using ketamine alone.

Tiletamine-zolazepam, a dissociative anaesthetic-tranquilizer combination, is relatively safe in most species. The combination has a rapid induction, and can be concentrated to 200 mg/ml to allow a small delivery volume. A disadvantage of this drug is that no complete antagonist exists; therefore, recoveries can be longer than with other drug combinations. It is commonly used for anaesthesia of carnivores and primates.

The potent opioids like etorphine and carfentanil, alone or in combination with other agents (e.g. acepromazine, xylazine, detomidine), have been used extensively for anaesthesia of large ungulates, elephants, and rhinoceros. The antagonists for etorphine or carfentanil are diprenorphine, naloxone and naltrexone. Naloxone is a pure antagonist so the danger of overdose is minimum. Isoflurane has become

the inhalation anaesthetic of choice for small mammals, birds, and reptiles. Isoflurane is safe and potent and has minimal side effects, short induction, and quick recovery periods. Diazepam (0.1 to 0.5 mg/kg) in combination with ketamine has also been found suitable. Diazepam also takes care of convulsive seizures in some felids. Acepromazine induces hyperthermia in felid, thus should not be used. Etorphine is a very potent derivative of thebain and is 1000 times more effective than morphine. In combination with phenothiazine (acepromazine or methotrimeprazine) it induces neuroleptanalgesia (a state of sedation combined with analgesia) that is suitable for minor surgery in bovines, equines and dogs. Since only a small volume of drug is required, it is useful for darting in some species of zoo animals including deer. Etorphine should be avoided in cats. Etorphine is also highly toxic to human and necessary precaution should be taken to avoid exposure by self- injection of the drug. Alphazaline and alphadeline are the other drugs used for light anaesthesia. Table 8.2 summarizes the dose regimen of some of the common anaesthetizing drugs used for different zoo animals.

Prescribing Scheduled drugs

Most of the drugs currently used to sedate or immobilize wild animals are scheduled drugs and must be used by or on the prescription of the registered veterinarian. Most of the opioids used for animal immobilization such as etorphine, fentanyl, carfentanyl and opioid antagonist like diprenorphine and some barbiturates are Schedule II drugs and are subjected to special prescription requirements. Zoo vets should maintain a purchase inventory (types of drug received, amount received, date received, from where received) and also a use inventory (amount used, to be used, species used on, reason for use). While using Schedule II immobilizing drugs, it is desirable to maintain even a running inventory. Open a new pack of drug only when an already opened pack is exhausted. Records must be maintained at least for 2 years for all drugs in Schedule II, III, IV and V. Records of such drugs should also be kept in a computerized programme. The veterinarians should also maintain an immobilization register (date, species, drug dosage and site used, antidote used, supporting drug, name of the veterinarian and his team, special remark, if any).

Table 8.2: Dose regimen of some sedative and anaesthetizing drugs in different wild animals species

Family	Species	Anaesthetizing drug	Dose regimen
Erinaceidae	Hedge hogs	Ketamine and medetomidine	10-20mg/kg and 0.1mg/kg IM
Chiroptera	Flying Foxes	Ketamine and xylazine	10-20mg/kg and 2-4mg/kg IM
Lorisidae	Lorises	Ketamine and medetomidine	5mg/kg and 0.05mg/kg IM
Cercopothecidae	Macaques, langur and leaf monkeys	Ketamine and medetomidine	5-10mg/kg and 0.05mg/kg IM
Pongidae	*Pongo pygmaeus* (Orangutan)	Ketamine and medetomidine	2mg/kg and 0.03-0.04mg/kg IM
	Gorilla gorilla gorilla (Western Lowland Gorilla)	Ketamine and medetomidine	2.6mg/kg and 0.026mg/kg IM
	Pan troglodytes (Chimpanzee)	Ketamine and medetomidine	2.5-3mg/kg and 0.025-0.03mg/kg IM
		Ketamine and diazepam	7-10mg/kg and 0.8-1mg/kg IM
Canidae	Wolf	Ketamine and xylazine	10mg/kg and 2mg/mg IM
Ursidae	Himalayan Black Bear (*Ursus thibetanus*)	Tiletamine/zolazepam and medetomidine	0.5mg/kg and 0.01mg/kg IM
	Sloth Bear (*Ursus ursinus*)	Ketamine and xylazine	7.5mg/kg and 2mg/kg IM
		Ketamine and medetomidine	3mg/kg and 0.05mg/kg IM
Ailuridae	Red Panda *(Ailurus fulgens)*	Ketamine and medetomidine	5mg/kg and 0.1mg/kg IM
	Asian small-clawed Otter (*Aonyx cinerea*)	Ketamine and medetomidine	4-5mg/kg and 0.1-0.12mg/kg
Viverridae	Civets and binturong	Ketamine and xylazine	10mg/kg and 1-2mg/kg
Hyaenidae	*Hyaena hyaena* (Striped hyaena)	Ketamine and xylazine	8-10mg/kg and 0.5-1.0mg/kg IM
Felidae	Small felids	Ketamine	5-10 mg/kg IM
		Ketamine and xylazine	3-5mg/kg and 0.5mg/kg IM
	Large Felids	Ketamine and medetomidine	2-4mg/kg and 0.06-0.08mg/kg
	Fishing cat (*Felis viverrinus*)	Ketamine	22mg/kg IM
	Leopard (*Panthera pardus*)	Ketamine and medetomidine	3mg/kg and 0.07mg/kg IM
	Snow Leopard (*Panthera uncia*)	Ketamine and medetomidine	2.5-3.0mg/kg and 0.06-0.08mg/kg IM
	Lion (*Panthera leo asiatica*)	Ketamine and xylazine	4.5 mg/kg, 1mg/kg, IM
	Tiger (*Panthera tigris)*	Ketamine and xylazine	5mg/kg and 1 mg/kg, IM
Proboscidae	Asian elephant (*Elephas maximus*)	Xylazine and ketamine	0.05-0.1mg/kg and 0.05-0.1mg/kg
		Etorphine	0.002 mg/kg

Family	Species	Anaesthetizing drug	Dose regimen
Eqquidae	Asiatic Wild Ass (*Equus hemionus onager*)	Etorphine and acepromazine	2-5 mg and 5-20 mg IM
	Common Zebra (*Equus burchellii*)	Etorphine and acepromazine	2-5 mg and 5-20 mg IM
Rhinocerotidae	One-horned Rhinoceros (*Rhinoceros unicornis*)	Etorphine and acepromazine	0.002 mg/kg and 0.02mg/kg
Hippopotamidae	*Hippopotamus amphibious* (Hippopotamus); *Choeropsis liberiensis* (Pygmy hippopotamus)	Etorphine and xylazine	0.001-0.005mg/kg and 0.067-0.083mg/kg IM
Cervidae	Axis Deer (*Axis axis*)	Xylazine and Ketamine	6mg/kg and 1.2mg/kg
		Meditomidine and ketamine	0.05-1.0 mg/kg and 0.8-3.2 mg/kg IM
	Hog Deer (*Axis porcinus*)	Xylazine and Ketamine	6mg/kg and 1.2mg/kg
		Meditomidine and ketamine	0.05-1.0 mg/kg and 0.8-3.2 mg/kg IM
	Barasingha/Swamp Deer (*Cervus duvaucelii*)	Etorphine and Xylazine	0.003 mg/kg and 5-8 mg/animal
	Black buck (*Antilope cervicapra*)	Ketamine and medetomidine	2mg/kg and 0.25mg/kg IM
		Xylazine	20 mg/animal
	Nilgai (*Boselaphus tragocamelus*)	Etorphine, acepromazine and xylazine	0.03mg/kg, 0.12mg/kg and 0.16-0.23mg/kg IM
	Gaur (*Bos gaurus*)	Etrophine, acepromazine and xylazine	0.015mg/kg, 0.06 mg/kg and 0.12-0.15mg/kg
	Muntjacs (*Muntiacus species*)	Ketamine and xylazine	3mg/kg and 2mg/kg IM
Giraffidae	Giraffe (*Giraffa camelopardalis*)	Etorphine and xylazine	1.5-2.5mg and 70-100mg/adult Xylazine given 15 min prenned

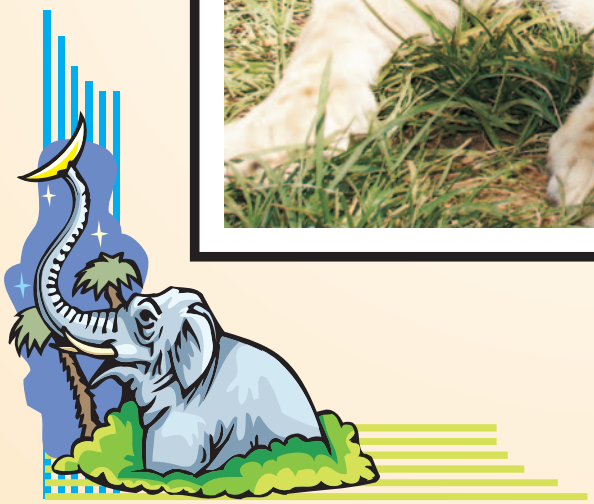
8.5. Post-immobilization care

The post immobilization period represents the most critical stage in the course of chemical restraint. An excited animal usually requires more drug and, once anesthetized, has a greater tendency to develop capture myopathy secondary to hyperthermia, respiratory depression, and acidosis. Capture myopathy can also occur in manually restrained animals and is more common in ungulates or long-legged birds. Monitor heart and respiratory rates, temperature and ECG, and blood oxygen saturation through pulse oximetry (if facilities are available) in sedated/anaesthelized animals. Attention must be paid for appropriate positioning/recumbency and padding of anesthetized animals and extremes of environmental conditions to prevent secondary complications. For example, being prone to hyperthermia immobilised felid should be moved to shady place and placed in lateral recumbency. In case of elephant, sternal recumbency is not desirable. In such instances, emergency treatment of restrained animal may be required.

In general a successful restraint technique may be achieved either by physical or chemical means and needs special skill, careful planning, knowledge of animal behaviour and biology and the experience.

CHAPTERS 09

METHODS FOR ASSESSING PARASITIC LOAD AND CONTAINMENT OF PARASITIC INFESTATIONS IN WILD ANIMALS



9. Methods for Assessing Parasitic Load and Containment of Parasitic Infestations in Wild Animals

Wild animals are frequently infested by a broad range of endoparasites and ectoparasites. These parasites not only inflict harmful effects on the host animals but can also transmit many other pathogens Many parasitic infections assume zoonotic significance and could be transmitted to man and other animals. Assessment of parasitic load is therefore important to maintain good health and immunity of wild animals and to prevent the transmission of parastic diseases to human and other animals. The assessment is based on gross and microscopic examinations of faeces and other methods as described below.

9.1. Fecal examination

The faecal samples should be collected preferably directly from rectum or freshly dropped faeces with minimum soil contamination. Since the rectal faecal collection method is not practically possible in wild captive animals, the best approach is to collect about 5-10 g fresh faecal droppings. The sample should be preferably examined immediately or refrigerated till examination. Samples can be transported to nearby laboratory by adding 10% formalin or formal saline or 2% potassium dichromate at the time of collection.

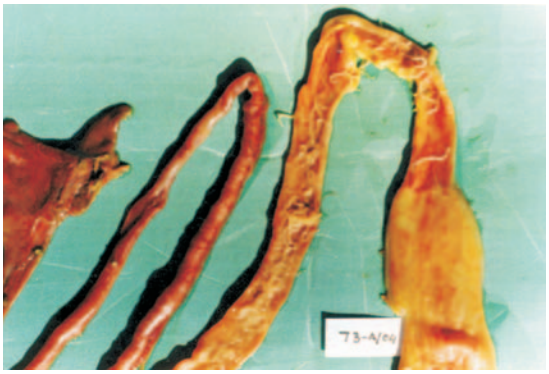


Fig 9.1 Gross examination of parasites in intestine of Turtle

Gross faecal examination: In fresh faecal samples, spontaneously voided tapeworm segments and nematodes can be recognised by gross examination or by pouring the faeces mixed with water through a sieve. Gross examination of colour, consistency, and the presence of blood or mucus are helpful in indicating the possibility of specific parasitic infections.

Microscopic faecal examination: Microscopic faecal examination for parasitic ova and parasites is conducted as per following methods.

Direct wet mount: Place a pinch of faeces on a glass slide and add a drop of saline to it; mix thoroughly using a match stick. Apply cover slip over it and examine under microscope. The method is suitable for detection of heavy parasitic load and motile protozoal infection. Negative finding are uncertain, particularly in light infestation. The test is not performed if samples have been preserved with fixatives.

Concentration method: It is based on the principle that when the faecal samples are suspended in a liquid with specific gravity higher than the eggs/ova of the parasite, the parasitic ova will float and gather on the surface of suspension. Commonly used fluids are saturated zinc sulphate, sodium nitrate, magnesium sulphate, and Sheather's sugar solutions. These fluids are useful for cestode and nematode eggs. Trematode eggs are heavier and therefore floats in solution with higher specific gravity like saturated zinc sulphate, zinc chloride. However these solutions can cause some distortion of eggs. Therefore, sedimentation technique is preferred.

Permanent stained smears: It is mostly employed for identification of intestinal protozoa. Several staining methods are available. The two most commonly used methods are Wheatly modification of Gomori tissue trichome stain and iron haematoxylin staining. The stained smears are examined under oil immersion.

Larval culture: Nematode infections associated with growth of larva in soil or in tissue may be diagnosed by faecal culture test. This test is useful when the nematode infection is low and could not be diagnosed by centrifugation concentration methods. There are many methods for faecal larval culture such as Petri dish filter paper culture, agar plate method, charcoal culture and the Baermann concentration method. The larval culture method also provides many infective larval stages for research purpose.

9.2. Egg counting technique

This method is suitable under field conditions to evaluate gastro-intestinal parasitic load. The intensity and severity of infection is assessed by counting the number of eggs in the known quantity of faeces.

Laboratory method: Take 1 g of faeces in test tube and add 15 ml of water or 0.1N sodium hydroxide (if the faeces contain fat or mucus). Emulsify by shaking the tube and transfer 0.15 ml of emulsion on a glass slide and apply cover slip. Count all the eggs in that sample. Egg per gram (EPG) is calculated by multiplying the egg count by a factor 100.

McMaster method: McMaster slide contains two chambers of 0.15 ml volume each. Fill this chamber with suspension of faeces in the floatation solution. Eggs of nematodes and cestodes float immediately below the upper glass of the chamber. About 3 gm of faeces is mixed well in 42 ml water. After mixing take 15 ml of mixture and centrifuge it. The resultant pellet is mixed thoroughly with floatation fluid. Charge side chambers of the slide with this fluid. Count the egg in both chambers and multiply the total count by factor 50.

9.3. Faecal oocyst culture for coccidiosis

For definitive diagnosis of coccidia, oocyst culture is done by placing the oocyst-infected faeces into optimum conditions of temperature and moisture so that the oocysts have the best chance possible of maturing into their infective, identifiable stages. To perform an oocyst culture, place the oocyst containing faeces in a 1% potassium dichromate solution in a Petri dish in form of a shallow suspension. Incubate at room temperature and after 2-4 days microscopically examine the sporulated coccidial organisms in the culture sample.

9.4. Skin scrapping examination for ectoparasites

Skin scrapping is collected from the edges of the moist part of lesions using scalpel until blood/ tissue fluid oozes from the site. Place the skin scraping in a test tube and add 5 ml of 10% sodium hydroxide or potassium hydroxide solution. Boil it for few minutes, so as to digest the hair and crusts. Centrifuge at 2000 rpm for 2 minutes and examine the sediment for presence of ectoparasites.

9.5. Blood smear examination for haemoprotozoa

It is simple and highly useful procedure for detection of most of the blood protozoan parasites *(Babesia, Theileria,Ttrypanosoma, Anaplasma, etc.)* of wild animals. This procedure can also provide information about haematological status of the animals.

Wet film examination is done for identification of moving blood parasites like trypanosomes. Thin film smear is useful for identification of intracellular parasites. The thin blood smear made, air dried and stained with either Leishmans or Geimsa stains. Stained smear is examined under oil immersion microscope.

9.6. Control and treatment of parasitism

Helminth, protozoa and athropodes cause parasitc infections in wild animals. The drugs used for endoparasites include anthelmintics for roundworm (nematodes), tapeworms (cestodes) and flukes (trematodes); antiprotozoan for protozoa and ectoparasiticidal for arthropode parasites. Anthelmintics are used to treat acute helminthic infection, but more often they are used prophylactically (deworming). It should be kept in mind that helminthic infections generally leads to deficiencies of essential nutrients, particularly microminerals such as cobalt, iron and selenium. These nutrients should be therefore used as an adjunct while treating or deworming the animals. The anthelmintics ment for three different groups of parastes may act with different mode of action and with a varied spectrum of activity. It is

therefore important to select a proper anthelmintic with broad safety margin, especially for treatment and deworming of wild animals. As for majority of other drugs, most anthelmintics used in wild animals are those that have been safely used in related domestic species. There are several species of round worms that infest wild animals and it is often difficult to make definitive diagnosis, if the infection is caused by a single species or by multiple species. Therefore select a broadspectrum anthelmintic.

The antiprotozoal drugs include anticoccidials, drugs for histomoniasis, trichomomonacides and drugs for haemoprotista (trypanocides, babesicides and antitheilerial drugs). Importantly, continuos use of a single anthelmintic or anticoccidial may cause treatment ieffective as parasites develop drug resistance. Use of anticoccidials is important in birds to check coccidiosis. Some of the antiparasitic drugs and their suggested doses are given in table 9.1.

Table 9.1.Recommended drugs for control of helminthic/protozoan parasites in wild animals

Class/Species	Parasitism	Anthelmintic, dose and route	Remarks
REPTILES (Muggar, Snakes, turtles, etc.)	Nematodes	Albendazole 50-75 mg/ kg, P O as a single dose	Avoid in pregnent animals
		Fenbendazole 10-25 mg/ kg, PO for 3- 5 days *Break treatment for 10 days and repeat the regime	Increase dose up to 50 mg/ kg bw, if protozoa are treated concurrently
		Ivermectin 0.2 mg/ kg, SC/PO. Repeat after 7-10 days	Not for use in turtles (Chelonia)
		Mebendazole 20-25 mg/kg PO	
		Thiabendazole 50 mg/ kg PO	
		Levamisole 10-50 mg/ kg, IM/SC & 200 mg/ kg, PO	Use with caution, low safety
	Trematodes	Praziquintal 5-8 mg/ kg PO/SC as a signle dose	Turtles and snakes
	Cestodes	Niclosamide 150-300 mg/ kg PO	
		Bunamidine hydrochloride 150-300 mg/ kg, PO as a single dose	
		Praziquintal 5-8 mg/ kg PO/SC	Repeated after 2 weeks
	Protozoa (Entamoeba invadens)	Metronidazole 20 mg/ kg , PO	Repeat after 48 hrs
		Iodoquinol 50 mg/ kg PO	
		Dimetridazole 40 mg/ kg PO for 10 days	
		Emetine Hydrochloride 2.5-5 mg/ kg IM or SC for 10 days	

Class/Species	Parasitism	Anthelmintic, dose and route	Remarks
	Protozoa *(Giardia, Hexamita)*	Metronidazole 25-50 mg/ kg , PO	Repeated after 3-5 days
	Protozoa *(Coccidia)*	Sulphadimethaxoine 50 mg/ kg for 3 days	Repeat after 48 hrs for 2 weeks
		Trimethoprim/Sulpha 30 mg/ kg,PO every 48 hr	Complication in dehydration and renal compromised state
AVIAN (Water fowl, Pigeons, Raptors, Psittacines, etc.)	Nematodes	Chlorsulon 20 mg/ kg , PO three times at 2 week interval	
		Fenbendazole100 mg/ kg, PO for raptors; 20 mg/ kg, PO x 14 days for water fowl and 15 mg/kg, POx 5days for Psittacines	May be effective against *Syngamus* spp.
		Ivermectin 0.2 mg/ kg, IM/SC or PO	May be toxic to some small birds, finches, budgerigars
		Levamisol 10-20 mg/ kg, PO	
		Mebendazole 5-15 mg/ kg, PO	Primarily used for Capillaria. Toxic in pigeons, cormorants, finches, raptors
	Cestodes/trematodes	Praziquintal 5-20 mg/ kg, PO or SC	Parenteral form may be toxic to finches
		Chlorsulon 20 mg/ kg, PO 3 times at 2 week interval	For raptors and water fowl
	Protozoa	Amprolium 5-100 mg/l in drinking water. for 5-7 days, PO	For Coccidiosis
		Carnidazole 20-30 mg/ kg, once, PO	For Trcihomoniasis, Histomoniasis
		Clazuril 5-10 mg/ kg, PO, every 3rd days, such three times	For Coccidiosis
		Chloroquine 10 mg/ kg, PO once follwed by 5 mg/ kg, at 6, 18, 24 hours	Effective in Plasmodium infection in Penguins
		Metronidazole 10-50 mg/ kg, POx 5-10 days	
		Toltrazuril 15 -20 mg/ kg, PO x 2 days	Treatment of choice for coccidiosis in falcons
MAMMALS			
Primates (Langur, Bonnet Monkey, Chimpanzee)	Nematodes	Thiabendazole 100 mg/ kg, PO	Repeat after 3 weeks
		Ivermectin 0.2 mg/ kg, IM or SC	
		Fenbendazole 50 mg/ kg, PO	
		Mebendazole 22 mg/ kg, PO	
	Cestodes	Praziquintel 5 mg/ kg, IM	*Bertiell studeri*
	Protozoa	Metronidazole 30-50 mg/kg, PO x 5 days	Entamoeba, Giardia

Class/Species	Parasitism	Anthelmintic, dose and route	Remarks
Carnivores			
Canine	Nematodes	Levamisole 5-7.5 mg/ kg/day, PO/SCx3 days	
		Ivermectin 6 mg/ kg, PO monthly	For heartworm prophylaxis
		Pyrental palmoate 25-60 mg/ kg, PO	
		Fenbendazole 50 mg/ kg/ day, POx 3 days	
		Mebendazole 10-22 mg/ kg / day, POx 3 days	
	Trematodes	Praziquantel 25 mg mg/ kg /day, PO x 3 days	
		Fenbendazole 50 mg/ kg /day, PO x 14 days	
		Albendazole 50 mg/ kg /day,PO x 14 days	
	Cestodes		
		Praziquantel 5 mg/ kg, PO	
		Fenbendazole 50 mg/ kg /day, PO x 3 days	
		Niclosamide 75-100 mg/ kg, PO	
	Protozoa/ Rickettsia	Tinidazole 30-50 mg/ kg PO (amoebiasis)	Avoid use in pregnancy
		Metronidazole 25-50 mg/ kg, PO in divided doses(amoebiasis)	Avoid use in pregnancy
		Quinpyramin pro-salt 0.25 ml/10kg, SC (Trypanosomosis)	May cause hypersensitivity reaction
		Doxycycline 2.5-5 mg/kg, BD, PO x 7-14 days (Ehrilichiosis)	
		Oxytetracycline 5-10 mg/kg, slow IV; 20 mg/kg, PO	Avoid use in pregnancy
Feline	Nematodes	Fenbendazole 20-30 mg/ kg/day, PO x 5 days	
		Mebendazole 10-22 mg/ kg/day, PO x 3 days	
		Morantel citrate 7.5 mg/ kg, PO	
	Trematodes	Fenbendazole 20 mg/ kg/day,POx 5 days	
		Albendazole 25-50 mg/ kg, PO	Avoid use in pregnancy
	Cestodes	Niclosamide 75-100 mg/ kg, PO	
		Fenbendazole 20-30 mg/ kg/day, POx 5 days	
		Mebendazole 10-22 mg/ kg/day, POx3 days	
		Praziquantel 5-7.5 mg/ kg, PO	Avoid use in new born
	Protozoa/ Rickettsia	Tinidazole 30-50 mg/ kg PO (amoebiasis)	Avoid use in pregnancy
		Quinpyramin pro-salt 0.25 ml/10kg, SC (Trypanosomosis)	May cause hypersensitivity reaction

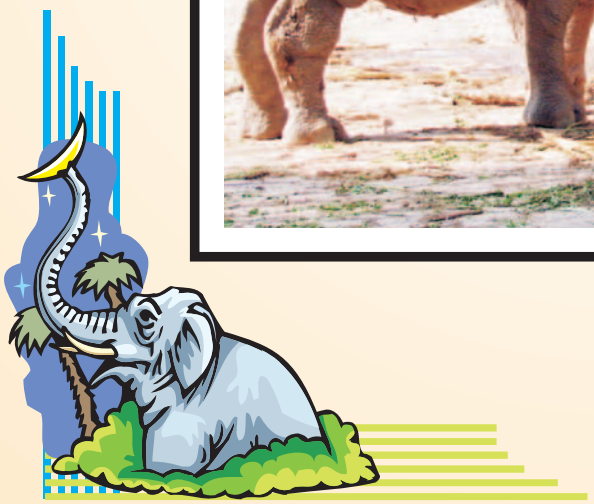
Class/Species	Parasitism	Anthelmintic, dose and route	Remarks
Proboscidea	Nematodes	Ivermectin 0.1 mg/ kg, PO	
(Elephant)		Albendazole 2.5mg/kg, PO	
		Thiabendazole 20 mg/kg, PO	For Strongyles
		Mebedazole 2.5-4 mg/ kg, PO	
		Oxfenbedazole 2.5 mg/kg, PO	
		Levamisole 2.5-3 mg/ kg, PO	
		Morantel tartarte 2-4 mg/ kg, PO	ForStronglyes; Hook worm
	Cestodes	Albendazole 2.5mg/kg, PO	
		Praziquintal 2.5-4.0 mg/kg, PO	
	Trematodes	Albendazole 2.5mg/kg, PO	
		Mebedazole 6-7 mg/kg, PO	
		Praziquintal 2.5-4.0 mg/kg, PO	
Perissodactylids	Nematodes	Ivermectin 0.2 mg/ kg, PO	
(Rhinoceros,		Doramectin 0.3 mg/ kg, PO	
Wild ass, Zebra)		Albendazole 6 mg/ kg, PO	For Strongyles
		Fenbendazole 7.5-10 mg/kg, PO	
		Thiabendazole 44 mg/ kg, PO	For Strongyles
		Mebedazole 6-10 mg/ kg, PO	
		Oxfenbedazole 10 mg/kg, PO	
		Oxibendazole 10 mg/ kg, PO	
		Pyrantel 6.6-13.2 mg/ kg, PO	For Ascarids, Strongyles
		Piperazine 110 mg/ kg, PO	For Ascarids
	Cestodes	Albendazole 6 mg/ kg, PO	
		Pyrental 6.6-13.2 mg/kg, PO	
	Trematodes	Albendazole 2.5 mg/kg, PO	
		Mebedazole 6-7 mg/kg, PO	
		Praziquintal 2.5-4.0 mg/kg, PO	
	Protozoa/ Rickettsia	Diaminazine aceturate 8 mg/kg,	Local reaction at site of
		deep IM(Babesiosis, theileriosis)	injection
		Oxytetracycline 10 mg/kg, slow IV	Avoid in newborn and pregnancy
		Quinpyramin pro-salt 0.25 ml/10kg, SC	May cause hypersensitivity
		(Trypanosomosis)	reaction

Class/Species	Parasitism	Anthelmintic, dose and route	Remarks
Artiodactylids (Giraffe, deer, Chinkara, Nilgai, Black buck, Sambhar, Bison, Pigmy hog, etc.)	Stomach worms and Intestinal Nematodes	Thiabendazole 50-100 mg/kg, PO	
		Mebendazole 10-15 mg/kg, PO	
		Levamisole 8-10 mg/kg, PO	
		Oxyclozanide 20 mg/ kg, PO	
	Lungworms	Tetramisole HCl 10-15 mg/ kg, PO	
	Cestodes	Niclosamide 50-75 mg/ kg, PO	
		Dichlorophen 0.5g/kg, PO	
	Trematodes	Fenbendazole 5-7.5 mg/kg, PO	
		Niclosamide 50-100 mg/kg, PO	
		Rafoxanide 7.5 mg/kg, PO	
		Oxyclozanide 10-15 mg/ kg, PO (Facsiolosis); 20 mg/ kg, PO (Paramphistomosis)	Overdose may cause signs of depression and diarrhea
		Triclabendazole 10-12 mg/ kg, PO	
	Protozoa/ Rickettsia	Metronidazole 20mg/ kg , IV in divided doses	Avoid in pregnancy
		Buparvaquinone 2.5 mg/ kg, deep IM (Theileriosis)	
		Diminazine aceturate 8 mg/ kg, deep IM (Babesiosis)	Contraindicated in Camilidae
		Oxytetracyclin 10 mg/ kg, IV (Anaplasmosis)	Avoid in pregnant and young animals
		Quinpyramin pro-salt 0.25 ml/10kg, SC (Trypanosomosis)	May cause hypersensitivity reaction
Rodents (Porcupines, Giant squirrel, etc.)	Cestodes	Piperazine salt 200-400 mg/ kg, PO	
		Praziquintal 5-10 mg/ kg, PO/IM	Repeated in 10 days
		Niclosamide 10 mg/100 g, IM x 7 day	Repeat regimen once after 7 days interval
	Nematodes	Mebendazole 15 mg/ kg/day, PO x2 day	
		Levamisole 10 mg/ kg, PO/IM	
		Ivermectin 0.4 mg/ kg , SC/PO	
		Thiabendazole 25-100 mg/ kg, PO	
	Protozoa	Metronidazole 2.5 mg/ml drinking water for 14 days PO	
		Furazolidone 100-500 mg/l in drinking water PO	

IM= Intramuscular, PO= Oral, SC Subcutaneous, IV=Intravenous
l= litre, kg= body weight in kg, BD= Twice a day

CHAPTERS 10

GENERAL GUIDELINES FOR MAINTAINING OVERALL HYGIENE AND SANITATION IN ZOOS



10. General Guidelines for Maintaining Overall Hygiene and Sanitation in Zoos

Good hygiene and sanitation are important for maintaining healthy animals and reducing incidences of infectious diseases at zoo. Following points should be considered for better hygiene and sanitation at zoos:

- Always consider about easiness of cleaning when designing enclosures.
- Thorough cleaning of enclosures, before the use of any disinfectant will itself remove most of the pathogens from feeding utensils, incubators and inside the buildings.
- Correct handling and disposal of carcasses at zoo is essential.
- Periodical inspections of the food sources (slaughter houses, areas where the grasses are grown) must be given top priority.
- Always try to identify routes of infections, before taking any hygienic measure, which could be as follows:
    - Humans: Hands, hair, clothing, footwear etc.
    - Contaminated equipment including the food distribution vans
    - Domestic and wild animals
    - Improperly disposed carcasses
    - Contaminated food and water
    - Backyard flock like rodents and other vermins
    - Infected premises
    - Migratory birds.

Hygienic measures should starts from very first step of entry of edibles i.e. periodical inspections of the food sources (meat, feed and fodder) at zoo. Walls and floor of feed storage room should be well cemented, dry and provision for restricting entry of rodents.

Kitchen

Kitchen is one of the important places to be taken care for better hygienic level of zoo. Remove and properly dispose the garbage atleast twice daily and make sure the trash-can lid is closed properly. The kitchen trash-can should have one plastic liner in it and one small plastic grocery bag in which all garbage is placed. Diluted bleach should be used once in a week to scrub food buckets. Do not enter in the kitchen with dirty shoes or barefoot. Wear slippers or different pair of shoes indoors. Rubber boots should be sprayed with water at the end of each day.

Animal premises or enclosures

After kitchen, dwelling premises or enclosures of animals are of utmost importance in view of hygienic and sanitary measures. An effective pest (including rats) management program should be implemented and maintained as they are carrier of many infectious diseases. Cleaning and disinfecting the enclosures on regular basis is crucial for healthy zoo and should be followed strictly with standard disinfectant and chemical protocol. Cleaning and disinfection are two entirely separate procedures. Cleaning of premises/enclosure is an important and essential process before the disinfection is to be done. Cleaning the premises refers to the physical removal of organic matter, thus exposing the pathogens to the killing power of the disinfectant. Organic materials such as soil, plant debris (like straw or hay), milk, blood, pus, and manure can inactivate some disinfectants or may protect microorganisms from the disinfectant's active ingredients. Chlorine-based disinfectants are especially problematic in this regard. The active ingredient in bleach is chlorine which gets relatively quickly inactivated by organic debris such as manure, and even milk, at the concentrations used for disinfecting surfaces. This is why cleaning to first remove organic debris and dirt is so important. Water pressure to clean walls of enclosures of carnivores is likely to spread hidden parasitic eggs and cysts from crevices and may contaminate the enclosure. Use of blow lamp is more beneficial.

Drinking water

Water is one of the major routes for entry of harmful microbes into the animal's body. So a close watch over this route is needed to be taken care off. Check the water bucket or container during each feed, if stools, food, or other contaminating matter are present, change the water immediately. Water must be changed every day, whether it is dirty or not, in order to prevent algae growth and contaminating foreign matters.

Cleaning

Cleaning should be first done with the help of a broom and thereafter, if necessary, by the sills. Floor should be hand scraped to remove any dung or manure, food, or debris. After that wet cleaning with water (in case of cemented enclosures) should be done.

Disinfection

Disinfection is the destruction of all vegetative forms of microbes by some chemical agents (disinfectant), but the spores may not be destroyed. Use proper and correct strength and spraying

rate of the disinfectant solution; otherwise it will be ineffective against the microbe and will generate a false sense of security to the disinfection process. Avoid use of 'hard' water for preparation of disinfectant solution; it can neutralize the activity of some disinfectants.

Activity of different disinfectants varies considerably against different pathogens concerning wild animals and zoo keepers. For example, plain vinegar (4% acetic acid) will readily kill the Foot and mouth disease virus, but it is ineffective against *Mycobacterium paratuberculosis,* the causative agent of Johne's disease. Many widely used disinfectants are not active against bacterial spores. Formaldehyde is effective against most spores, but it is not a practical disinfectant and is now considered a potential carcinogen. It is generally recommended to select a disinfectant that is active against a wide spectrum of pathogenic organisms under the existing conditions. The product label should be checked for the expiry date.

All disinfectants, whether they are sprays, foams, aerosols or fumigants, work best at temperatures above 65ºF. Temperatures for chlorine and iodine-based disinfectant should not exceed 110ºF. Disinfectants must have sufficient contact time with the surfaces to which they are applied in order to allow them to kill the pathogens concerned. Usually 20-30 minutes is a sufficient contact time for most disinfectants.

Rotating low pH disinfectant with high pH disinfectant reduces chances of development of microbial resistance and is more effective than continuous use of the same kind of disinfectant. The disinfecting agents should be selected on the basis of effectiveness and low toxicity to animal and should not be used in concentrations which exceed the manufacturer's recommended effective dilution. Some of important disinfectants are discussed below.

Quaternary ammonium salts: These are effective against gram-positive and gram-negative bacteria and some fungi. They are ineffective against FMD virus and *Mycobacterium paratuberculosis.*

Sodium Hydroxide/lye (2%): Add 1/3 cup of NaOH pellets (2.7 ounces of the lye) to 1 gallon of cold water; mix thoroughly. This solution is highly caustic. Use protective clothing and gloves. Always add lye to the water and never pour the water over it. Effective against FMD.

Quaternary ammonium salts: They are used to clean incubators and hatching trays. They are effective against gram-positive and gram-negative bacteria and somewhat effective against fungi and viruses, but are not particularly effective against FMD or *Mycobacterium paratuberculosis*.

Phenol-based compounds: They are coal-tar derivatives and often have a strong pine-tar odour. These disinfectants are good all-purpose disinfectants for zoo use. They are effective in the presence of some organic material and are active against number of bacteria (including tuberculosis and JD organisms), viruses, and fungi. They are ineffective against the FMD virus. Phenol compounds should be avoided in enclosures of felines due to the susceptibility of cats to these compounds.

Hypochlorites: Chlorine compounds have broad antimicrobial spectrum and are good disinfectants on clean surfaces. They are effective against bacteria and many viruses, especially parvovirus, but are not sporocidal. The hypochlorite may be irritants and can be harmful to clothing, rubber goods, and some metals. Chlorine based compounds must be totally rinsed from any flooring or surface to avoid footpad burns.

Iodophores (povidone-iodine): Iodine compounds have been routinely used as antiseptic and disinfectant. The iodophors are combinations of iodine and a solubilizing agent that makes them water-soluble, allowing the slow release of free iodine. These compounds are generally less toxic and are effective disinfectants, particularly for sanitizing food and water utensils. However, these disinfectants are expensive, and like hypochlorites, are not as effective in the presence of organic material.

Lime (Quicklime, CaO): Lime, a strong alkaline corrosive disinfectant. It is produced by burning limestone. It is generally used to spread over carcasses prior to burial to destroy infected animal tissue and pathogenic micro-organisms due to its caustic action. The major disadvantage of lime is to its caustic nature causing severe burns on contact surface. It may also be explosive; If lumps of lime come into contact with water. Ground or floor containing lime may also be injurious to footpads and hooves of animals.

Aldehydes (Formalin, formaldehyde, glutaraldehyde): Formalin is a 40% solution of formaldehyde gas in water. The standard disinfection solution is made by making a 10% solution, resulting in a 4% solution of formaldehyde gas in water. Formalin has been used to kill various bacteria, viruses, and fungi, including anthrax spores, and is effective against mycobacterium *in vitro* but is less effective in the presence of organic material. These products are often used as fumigants for avian houses as long as the houses are empty because the fumes are toxic to birds if inhaled or ingested. They are relatively inexpensive but are corrosive and also carcinogenic, which limits their use unless personal protective equipment is used.

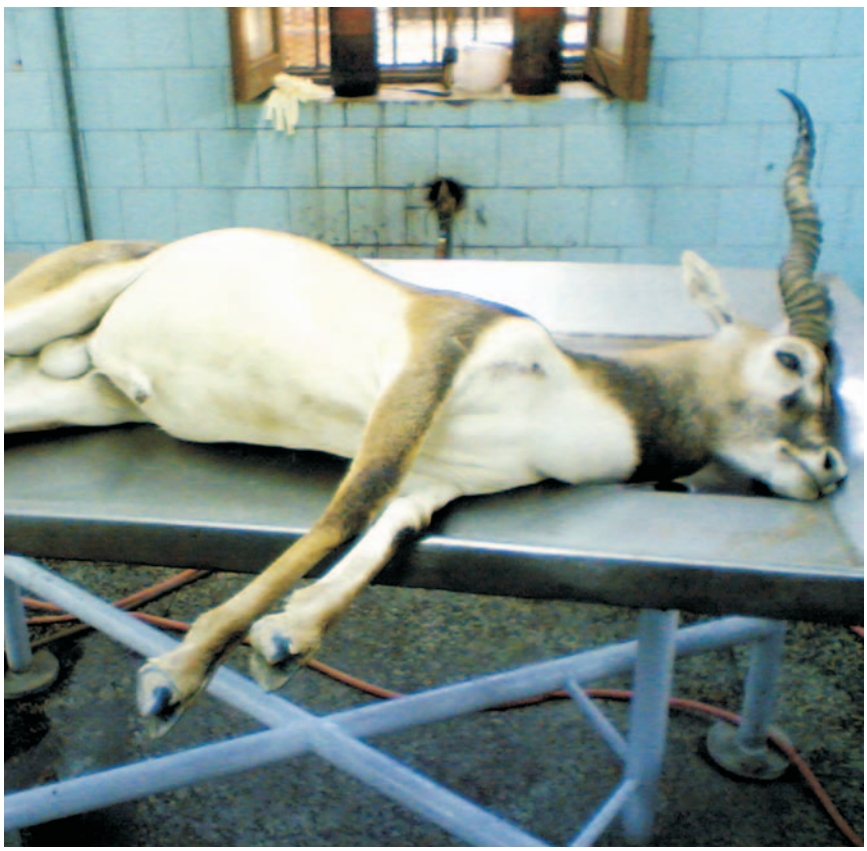
Chlorhexidine (Nolvasan-S): It has been extensively used as a virucide, with activity against rabies virus. It is not particularly effective against gram-positive bacteria or *Pseudomonas*. It is only minimally toxic with minor eye irritation but the product has been used on mucous membranes with safety.

Potassium permanganate: It is one of the most popular antiseptic with broad spectrum antimicrobial properties. A 0.01% solution is effective algaecide and 1% solution is virucide. Solution of higher concentration (>1: 10,000) causes tissue irritation.

In summary, there should be provision of strategically located disposal facilities in a zoo. Burial and incinerations are possible options for carcass disposal. In addition, composting/ burning are a better option for the disposal of waste materials. However, one should also consider the existing pollution abatement law before burning the carcass in open air. All procedures for carcass disposal should comply with CZA guidelines and existing pollution control law.

CHAPTERS 11

DISPOSAL OF WILD ANIMAL CARCASSES AND WASTES IN ZOOS



11. Disposal of Wild Animal Carcasses and Wastes in Zoos

Proper disposal of zoo wastes (feed residue and faeces) and dead animals is one of the most important aspects for maintaining proper sanitary and hygienic conditions of the zoo premises. The problem becomes more complicated and requires serious consideration when mortality occurs due to some endemic infectious disease. An effective disposal of the carcass should be performed to minimize potential transmission of pathogens to humans and other animals within the zoo. Following important factors influence effective disposal of carcasses:

- Biosecurity issues
- Environmental contamination
- Psychological stress of waste disposal workers and zoo keepers
- Public health concerns

11.1 Disposal methods

In almost all cases, more than one type of disposal method can be implemented. The normal method of disposal of carcasses should be either by burial or by burning.

Special care must be taken in respect to carcasses of felids, which needs to strictly disposed of by burning in the presence of Zoo Directors or officers nominate by him to rule out the possibilities of illegal use of wildlife materials. Skinning of animals and processing their skins for making trophies leads not only in wastage of government money but also involves the risk of some of these trophies being smuggled into clandestine trade.

The carcasses of animals died of anthrax or such other communicable diseases should be disposed of only by burial, without opening the body cavity. Lime powder should be spread at bottom of burial pit and then carcass should be buried covered with a layer of lime. Place, bushes and wires over the burial site to check digging of the site by the scavenger animals.

On-site burial is usually considered the easiest and least expensive method in most cases. It is the method of choice in many situations, but it is often difficult to select a suitable site. Air curtain incineration is not useable in flood prone areas, but is advantageous for carcass clean up, as it can burn debris and carcasses simultaneously if managed properly. The air curtain incinerator can also burn large number of dead animals if sufficient fuel is available. Fuel availability is a limiting factor in considering either types of burning process. Birds are not amenable to most burning procedures, and successful burning of carcasses is somewhat dependent on weather conditions (rain can hamper effectiveness). Composting is useful for disposal of bird carcasses, when bio-security is not a concern as in case of deaths caused by natural causes. Composting is also considered to be environmental friendly, because it produces a useable end-product. The disadvantages are that it is slow, is not appropriate for large numbers of animals, and is not bio-secure in all cases.

The rendering process also produces a useable end-product, usually destroys pathogens completely, and is environmentally sound. Rendering poses a different bio-security concern; even though it destroys pathogens completely. It is because animals must be transported from the zoo to the plant site. There is also limited rendering capacity in many areas, and it is not useable for disposal of birds. Alkaline hydrolysis is a new technology that has application especially for disposing carcasses suspected of harbouring a Transmissible Spongiform Encephalopathy (TSE). It is inexpensive and biosecure, but poses severe capacity constraints and the technology is not widely distributed. Table 11.1 provides an overview of the strengths and weaknesses for some disposal methods.

11.2. Disposal of animal house waste

Disposal of animal house wastes (faeces, beddings, residues etc.) is another matter of consideration. They are produced in large scale on daily basis, which can not be ignored. Composting could be better option for such waste disposal if space and labour is not an issue, as it is environmentally sound, inexpensive and will generate useable end product which can generate extra income for zoo.

In a mammalian disease emergency, faeces, bedding, and used hay should be preferably burnt or properly buried on-site. Non-infective faecal material, i.e. from non-infested animals may be composted.

In broad sense, we may say that proper disposal of waste and carcasses are of utmost importance from health point of views, as improper disposal may result into spread of many infectious diseases to animals and will also cause public health hazards.

Table 11. 1: Strengths and limitations of some disposable methods for zoos

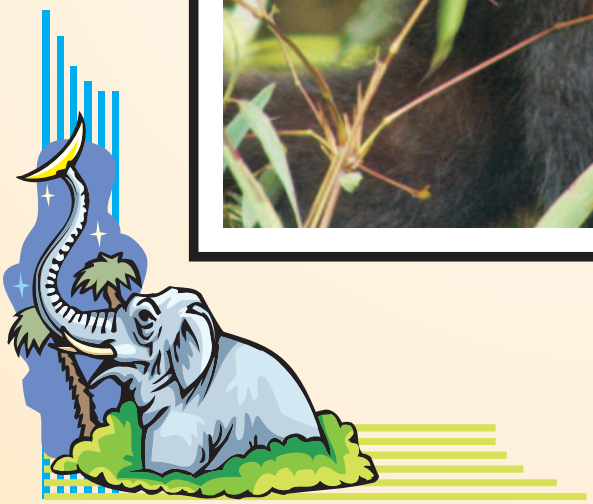
Method of disposal	Advantages	Limitations
Burial	Economic, easy, bio-security, and environmental friendly (except chances of ground water contamination)	Selection of site, inappropriate in shallow ground water table regions, aesthetic issues if improperly disposed
Open air incineration	Economic, bio-security	Availability of fuel and labour, chances of air pollution, difficult during rainy season
Closed Incineration (electric incinerators)	Bio-security, effective disposal of carcass and debris,environmental friendly	Availability and cost installation, inappropriate for poultry, availability of electric supply
Composting	Choice of method for birds, environmentally sound, economic, useful end product	Lack of biosecurity, slow bio-process, constant monitoring required
Alkaline Hydrolysis	Bio-security, economic, Environmentally sound	Capacity Constraints Not widely available specialized equipment

Important note

Any disposal procedure that necessitates the transport of carcasses from inside the infected premises to a distant location (within the Zoo) increases the risk of spread and requires special measure. Therefore, provision of trucks, other vehicles and manpower should be made for removal and disposal of animal carcasses.

CHAPTERS 12

FIRST AID AND EMERGENCY TREATMENT OF ZOO ANIMALS



12. First Aid and Emergency Treatment of Zoo Animals

In general terms 'First aid' is the provision of initial care for an illness or injury. The first aid to a sick or injured animal can be performed by non-veterinary professionals until definite veterinary treatment can be accessed. In context of zoo animals, the first aid treatment can be given by an animal attendant or zoo keepers. Wild animal emergency and non-emergency ailments and trauma require immediate attention to prevent life threatening conditions. Some problems, like bleeding, traumatic wound, fracture or convulsions require the immediate attention of a wildlife veterinary expert. Many other problems can initially be managed by the animal keepers. However, as with any veterinary condition, if the symptoms persist or the zoo keeper is unsure about the nature of the problem, it must be brought to the attention of the zoo veterinarian. All wildlife causalities will show some degree of dehydration and can be considered to be suffering from some degree of shock. In trauma, shock may be precipitated because of dehydration and/or haemorrhage. Therefore fluid therapy is an import aspect of emergency veterinary aid which needs to be provided with utmost care.

Wild animals unlike domesticated ones are more prone to self-inflicted injury and may also inflict injury to fellow animals in the enclosure. The initial step of providing first aid and emergency treatment to wild animals is to capture and/or restrain the animal and if possible to transport it to separate ad hoc enclosures/cages where veterinary assistance can be provided. As such, there must be provision for such enclosures and/or cages where the animals requiring emergency veterinary care can be kept until complete recovery. Every possible precaution should be taken to minimize struggling of animals during restraint, capture and transport. The cages and/or enclosures should be spacious and comfortable.

12.1. Management of wound/ trauma

Wound is defined as any break in continuity of skin or tissue cause by injury or surgical intervention. Trauma also literally means physical injury. However trauma is more deeply distressing or disturbing condition resulting from any stressful event or physical injury. It may be associated with physical shock and sometimes to long-term neurosis. Wound can broadly be grouped as open or closed wound. Open wounds are easily identified by gross superficial examination and can further be categorized as :

- Clean open wound or aseptic wound, which seems practically non-existing.
- Contaminated wounds, which are inflicted by clean objects such as puncture wound and wounds of compound fracture.
- Infected wounds are most common form of wounds under field conditions. Owing to the presence of debris and exudates and poor blood perfusion due to infection, infected wounds are difficult to heal.
- An abrasion is a wound in which the skin is not completely punctured and only outer layer is lost. These wounds heal up rapidly after cleaning, as the epithelial layers are still intact.

Protocol for wound management in wild animals:

Following general guidelines are recommended for management of wound:

- Always wear the protective clothing including head and face masks and gloves while handling an injured or wounded wild animal.
- The basic objective of all wound/trauma management is to clean the wound, so that it can be closed and further bacterial invasion is prevented.
- Contaminated wound should never be closed. It may lead to abscess and latter septicaemia.
- Carefully remove wound inflicting agents or contaminants like piece of wire, glass, pebble pieces, etc. by using clean/ sterilized forceps. This will help in better healing.
- Collect bacteriological swab for culture and antibiotic sensitivity test. This helps in deciding appropriate course of antibiotics.
- Clip the hair of the area surrounding the wound. In case of birds, pluck the feathers.
- Clean the surrounding areas with antiseptic like povidone iodine, cetrimide (1: 1 dilution), chlorhexidine (1:1000 dilution), etc. Avoid contaminating wound during the process.
- After cleaning the surroundings, clean the wound. Mechanical cleaning of wounds with swabs or cotton wool will damage healthy tissues and may force debris further deep into the wound. Loose strands from swabs or cotton may also get deposited as additional debris.
- The safest way to clean the wound is to flush it with sterile saline. No antiseptic or disinfectants is required, as some of these may be cytotoxic and destroy healthy tissues except chlorhexidine 0.05% solution. Plain water can be used for flushing out bulk of the foreign matter in very dirty wound. But being isotonic, best option is saline.
- Chemical debriding agents such as mixture of benzoic and salicylic acids will facilitate removal of necrotic tissue from the wound. This is very useful in wild animals, as sometimes it is not easy to dress the wounds.

- Then apply antiseptic dressing. The aim of wound dressing is to keep the wound in moist condition, so that the necrotic tissue can be removed by animal defence mechanism. Use of silver ions and silver mixed with sulpha drugs is very effective in treatment of chronically infected wounds or heavily contaminated wounds.
- The wound should be packed with some antiseptic swab, to prevent the ingress of more debris during cleaning. This practice also continues to keep the wound moist, which is essential for good, rapid healing.
- If wound is assumed to be cleaned of contamination, apply antiseptic dressing at daily interval.
- Removing dressing may dislodge any clots that might have formed. Any resulting bleeding can be controlled with sterile pads of preferably haemostatic dressing.

12.2. Management of maggoted wound

Any wound during warm and moist period of the year is susceptible to invasion by flies and maggot infestation. Animals with diarrhoea or faecal contamination around the hindquarters are at high risk. Flies lays egg on these wound and they hatch quickly into tiny maggots that starts eating necrotic and healthy tissues. Removal of the maggots either mechanically (picking with forceps) or chemically (by applying turpentine oil or diluted cypermethrin solution) is the first step towards management of maggoted wound. Injection of ivermectin can also be used to control maggots. Inject non-steroidal anti-inflammatory agents such as flunixin or meloxicam to counteract inflammatory effects of toxin produced by the maggots.

12.3. Fracture management

Fracture is a complete or incomplete break in the continuity of a bone. Wild animals are prone to bone fractures, usually as a result of collision and infighting, trauma, predator damage, self inflicted trauma, etc. Fractures can be a simple fracture, when there is only a single fracture through the bone or comminute fracture when there are three or more bone fragments. Further depending on involvement of skin, fracture can be open/compound fracture where the continuity of skin is also broken with the bone and closed fracture in which there is no break in the skin.

First aid treatment is to restrict the movement of the animals before it receives further treatment. This will prevent further displacement at fracture site, provide some pain relief, and prevent further soft tissue damage and contamination of wound. There are common apparent signs of fracture which provide clue for further investigation. Open wound, deformity in limbs or wings, immobility of any limb and lameness may be associated with fracture. The suspected fractured site is generally hot, swollen, and painful and may produce grating feeling. Based on these signs, immediate first aid treatment should be provided as per the following protocol

First aid for suspected fractures in wild mammals: As natural instinct wild animals will try to escape even with fractured bones and cause further damage. Therefore, animals suspected should be immobilized carefully avoiding any further damage.

- Compound or open fracture should be covered with sterile dressing or a piece of clean cloth. A pressure ring pad held in place with cohesive bandage will protect any wound site, control further haemorrhage and restrict inflammation. After the open wound is covered, fractured limbs can be splinted.
- Splints or piece of wood can only be applied on fractures of radius, ulna, tibia, fibula, carpal or tarsal bones. A few layers of padding with cotton wool should be wrapped first around the limbs. Avoid any attempts to reduce the fracture. The splints is applied to the caudal surface of the limb and held in place with three or four strips of cohesive bandage.
- Whereever possible, splints should include one joint above and one joint below the suspected fracture point. Splinting can be done using wooden scale, aluminium strips, thick newspaper, cardboard, etc. Keep the toe exposed to monitor any swelling.
- Suspected fracture of the spine, pelvis, neck, femur or humerus cannot be immobilized by simple splint. Therefore, these suspected animals should be strapped to a stretcher or laid out on the bottom of a suitable carrying basket. For larger animals such as deer, more than one person should lift or roll the casualty onto the stretcher or flat piece of wood support.

First aid for suspected fractures in birds: Fracture of wings should be managed by restraining the bird by wrapping it in a towel or slipping into a sock with the toe cut out, till veterinary aid is provided to it. Fracture of leg also requires immediate restraining by wrapping in a towel or sock, leaving leg exposed. Splint the leg with 2 pieces of adhesive tape placed perpendicular to leg across break site.

12.4. Management of shock

Shock is a critical condition caused by a sudden circulatory failure due to drop in blood flow. This sharply reduces adequate perfusion and thus supply of oxygen and nutrients to cells, tissues and vital organs. It also affects the kidney and hampers removal of wastes from the body. Shock can be due to a number of different mechanisms and can be classified as:

- Hypovolaemic shock (decrease blood volume shock) resulting from dehydration and electrolyte loss due to vomiting and diarrhoea, heat stroke or burns, haemorrhages due to injury, trauma, internal bleeding due to poisoning, coagulopatheis, etc.
- Toxic shock due to sepsis or endotoxaemia
- Vasogenic shock due to traumatic injury, anaphylaxis, or electrocution

Manage shock in wild animals

Injury or illnesses in wild animals cause some degree of shock or dehydration which must be taken care for favourable prognosis. Stress and captivity induce further degree of dehydration and shock, Severe haemorrhages may lead to life threatening shock. To counteract shock administer plasma volume expander (colloids), corticosteroids (dexamethasone @ 1-2 mg/Kg body weight IV) and antibiotics as and when indicated use of colloids and electrolytes solutions in preference to whole blood minimizes sludging phenomena occurring in the peripheral microcirculation. Early intravenous administration of large doses of corticosteroids (betamethasone or dexamethasone or methylprednisolone) is beneficial in management of shock irrespective of causes

Fluid therapy: Fluid therapy is an essential component of therapeutic regimen for management of shock and dehydration. The same guidelines applied for domestic animals may be used for instituting fluid therapy in wild animals. Dehydration is tantamount to shock. Therefore it is important to assess the degree of dehydration and nature of dehydration (i.e. isotonic, hypertonic or hypotonic).

- Degree of dehydration (percent dehydration) can be judged by clinical examination of skin tent test and dryness of mouth, heart rate, etc.
- The volume of fluid infusion required is calculated by multiplying the percentage dehydration with body weight of the wild animals or birds. Add the daily maintenance requirement to the calculated amount.
- Total fluid deficit in clinically dehydrated animals is about 50-150 ml/kg BW of which 50% should be corrected within 6 hours. Infuse fluid therapy @ 10 ml/kg per hour for 6 hours. Higher infusion rate can be used in case of shock.
- The daily maintenance requirement is about 50 ml/kg body weight per day for wild animals and 60-130ml/kg body weight per day for birds.
- The calculated total volume of the fluid requirement is given with the aim to replace the deficit in 2-3 days.
- Fluid replacement can be provided through various routes depending upon the urgency and suitability of the infusion fluid and species involved. Various routes are oral, intravenous (IV), subcutaneous (SC), intraperitoneal (IP) and intraosseous(IO). Intraosseous route is most suitable for small birds and animals. Intraperitoneal route may be recommended in neonates.
- Various fluid infusions indicated for management of dehydration and shock associated with different disorders are listed in Table12.1

Table12.1. Fluid therapy for various disorders

Condition	Recommended fluid, and route	Remarks
Simple dehydration (off feed, unable to drink or swallow, renal failure, pyrexia and hot conditions)	0.18% Sodium chloride + 4% glucose (IV)	Add potassium chloride solution (15% solution @ 1: 50), it must be added if treatment continued for more than 3 days
Haemorrhages and hypovolaemic shock	Compound sodium lactate solution or plasma expander. Whole blood if PCV falls (IV)	Contraindicated in patients with hepatic impairment and cardiac arrhythmias.
Burns, peritonitis	Compound sodium lactate solution+plasma expander(IV)	Add sodium bicarbonate solution (1-3 mmol/kg)
Vomiting	Ringer's solution or normal saline (IV)	
Diarrhoea	Lactated Ringer's solution (IV)	Add potassium chloride if therapy is prolonged and sodium bicarbonate if condition is severe
Intestinal obstruction, severe diarrhoea and acidosis	1.3% Sodium bicarbonate solution (IV)	An initial dose of 1-2 mmol/ kg may be given and repeated after few hours, if necessary
Urethral obstruction	5% Dextrose saline or normal saline or 0.18% Sodium chloride + 4% glucose (IV)	Add sodium bicarbonate in hypovolaemic shock

Important tips for fluid administration in birds

- Oral rehydration or gavage is a non-invasive method of fluid and liquid nutrition administration and is a preferred way for rehydration as it can be carried out without veterinary facilities. This is also safe from the point of view that it does not possess threat of over perfusion.
- Bird alimentary system is capable of taking 25 ml/kg of body weight.
- Intravenous (IV) route is suitable for only larger birds like swans, geese, herons. The vein of choice is medial tibial veins located inner side of both legs.
- One time IV infusion should never exceed 10 ml/kg.

Important tips for fluid administration in mammals

- Intravenous infusion is the route of choice for fluid therapy in most mammals.
- IV infusion in wild animals is problematic as they are difficult to be restraint and threat of injury to workers always exists. Use of sedatives such as diazepam is safe for use in these animals.
- Small mammals cannot be cannulised for intravenous route. Therefore, subcutaneous route is useful in these small mammals.

12.5. Treatment of capture myopathy

Capture myopathy is an affection of muscles associated with stress of capture, restraint and transportation. It is characterised by degeneration and necrosis of skeletal muscles and cardiac muscles affecting many wild animals and birds alike. It develops within few hours to 14 days after capture and/or transport. Both physical and chemical restraint can lead to the disease. There are many predisposing factors such as fear, stress, anxiety, overexertion, repeated handling, lack of rest during transportation and constant muscle tensions which predispose the disease. Muscles cramped into strange position in crates or sacks may develop local muscular anorexia and necrosis. Metabolic switch over from aerobic to anaerobic oxidation results in high accumulation of lactic acid, which further causes damage to muscle. Clinical symptoms are similar to Tying-up syndrome in domestic horses.

Management and prevention of this condition is very important. Affected or suspected animals should be treated for acidosis with intravenous infusion of isotonic 1.3% sodium bicarbonate solution or Ringer lactate solution. Keep the animals in well ventilated areas. Parentral Injection of selenium and vitamin E combination can be effective. Once muscle necrosis has occurred, general nursing care and hot pack application can be useful in providing some relief. Prognosis is often unfavourable.

12.6. Care of orphaned neonates

Wild animals rarely abandon their young. It can happen in situation of disaster, habitat destruction, death of mother, etc. In natural condition mothers provide all care and support to the new borne for its survival. Orphaned neonates are highly susceptible to adversity when proper care and support is not provided by human aid at rescue centres or zoo. Orphaned animals are hand reared by providing milk replacers. Each species of mammal produces its own individual milk suitable for nutritional and other species specific requirements. It is not practically possible to obtain exactly the same constituents in a milk substitute as that in mother's milk. However, compromisable substitutes can be made using suitable ingredients. Pet and cow milk are not considered good for wild mammal neonates. However, goat milk mixed with multivitamins is useful and has been tried successfully for nursing of orphans of wild mammals including large felids. Following tips may be used for feeding orphans:

- Milk or milk replacer should always be provided luke warm, so as the animal gets feeling of milk suckling from mother.
- Feeding bottles and teats of various sizes are required to suit the neonates. Commonly available feeding bottles should be improvised to suit the requirement.
- Proper housing and bedding should be provided for comfort of neonates.
- Various plastic cages, boxes and aquaria are available. Heat lamps or simple table lamps can be used to provide warmth to small animals and birds.
- Measures should be taken to stimulate the neonates to urinate and defaecate. Newly orphaned sometimes retain faeces and most neonates of mammals are unable to urinate without assistance. Urination can be facilitated by stimulating the genitalia and anal region by gently rubbing a damp cotton bud or paper towel. This procedure should be carried out before and after each meal.
- Feeding of orphaned neonates with bottle is easy for very young animals whose eyes are still closed. Neonates who can see are very much frightened, shocked and stressed due to loss of their mother and great care and patience is required for their rehabilitation.
- Avoid use of any perfume or scent during the exercise of bottle feeding to the neonates. Allow the neonates to get accustomed to smell of the care taker. It is always better to carry out this exercise in suitable quiet place.
- Start feeding with few drops of milk replacer using pipette or teat. Gradually over 2-3 days, the neonate will be relaxed and start trusting the handler and settle down to bottle feeding.
- First 2-3 servings should contain more of rehydrating fluid and less of milk replacer and then gradually replace it with full milk replacer diet in 4-5 servings.
- Do not force the animals to drink. It is important to check the hole size of the teat. If the size is big, it may cause inhalation pneumonia. Generally four servings a day can be planned.
- Mammals have unique property of passive transfer of immunity by feeding colostrum to the new borne animals.
- In most cases, orphaned neonates might have consumed colostrum from mother. However, some may require substitute colostrums, which should be provided for a day mixed with milk replacer in 1:1 ratio.
- In between feeding the animals should be provided rest and allowed to sleep and digest the meal. A development chart should be maintained. Any weight loss should be monitored for diarrhoea, or infection or parasitic load.

12.7. Emergency treatment of poisoning

Incidences of poisoning are more in free-range wild animals than wild animals in zoos. Diagnosis of poisoning is difficult, It is based basically on four evidences viz, circumstantial evidence, clinical evidence (specific clinical signs), pathological evidence (pathognomic lesions) and toxicological evidence (positive laboratory tests for presence of poison). A tentative diagnosis can be made for the presence of characteristic clinical and PM lesions alongwith presence of circumstantial evidences. Such animals require immediate medical care. Approaches to treatment of poisoning are directed to prevent further exposure to poison, reduce the absorption from skin or gastro-intestinal tract, hasten the elimination of absorbed poison by using specific antidote and to provide supportive therapy. Following protocol is suggested for management of cases of poisoning:

- Animal should be removed from the contaminated area and sources including removal of food.
- Wash any contamination from the skin, fur or fleece with running water. Oily materials can be removed by using rags or paper towel and then the area is cleaned by cooking oil. Commercial oil solvent or hand cleaners that can be removed by water may also be used. Wash the animal with soap or liquor detergents.
- In case animal has been in contact with strong alkali, wash with plenty of water and lemon juice or vinegar. Acids can be neutralized by weak solution of sodium bicarbonate. Ingested alkalis can also be neutralized by vinegar or lime juice (diluted 1:4 with water). However, sodium bicarbonate should not be used as an oral antidote for ingested acids because of gas formation. Antacids such as magnesium hydroxide can be used.
- In small monogastric animals, ingested poison can be removed by induced vomiting within 2-3 hours of ingestion. This practice should not be used in case of ingestion of acids or alkalis.
- Gastric lavage with slurry of activated charcoal or saline water can also be used.
- In large animals, laxatives may be used to eliminate toxins from GIT.
- Give specific antidote at recommended dose to animals to neutralized absorbed poison (Table 12.2)
- Supportive therapy including intravenous fluid infusion, analgesics and anti-epileptics may be necessary to alleviate effects of toxins.

Table12.2. Some specific antidotes for poisons

Poisoning	Antidotes	Remark
Paracetamol toxicity (in felids)	Acetylcystein @ 140 mg/kg followed by 70 mg/kg IV + ascorbic acid @ 30 mg/kg orally	Paracetamol poisoning in cats may occur due to prolonged drug metabolism
Nitrate-nitrite poisoning	Methylene blue 1% solution @ 5-10 mg/kg IV	
Organophosphate poisoning	Atropine @ 0.25-1mg/kg SC+ pralidoxime 40mg/kg slow IV	Give 1/3rd dose of atropine IV in serious cases
Lead poisoning	Penicillamine 33-55 mg/kg or Sodium calcium EDTA @ 75 mg/kg b wt (5% solution). In birds 38mg/100 g IM daily for 4 days	Thiamine hydrochloride @ 25 mg/kg SC is an effective adjunct therapy
Cyanide poisoning	1%Sodium nitrite 22 mg/kg followed by sodium thiosulphate (25% solution IV) in ruminants and 25 mg/kg (1% solution) IV in dogs and cats)	

12. 8. Drug contraindications

Drugs used for treatment of zoo animals are based upon extrapolation from treatment regimens of related domestic species. If a drug has been found safe and effective in a range of domestic animal species, it is presumed that it would be safe in related wild species. For deciding doses of a drug, body weight is taken into consideration. However there are indications that smaller doses in mg/kg of drugs like ketamine may be required for larger sized animals than the smaller individuals. There are also contraindications of drugs for use in specific conditions. The zoo veterinarians should be aware about these contraindications.

Drugs to be avoided or used with caution in canine and feline: The drug absorption from the gastrointestinal tract and from parenteral injection sites is related to drug formulation and is generally similar in canine and feline. The rate of per-cutaneous absorption of highly lipid soluble drugs may be more rapid in feline. There are specific problems related to drug use in felines. Felines are relatively deficient in hepatic microsomal glucuronyl transferase activity. Therefore, drugs which are metabolised by this pathway are eliminated at slower rate and should be used with caution. Renal excretion in canine and feline is similar and drugs excreted by renal route can be used at similar dose in both the species Drugs which are either avoided or used with caution in feline and canine are enlisted in Table 12.3. and those to be avoided in special conditions are enlisted in Table 12.4.

Table 12.3. Drugs to be avoided or used with caution in canine and feline

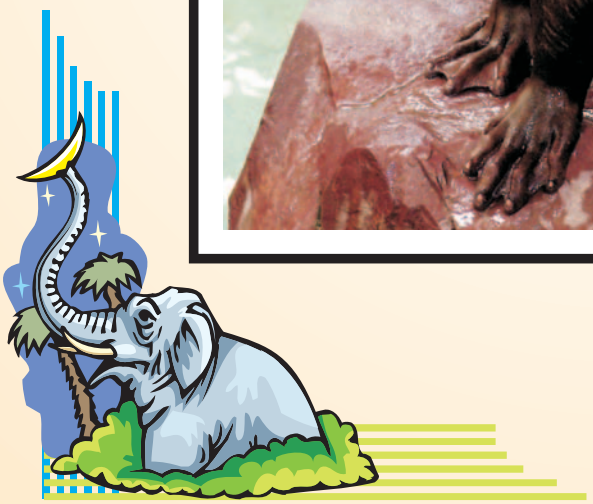
Canine	Feline
Salicylates	Organophosphorus compounds
Sulphonamides by parentral route	Salicylates(aspirin), paracetamol
Sulphasalzine by parentral route	Chloromphenicol
Acepromazine	Griseofulvin
Thiopentone	Antiseptics and disinfectants *viz*. Iodine disinfectants Benzyl benzoate, phenols, and cresol
Xylazine	Morphine, pethidine, acepromazine, xylazine, gentamicin, streptomycin, neomycin, Ivermectin

Table12.4. Drugs to be avoided or used with caution in wild animals during various conditions

Hepatic impairment	Renal impairment	Pregnant animals
Chloromphenicol	Aminoglycosides	Corticosteroids
Sulphonamides	Cephalosporins	Griseofulvin
Lincosamides	Sulphonamides	Ketoconazole
Corticosteroids	NSAIDs	Prostaglandins
Griseofulvin	Nitrofurantoin	Tetracycline
Ketamine	Amphotericin	Live vaccines
Halogenated anaesthetics	Tetracyclines (except Doxycycline)	Albendazole
Pentobarbitone	Ketamine	Cambendazole
Propofol	Acepromazine	Salicylates
Phenylbutazone	Chlorpromazine	Xylazine
Heparin	Cardiac glycosides	Meloxicam
Chlorpromazine	Piperazine	Albendazole
Antiepileptics	Thiazides	
Beta blockers	Spironolactones	

CHAPTERS 13

GENERAL GUIDELINES AND STANDARDS FOR VETERINARY CARE AND MONITORING HEALTH OF WILD ANIMALS IN ZOOS



13. General Guidelines and Standards for Veterinary Care and Monitoring Health of Wild Animals in Zoos

Some of the wild animal diseases may be similar in pattern and outcome to those observed in domestic or pet animals. However, the wild animals demand a completely different strategy and approach in their care and treatment. Zoo animals are not domesticated, and thus their response to people vary widely. Medically, they try to hide pain and illness whenever possible, and the diagnostic procedures and treatments are less straightforward with zoo animals than domestic species. Animals in captivity further differ from their free range wild counterparts, as they are maintained away from their natural environment and are exposed to diseases and stressors that they would not normally encounter in their natural environment. Following general guidelines are suggested for better health-care, disease diagnosis and treatment of animals in zoos:

Veterinary ethics and coordination

1. In order to provide optimum health and welfare to wild animals in a zoo, a close coordination and understanding between zoo veterinarian and zoo managers is essential and highly beneficial.
2. The standards of professional conduct, etiquette and code of ethics for veterinary professionals in India are regulated under Veterinary Council of India (Standards of Professional Conduct, Etiquette and Code of Ethics for Veterinary Practitioners) Regulations, 1992. The veterinarian is authorized to make a diagnosis, provide a prognosis, recommend rationale treatment, and control procedure. At the same time he/she can explain treatment options, including prognosis and euthanasia alongwith the cost of treatment and probable outcome to the zoo authorities.

3. Advise of Health Advisory Committee, constituted as per the provisions under Rule 10, SubRule (31) of Recognition of Zoo Rule-2009 may be sought of on all matters related with sanitation, hygiene, prophylaxis, nutrition and management of sick animals.

Management practices

4. The physical health and welfare of zoo animals are largely influenced by enclosure design, nutrition, husbandry, management, social group structure, behavioural enrichment and good veterinary care. It is essential to ensure that each animal has access to the protected cover, food and water. Watering and feeding facilities should be designed to avoid contamination from faeces, urine and other animal wastes.

5. Properly designed housing facilities that cater to the physical and behavioural needs of the captive animals should be used. The housing facilities should meet the standards prescribed by the Central Zoo Authority.

6. To check inbreeding and associated disorders, detailed information pertaining to a breeding/ studbook in a uniform manner should be maintained for proper selection of breeding population. It prevents inbreeding and gives chance for the expression of most of the founder genes.

7. Overpopulation is an emerging management problem in many zoos, and often requires veterinary interventions. Need based available contraceptive programmes, including surgical procedures (orchidectomy, vasectomy, ovariohysterectomy) or medicinal approaches (use of GRH agonists or injectable progestin) may be recommended.

8. Domestic and pet animals should be kept away from wild animal facility. Domestic animals can be potential source of transmitting infections like leptospirosis, FMD, parvovirus, infectious canine hepatitis, canine distemper, rabies, etc. to wild animals. Scenting, seeing and hearing of domestic or pet animals by wild animals can create a state of panic and stress leading to injury and even casualties.

9. Strict measures should be enforced to check contact of zoo animals with carrier animals such as stray dogs, jackal, fox and mongoose to prevent rabies.
10. There should be minimum noise in the surroundings and effort should be made to minimize disturbance to animals while they are in natural state of rest.
11. Avoid indiscriminate use of pesticides within or even near the animal enclosures. Lead bearing paints should not be used for painting the cages, fences, enclosure bars, etc.

Hygiene, sanitation and disinfection

12. The enclosures should be designed and constructed in a manner, which allows sanitary operations and thorough cleaning.
13. Personnel attending sick animals should wear clean protective clothing, gloves and masks. As a rule, sick animals suspected for infection should be isolated immediately and attended in the last or by a separate staff. After handling infected animals, the staff should not be allowed to attend other healthy animals without taking proper decontamination measures.
14. Every person entering the sick ward or isolation ward or quarantine area should tread through a foot bath filled with proper disinfectant.
15. Food bowels and other utensils, feeding cubicles and feeding areas should be sterilized/ disinfected properly.
16. While cleaning the enclosures and animal surroundings, all efforts should be made to remove waste debris including left over food.
17. The bedding and biomedical wastes should be discarded properly, preferably through incineration.
18. Proper handling and disposal of carcass is essential to minimize risk of spread of infection. A carcass meant for post-mortem examination should be removed immediately from enclosure and shifted to cold room or placed on an ice slab until necropsy.
19. To avoid spillage of blood or discharge, the natural orifices of the carcass should be stuffed with sterilized absorbent cotton or with disinfectant soaked stuffing straw or grass.
20. Dispose carcass, preferably through incinerators. In case incinerator facility is not available in zoos, carcass can be burnt in a 45 cm deep trench of sufficient length and width.
21. If carcass has to be disposed off by burial, it should be 1.5-2 meter deep with an ample supply of quick lime/bleaching powder or any standard disinfectant .The burial site should always be away from water sources, rivers, ponds, underground cable line, etc.
22. The food preparation area should be clean and free from flies, insect pests as well as pathogenic microorganisms.Transmission of pathogens should be minimized with proper hygiene and sanitation.

23. Regular disinfection of feed preparation area, feeding cubicles and utensils should be carried out. Use of ultraviolet lights and fly/insects repellents is highly recommended. Some zoos have effectively controlled insects in the food preparation areas and animal enclosures by using turmeric powder.

Nutrition and feeding

24. Provision of adequate, hygienic and balanced diet required for growth, maintenance and reproduction is essential for successful and efficient health management of zoo animals. A diet proximate to natural diet of free range wild counterparts is ideal and meets the dietary requirements of zoo animals. In case, the natural diet of captive wild animal is not known, nutritional requirements of the nearest related domestic species can be utilized for formulation of feeding regimes for such animals **(IVRI is developing standards for diets for Indian zoos with the financial support from Central Zoo Authority)**.

25. Monitoring nutritional status of animals to check malnutrition is always advisable. The popular saying, that a fat animal is a healthy animal may be taken with caution.

26. Diagnosis of malnutrition is relatively easy after death. Post-mortem examination revealing inanition should be viewed seriously and corrective measures be taken immediately to improve nutrition of surviving animals.

27. The most obvious and important gross changes noticed on post-mortem in malnutrition include lack of fat and gelatinous appearance of fatty tissues in natural depots. Other indices such as, malformed antlers and configuration of bones can be used to monitor status of calcium, protein and energy. Presence of dental lesions and bone deformity in deer, yak and in other Artiodactylids may be due to excessive fluorine in the diet.

28. Pregnant animals, new-born and orphans require special dietary care. Newborn animals should get adequate quantity of colostrum to guard against infection. Orphans can be hand reared or fostered by finding a suitable nursing mother.

29. Felids need special dietary care, since domestic as well as wild cats are unable to convert carotene to vitamin A, tryptophan to niacin and linoleic acid to arachidonic acid. Felines can suffer from ammonia toxicity, if fed on arginine deficient diet. Feeding of whole liver diet is reported to cause hypervitaminosis-A and associated problems in cats. Therefore, nutritionally balanced diet is essential for zoo felids to reduce chances of micronutrient deficiencies and imbalances.

30. Muscle meat is low in calcium and in certain essential micro-minerals and vitamins (niacin and vitamin A, D, E). As such, the sole meat diet of large felids needs to be supplemented with 5 g calcium carbonate and 10 g dicalcium phosphate per 2 kg of muscle meat. Good quality multi-vitamin-mineral mixture should also be added @1.2 gm multi-vitamin-mineral to meet the requirement of vitamins and minerals. Alternatively, 15 g steamed bonemeal can be used in place of calcium compounds.

31. Diet should be checked periodically, particularly with change in lots or source. Monitoring microbiological quality of zoo food is necessary to prevent outbreak of infections. *Escherichia coli, Salmonella spp, Listeria monocytogenes, Campylobacterium jejuni,* aflatoxins, etc, are the common contaminants and their levels should be monitored regularly in food.

32. Whenever a new batch of feed or new source of meat is introduced, it is always wiser to test the quality of feed, particularly for microbial load, fungal toxins and chemical contaminants such as pesticides and inorganic toxic chemicals.

33. Improperly stored grains and poor quality fodder are the potential sources of toxins and need to be tested in laboratory for mycotoxins and chemical poisons before these are used in the ration of animals. Meat should be examined carefully for presence of cyst and other contaminants.

34. Incidences of nitrate-nitrite toxicity have been reported in Artiodactylids in zoos. It is recommended that fodder supply, particularly during hot, humid weather and during drought conditions should be checked for the nitrate content. Similarly during foggy/cloudy days of winter also the levels of nitrate/nitrite in fodder could be quite high. Simple diphenylamine blue qualitative test is available for the testing.

Veterinary medical records

35. Systemic and comprehensive recording of patient (animal) data, disease history, management history and environment, clinical examination and evaluation of patient, laboratory reports and pathological data is essential in a uniform manner. Standard proforma should be used for post-mortem. Standardized computer programme such as MEDARKS of ISIS may be used for maintaining medical records.

36. The specimen for laboratory testing should be properly marked, stored, preserved and transported. They should be sent along with a request-note for test(s) desired with brief clinical history and tentative diagnosis.

Restraint

37. Squeeze cages and chute should be preferred for limited physical examination, tuberculin testing, injecting anesthesia and collection of blood.

38. Personnel selected for physical restraint of zoo animals should explicitly be instructed about their role and should be aware of the behavioral and physical traits of the animal.

39. Use protective gloves and face mask while handling the animal.

40. Avoid excessive pressure on animal while conducting physical examination

41. Reduce light and noise while restraining zoo ungulates by chemical method. Early morning period is quite suitable.

Vaccination and other preventive measures

42. Due to lack of sufficient epidemiological data, exclusive vaccines for use in wild animals are not available. As such, immunization programme should be decided based on the possibility of exposure, risks involved in handling of animals (e.g. in case of rabies) and report of health status available with the zoo veterinarian.

43. Most vaccines need to be administered annually. Care must be taken in selecting and administering a safe and effective vaccine for different species of animals.

44. The vaccines recommended for use in domestic bovines, caprine, ovine or porcine can be used for immunizing artiodactylids against HS, clostridial diseases, FMD, PPR and bluetongue.

45. Use of inactivated (killed) viral or bacterial vaccines is preferred because Modified Live Vaccines (MLV), recommended for domestic and pet animals may be insufficiently attenuated to be non-pathogenic in wild counterparts. In certain circumstances MLV can be used with great precaution.

46. In general, clinically sick animals should not be vaccinated. Avoid vaccinating the pregnant animals, unless the risk of not to vaccinate is too alarming.

47. It is recommended that new animals introduced to a zoo are vaccinated during quarantine. For example, carnivores susceptible to canine distemper and leptospirosis should invariably be vaccinated during the quarantine period.

48. All felids (large or small) are vaccinated below 12 weeks age with feline rhinotracheitis-calici-panleucopoenia killed vaccine followed by booster at 12-16 weeks age (optional at 24 weeks and 1 year of age) and then annual re-vaccination.

49. Infectious canine hepatitis (ICH), a serious disease problem in pet dogs, has been rarely reported in zoo carnivores. However, recent incidence of ICH in wolf and bears underlines the need for immunization of susceptible wild carnivores against this disease as well.

50. Deaths due to rabies have been reported in different species of animals including lion, leopard cat, white tiger, brown bear, wild dog, camel, rhinoceros, and wild ass in Indian zoos. The vaccination is recommended in rabies endemic areas for the protection of individual animal using a killed vaccine.

51. An effective post-exposure vaccination protocol for un-vaccinated pet dogs and cats, exposed to rabies includes immediate vaccination, followed by strict isolation for 90 days and administration of boosters during 3rd and eighth weeks of isolation period. This could be adopted in case of large cats. However, it is always recommended to destroy an animal confirmed for rabies.

52. Elephants are susceptible to a number of diseases such as tetanus, elephant pox, rabies, anthrax, pasteurellosis and clostridiosis, for which vaccines are available. An annual vaccination may be taken up against tetanus. FMD vaccination is recommended in endemic zones and during disease outbreak in surrounding region. Other vaccinations are rarely used. Adult elephants can be given two to three times the recommended doses for adult horse.

53. Repeated vaccination may induce anaphylaxis, therefore animals should be watched closely for one hour after vaccination and epinephrine is kept ready for intravenous administration, should anaphylaxis develop.

54. Birds may be vaccinated against Ranikhet disease, avian pox, Marek's disease and any other infectious condition that is endemic to the region where zoo is located. A cursory look into vaccination practiced for poultry in that region can be used as a guideline to decide vaccination in birds maintained in zoos.

55. As per the government policy, presently vaccination against H5N1 (avian influenza) is not permitted. Take all precautionary measures to restrict entry of persons in aviary during out-break of the disease in the surrounding areas.

Control of parasitism

56. Zoo animals are susceptible to a wide range of ecto- and endoparasites and need to be kept free from them by using appropriate methods including prophylactic medication.

57. Young, undernourished, new arrivals and stressed animals are more likely to suffer from parasitism and require special care. Deworming is recommended for control of helminth parasites. The interval for deworming depends on severity of infestation and may vary from 2 to 4 times in a year.

58. Perform faecal examination for parasitic load every four to six months and institute deworming where significant parasitism is found. To avoid drug resistance, single generic type of anthelmintics should not be used continuously.

59. Broad-spectrum anthelmintics recommended for domestic species can be used for zoo animals at the prescribed doses. However, care must be taken for choice of drugs, as some species of zoo animals are sensitive to certain anti-parasitic drugs. For example, use of piperazine salt as anthelmintics may be risky in large felids. Benzimidazole anthelmintics such as albendazole, cambendazole, fenbendazole and oxfenbendazole may cause teratogenicity and should not be used, particularly at higher doses, in advanced pregnancy.

60. Artiodactylids, kept in naturalistic exhibit with some access to pasture are much susceptible to helminthic infections. Incorporation of anthelmintics in their diet is an easy way of deworming.

61. For a herd or flock, calculate dose on the basis of total daily diet and mix anthelmintics in slightly higher than recommended doses. Always use safe broad spectrum anthelmintics with broad margin of safety.

62. Ascariasis and hookworm infestations are common in zoo felids. These can be controlled by using broad spectrum safe anthelmintics. The anthelmintics that are recommended for cats include fenbendazole, albendazole, pyrentel palmoate and mebendazole. Blow lamp method is recommended to burn ascaris ova in the crevices of feline enclosures.

63. Prophylactic treatment using quinapyramine salts can be given every four months to large felids to control trypanosomosis in zoos located in the disease endemic areas. Periodical screening of blood smear should be undertaken to asses the effectiveness of the treatment.

Vector control

64. Many pests such as flies, mosquitoes, snails and cockroaches commonly found in zoo premises serve as intermediate hosts/ vectors of important parasitic and microbial infections. For example, snails are intermediate hosts for liverfluke, amphistomes and schistosomes. Many gastrointestinal parasites of birds and reptiles are transmitted by cockroaches as the intermediate hosts and flies *(Tabanus tropicus)* transmit trypanosomes mechanically. Rodent pests, which harbour *Leptospira, Listeria* and *Francisella tularensis*, are important source of these infections to zoo animals.

65. All efforts, using mechanical and chemical control methods should be made to control/ eliminate these pest vectors. Utmost caution is required while using chemical pesticides, and care should be taken to minimize poisoning in zoo animals.

66. Cats are very sensitive to many pesticides. Observe strict precautionary measures in using pesticides on or near the felids. For example, synthetic pyrethroids, are less tolerated by cats and permethrin can be highly toxic to zoo felids.

Quarantine

67. According to Recognition of Zoo Rules, 2009 under section 38H of Wildlife (Protection) Act, 1972 (53 of 72) under Veterinary facilities requirements, it is mandatory that every large and medium zoo shall have a quarantine and isolation ward.

68. Besides preventing new infection to zoos, quarantine also provides an opportunity for adapting an animal to the new environment, which is of considerable significance for recently captured wild fauna.

69. The quarantine facility should be designed in such a manner that facilitates proper handling of animals and proper cleansing and sanitizing of enclosures. The facility should ideally be located at a considerable distance from the zoo exhibits and provision should be made for separate staff attending animals in quarantine.

70. All new animals, brought to zoological park should be placed in quarantine upon their arrival for a period generally varying from 14 to 30 days according to the species involved and clinical state of the animals. Retention period in quarantine for large carnivores may be two weeks and for small carnivores 3 to 4 weeks.

71. The quarantine period may be extended even more for primates, but it should not exceed 90 days. Free caught wild carnivores can be quarantined for $\geq$ 180 days to rule out possibility of rabies.

72. During the quarantine period, animal should be looked after carefully and examined physically. Stool samples be examined for parasites and if possible, blood should be obtained with minimum stress for haemato-biochemical examinations.

73. Examination of urine and testing of all primates and artiodactylids for tuberculosis is always desirable. Appropriate treatment for prevailing illness and preventive immunization should be carried out during the quarantine period.

74. The waste from quarantine facility should be disposed off carefully, preferably by incineration to prevent contamination of zoo surroundings.

75. In addition to imposing the quarantine for new entrants, resident zoo animals that are found positive or suspected for an infection should be shifted immediately to isolation ward away from animal display areas, zoo veterinary hospital and animal quarantine facilities.

Zoonoses control

76. In order to control potential zoonotic hazards, attending staff should be periodically screened for common zoonotic conditions, such as tuberculosis, leptospirosis, toxoplasmosis, ringworm, mange, toxocariosis and hookworm infections, and other communicable diseases endemic to that area. Annual testing for tuberculosis should be conducted for keepers, attending felids, primates and Artiodacylids. Cat keepers should be tested annually for toxoplamosis.

77. An individual, who has handled a confirmed rabies case/ carcass/ morbid material should be given post-exposure rabies vaccination under supervision of a medical professional as per the WHO guidelines.

Health monitoring and diagnostic approaches

78. Often, wild animals attempt to mask the pain and discomfort due to disease, and clinical signs may not be apparent till the advanced stage of illness. The change in natural behaviour of animals is key to detect incipient illness.

79. Animals should be examined individually for any deviation from their characteristic behaviour, physical state, food and water consumption, urination, defaecation, alertness and other physiological activities. Similarly careful examination of an animal's den and enclosure can also be rewarding.

80. Being closely associated with the upkeep of animals, keepers can provide important information about the health status of animal they attend. Daily rapport is therefore, necessary between the veterinary staff and animal keepers.

81. The ailing animal should be captured carefully for detailed investigation and treatment.

82. Temperature, pulse rate, respiration and blood biochemistry values can reflect the health status of animal and facilitate clinical diagnosis. Collect clinical material for clinico-pathological test.

83. Fresh stool samples should be collected in 5-10% formalin for parasitological examination. Sufficient exudates or scabs and crusts from exudates in 70% alcohol and deep skin scrapings need to be collected in 5% formalin for mites. The materials for toxicological examination should be collected as practiced for domestic species.

84. All dead animals should be necropsied and examined for gross lesions. Collect material for histopathological/ microbiological, toxicological, parasitological, and other laboratory examinations. A duplicate specimen of samples, submitted to laboratory, should always be preserved for any future investigation.

85. Periodic screening of all the animals for parasitic, bacterial and viral infections is essential for proper health management. The faecal screening should be carried out every three months.

86. Blood samples should be collected for assessing nutritional status at least once in a year and for haemoprotozoan parasites quarterly.

87. Whenever an animal is restrained, it is advisable to collect blood sample for routine haemato-biochemical tests and for screening of protozoan parasites.

88. Bacteriological screening of animals for important bacterial pathogens should be carried out every six months.

Therapeutic approaches

89. Only few label drugs are available for use in wild animals. Therefore, extrapolation of data available for related domestic or pet species on dose and treatment schedule, drug side effects, contraindications and antagonisms is necessary.

90. Generally, if a drug has been found to be safe and effective in wide range of domestic species and man, it is likely to be safe in other species also.

91. Generally, smaller animals of the same metabolic group require larger dose than the larger animals. For example, a large felid may be 20 times of the body weight to a small feline species, but it may not require 20 times of the dose used in small species.

92. Use of an unknown product on large number of wild animals at a time should be avoided. Initially new drug should be given to one or two animals to test its safety.

93. Always consider the compatibilities of drugs before mixing them in intravenous infusions. Avoid mixing acepromazine maleate with atropine sulphate; adrenaline with sodium bicarbonate infusion; ampicillin with intravenous glucose or dextran solution; calcium gluoconate with streptomycin or tetracycline or prednisolon and Vitamin B complex with other drugs.

94. Benzimidazole anthelmintics may cause feather abnormalities in some birds during the moult and may induce vomiting and death in nestling if used during breeding season. In other species also, benzimidazole anthelmintics can cause teratogenic effects at high doses and should be avoided or used with precaution in pregnant animals.

95. Use of corticosteroids, cytotoxic drugs, tetracycline, griseofulvin, ketoconazole, salicylates, and live vaccines should be avoided in pregnant animals. Barbiturates, xylazine, opoid analgesics and chlorpropamide should be avoided or used with caution at parturition.

96. Before prescribing multi drug therapy, information on drug interactions are important. Drug combinations such as, diuretics (K sparing diuretics) with NSAIDs, corticosteroids aminoglycosides-antimicrobials, metronidazole and penicillin; metoclopramide with paracetamol, glucocorticoides or pentazocin; tiamulin with monensin, and muscle relaxant with aminoglycosides, lincomycin and cardiac glycosides, should be avoided

97. Hepato-renal problems have been noted in many species of zoo animals in India. Since these two organs play vital role in drug metabolism and excretion, caution should be taken to prescribe drugs for animals with hepatic or renal impairment.

98. The drugs, which depend on hepatic metabolism, should be given in reduced doses to animals with liver impairment. Drugs like antiepileptic, butorphanol chlorpromazine, corticosteroids, ketamine, sulphonamides, doxorubicin, etc should be avoided or used with caution in animals suspected for hepatic diseases.

99. Drugs such as aminoglycoside antibiotics, polymixin, cephalosporines, chlorpromazine, ketamine, methotrexate, sulphonamide, tetracycline (except doxycycline), and NSAIDs should be avoided or used with precaution in cases suspected for renal impairment.

100. While prescribing the drug for wild animals, consideration should be given for species specific toxicity of drugs and different metabolic rates of various classes of animals.

101. Necessary precautions should be taken while prescribing drugs for large felids, as cats have reduced capacity for hepatic glucuronide conjugation. Therefore, use of drugs such as organophosphorous compounds, aspirin, paracetamol, chloramphenicol, griseofulvin should be avoided in felines.

102. Antiseptic and disinfectants such as iodine, and its derivatives, benzyle benzoates and phenols are particularly toxic to cats and should not be used for disinfection of enclosures of felids.

103. Opoid analgesics including morphine, butarphanol, pethidine and its derivatives may cause violent excitatory activity in high does in cats. Aminoglycosides antibiotics such as gentamicin, streptomycin and neomycin are also toxic in high doses and cause ototoxiciy and or nephrotoxicity in cats.

104. Reptiles are poikilothermic and their metabolic rate and drug pharmacokinetics are affected by ambient temperature. Therefore, when medicating reptiles, ambient temperature before, during and after the treatment should be taken into consideration.

105. Avoid using antibiotics in debilitated reptiles. Any antibiotic therapy, particularly, gentamicin should be accompanied by fluid to maintain adequate kidney function.

Necropsy and specimen collection

106. All the dead zoo animals need to be necropsied carefully. Wearing protective clothing including gloves, face mask, apron and gum boots is always desirable while conducting PM.

107. Never open a carcass suspected to have died due to anthrax.

108. Proper clinical history should be recorded before PM examination. Note external injury like injury by antlers, horns, bruises, fang mark etc, if any and look for ectoparasites and lesions of mange.

109. Specimens of tissues having gross lesions, and pieces of liver, stomach, small intestine, spleen, heart, lung, kidney, brain, etc should be submitted invariably for histopathological examination.

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Annexure-I

List of zoos visited to collect data on animal health and mortality of zoo animals

A. Large zoos

S.No	*Name of the Zoo visited*	*Period of Visit*
1.	Nandankanan Biological Park, Bhubaneswar	06.12.06 to 09.12.06
2.	Assam State Zoo Cum Botanical Garden, Guwahati	19.12.06 to 24.12.06
3.	Kanpur Zoological Park, Kanpur	29.1.07 to 03.02.07
4.	National Zoological Park, Delhi	07.02.07 to 11.02.07
5.	Sanjay Gandhi National Park, Mumbai	14.04.07 to 18.04.07
6.	Alipore Zoological Garden, Kolkata	21.04.07 to 29.04.07
7.	Mahendra Chaudhury Zoological Park Chhatbir	12.06.07 to 16.06.07
8.	Rajiv Gandhi Zoological Park, Pune	24.06.07 to 30.06.07
9.	Sanjay Gandhi Biological Park, Patna	30.07.07 to 5.08.07
10.	Van Vihar National Park, Bhopal	29.08.07 to 3.09.07
11.	Nehru Zoological Park, Hyderabad	14.11.07 to 21.11.07
12.	Lucknow Zoological Park, Lucknow	26.11.07 to 1.12.07
13.	Kamla Nehru Zoological Garden, Ahmedabad	17.08.08 to 23.08.08
14.	Sakkarbaug Zoo, Junagarh	23.08.08 to 27.08.08
15.	Shri Venkateswara Zoological Park, Tirupati	16.10.08 to 20.10.08
16.	Zoological Gardens, Thiruvananthpuram Zoo	25.11.08 to 29.11.08
17.	Bannerghatta National Park, Bangalore	08.01.09 to 13.01.09
18.	Sri Chamarajendra Zoological Garden, Mysore	13.01.09 to 18.01.09

B. Medium zoos

S.No	*Name of the Zoo visited*	*Period of Visit*
1	Manipur Zoological Garden, Imphal	16.12.06 to 18.12.06
2	Jaipur Zoo, Jaipur	13.04.09 to 16.04.09

C. Small zoos

S.No	Name of the Zoo visited	Period of Visit
1.	Biological Park, Itanagar	10.12.06 to 12.12.06
2.	Himalayan Nature Park (Kufri), Kufri	17.06.07 to 19.06.07
3.	Bondla Zoo, Goa	01.07.07 to 5.07.07
4.	Bhagwan Birsa Biological Park, Ranchi	06.08.07 to 11.08.07
3	Udaipur Zoo, Udaipur	16.09.07 to 20.09.07
5.	Jodhpur Zoo, Ummed Park	20.09.07 to 25.09.07
6.	Pt. Govind Ballabh Pant High Altitude Zoo, Nainital	17.12.07 to 20.12.07
7.	Padmaja Naidu Himalayan Zoological Park, Darjeeling	22.05.08 To 28.05.08

D. Mini zoos

S.No	Name of the Zoo visited	Period of Visit
1.	Sarnath Deer Park Sarnath	4.02.07 to 05.02.07
2.	Ludhiana Zoo, Ludhiana	12.08.07 to 15.08.07
3.	Deer Park, IFFCO, Aonla	5.04.2008
4.	Himalayan Zoological Park, Gangtok	29.05.08 to 02.06.08
5.	Rajkot Municipal Corporation Zoo, Rajkot	13.01.09 to 14.01.09
6.	Bear Rescue Centre Facility, Agra	05-3-2009
7.	Kota Zoo, Kota	17.04.09 to 19.04.09
8.	Van Prani Udyan, IVRI, Bareilly	Continuous

Annexure - II (a)

Patient History and Treatment Card

_____ Zoological Park

1.	Case No.	:	
2.	Common name and house name (if any) :		
3.	Scientific name	:	
4.	Animal ID	:	
5.	National studbook no. (if any)	:	
6.	Sex :		Date of birth/age:
7.	Date & time of illlness	:	
8.	Date and time of treatment	:	
9.	Disease history	:	
10.	Patient data		
	Body weight:		Respiration:
	Temperature:		Mucous membrane:
	Pulse:		Secretion, if any
11.	Physical		
	Gait:		Defecation:
	Urination:		Feeding habit
12.	Para-clinical examinations conducted		
	Urine:		Skin scrapings:
	Faecal:		Blood:
	Biopsy:		Radiograph:
13.	Special examination (if any)	:	
14.	Remarks		

Veterinary Officer

Date	Details of observations and treatment given	Signature of Veterinary Officer

Annexure - II (b)

Post-mortem Report

_____ Zoological Park

No..... Dated .....

Animal species	Scientific name	Sex	In-house name/ Animal ID/or National Studbook number (if any)	Age	Size	Weight

Time, date and place of death: .....

Time and date of post-mortem examination: .....

Short history of illness, if any: .....

A. General description : Weight: Length: Tail length: Girth:

B. Organ-wise description of lesions: .....

1. Head and neck ..... (a) Skull and brain
   (b) Cervical vertebrae
2. Thorax ..... (a) Lungs
   (b) Heart
   (c) Ribs
3. Abdomen..... (a) Liver
   (b) Stomach
   (c) Intestines
   (d) Kidney
   (e) Spleen
4. Pelvic girdle..... (a) Uterus and ovaries
   (b) Bladder
   (c) Genital passage

5. Limbs:..... (a) Fore limbs

(b) Hind limbs

6. Any other special features:

Biological tests done (if any)

i. Blood:.....

ii. Urine:.....

iii. Discharges:.....

iv. Biopsy:.....

7. Opinion (tentative cause of death):.....

8. Instruction for disposal:.....

Place:

Signature .....

Name.....

Date:

Designation.....

Seal

9. Sample sent for Laboratory test

i. HPE

ii. Toxicological examination

iii. Bacterial

iv. Viral

v. Any other

10. Name of the laboratory: .....

11. Laboratory finding:.....

12. Confirmed cause of death:.....

Signature .....

Name.....

Date:

Designation.....

Seal

Annexure - III

Record sheet for monitoring immobilization in wild animals

Species.....Date.....

Sex.....Breeding status.....

Age.....Weight (if possible).....

Captive or wild animal.....

Name (s) of operator/supervisor(s) with qualification and designation .....

.....

Purpose of capture.....

Location of capture.....

Ambient temperature.....Day (cloudy, bright).....

In herd or individual.....

Physical condition of animal.....

Behavioural state (before darting).....

Clinical history of animal.....

Details of the drug (s) used

*Generic and brand name of drug(s).....

Attempts	Drug used*	Dose (mg/kg)	Volume used (ml)	Route	Site	Time

Behaviour at the time of darting and duration of response (running, walking, standing, excited) .....

.....

Induction time (time when animal goes down) .....

Condition of animal – indicate: excellent/ good/ fair/poor.....

Injuries or abnormalities noted .....

Vital signs:

Respiration (shallow, deep, irregular) .....

Time						
Respiratory rate						
Heart Rate						
Temperature						

Salivation (none, moderate, extreme) .....

Eye condition .....

Method used for eye protection .....

Position of tongue .....

Salivation (none, moderate, extreme) .....

Eye condition .....

Method used for eye protection .....

Position of tongue .....

Others convulsion (none, moderate, extreme) .....

Test/ treatment performed .....

Sample(s) collected; Time and type (indicate blood, body fluids, swabs, tissue, tooth, hair, others) .....

Morphometrical (Body measurement) data (Optional when animal is restraint for veterinary purposes):

Length ..... cm. Tail length .....…cm

Height at shoulder..... cm Girth..... cm

Any other test .....

Recovery (normal or complicated) .....

Reversal drug used (if any for recovery or antidote)

Generic/brand name of drug given .....

Time, why, when reversal drug used .....

Quantity (mg) used..... volume (ml) used ..... route ..... .site.....

Antibiotics and other supportive drugs used

Name of antibiotic used .....

Other supportive drugs .....

Signs at the time of recovery (give details of vital signs, behaviour, and physical status of animal, any other sign) .....

Any other comments:.....

Signature of Veterinary Officer and investigators