

STUDY OF DISEASE RECORDS OF ZOO ANIMALS IN LAHORE ZOO, PAKISTAN

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ABSTRACT

Captivity induces higher levels of stress resulting in health and behavioral problems. Well managed records and improved standards are critically important for minimizing risks of diseases and conservation purposes. This research was conducted to determine the disease prevalence and mortality rate of the animals at Lahore zoo. For this purpose, the research involved consultation of relevant books and online databases. The most important source for the information and records of the prevalence was the Veterinary care department at Lahore zoo. This department comprised of veterinary doctors, fellowship interns, volunteers and other helping staff. They treated the diseased animals on daily basis and the details of dietary supplements and given treatments were recorded. The data collected was analyzed and tabulated from year 2009-2013. Also the personal observations were made to assess the additional factors like environment enrichment, disease causing factors, duration of treatment and time of recovery from disease etc. The time taken for recovery and modes of treatment were satisfactory. More environmental enrichment techniques could be incorporated for better health conditions. Regular surveillance is necessary to prevent diseases.

Key words: Lahore Zoo, disease prevalence, mortality in zoo animals.

INTRODUCTION

A zoo is an institution where wild animals are kept for public display only rather than circus purposes (Clubb and Mason, 2002). Zoos and biological parks are considered as a centre point for public recreation and education (Chethan *et al.* 2013).

As a consequence of the collision between disease causing factors and the susceptible host, the indication of the disturbance in the physiological process leads to structural and functional changes in the cells of the living body of an individual, is termed as a disease. The environment factors such as air, water, food, fodder, and space in the enclosure, social group and climate; age, and the species can be the disease causing factors (Cheeran, 2008). However, diseases can be divided into four categories such as

a) **Infectious and non-infectious diseases:** The diseases which are not caused by a pathogen and cannot be transferred from one animal to another, and may be because of dietary deficiencies (e.g. lack of vitamin C), environment (stress) or inheritance are termed as non-infectious diseases such as Diabetes mellitus in monkeys. Infectious diseases also called communicable diseases are those that are caused by microorganisms and may be passed from animal to animal or sometimes from species to species e.g. TB, rabies and FMD (Rees, 2011). Infectious diseases further involve bacterial diseases such as salmonellosis, shigellosis, anthrax, TB, yersiniosis, clostridial diseases, and campylobacteriosis, viral diseases for example rabies, herpes, and various diseases

caused by poxviruses and fungal diseases (caused by pathogens like *Aspergillus*, *Candida*, *Cryptococcus*, and *Pneumocystis*).

- b) **Degenerative diseases:** Degenerative diseases frequently found in felids, canids, bears, primates, and ruminants include arthritis and chronic renal disease (Rothschild *et al.* 2001)
- c) **Nutritional diseases:** Metabolic bone disease, iron storage disease (haemochromatosis), and emaciation or, more frequently, obesity (Hosey *et al.* 2013) are involved in nutritional disorders.
- d) **Genetic diseases:** Genetic abnormalities occur rarely such as hereditary blindness associated with inbreeding reported in grey or timber wolves *Canis lupus*.

Parasitic diseases include protozoan diseases such as Trypanosomiasis and White spot. Few other commonly occurring parasitic diseases are Mange and Warbles (Laikre and Ryman, 1991).

Some diseases can be transmitted from humans to zoo animals and vice versa. Anthro-po-zoonotic diseases are the diseases that are transferred from humans to animals whereas zoonoses or zoonotic diseases are the diseases that are passed from animals to humans (Ott-Joslin, 1993). Most affecting and prominent diseases, all of which have basically serious consequences for zoos, are West Nile virus (WNV), Avian influenza (AI) or bird flu and Chytrid fungus among amphibians (Hosey *et al.* 2013).

Zoos in Pakistan are in transformation, even there was not a complete list of zoos (Mitchell, 1929;

Buchanan and Gibbons, 1906) has been recorded. Therefore, by the subsistence of Lahore municipality and its collaboration with Punjab government, Lahore zoo, Pakistan's oldest zoo, was established in 1872 (D'Oyly, 1820).

Our goal was to study the disease prevalence in animals at Lahore zoo from 2009 to 2013, to determine the mortality rate either because of natural incidence or disease and to make suggestions and recommendations

for the betterment of animals present at Lahore zoo regarding health.

MATERIALS AND METHODS

Data Collection: Lahore zoo is the third oldest zoo of the world. It is located with GPS coordinates 31.556006° North and 74.325959° East at Mall Road, Lahore Pakistan. It spreads over an area of 25 acres (10 ha) (Figure 1). Zoo houses 914 animals of 121 species.



Figure 1: Road map to Lahore Zoo

The data related to disease prevalence in Lahore zoo for the past five years was collected from the office of Veterinary department of the zoo. The mortality rate was noted and the disease occurrence and death ratios were tabulated. The zoo was visited three days a week, for continuous six weeks, 6 hours a day, from 9am to 3pm for monitoring the disease and health conditions of all animals. During the visit any discomfort or uneasiness faced by animals resulting from the improper handling of animals by zoo staff or due to public interactions were also noticed.

RESULTS AND DISCUSSION

The frequency of diseased animals per year was noted for five years from 2009 to 2013 as listed in table 1-5. This data also showed the number of deaths due to

diseases each year and those of natural deaths of animals at Lahore zoo. The most prevalent diseases were categorized as general GIT diseases, respiratory tract malfunctioning, eye infections, joint dislocation in some animals, nervous disorders, respiratory tract infections, weakness, paralysis, dullness, skin infections, inflammations and heat/cold stress.

As far as per year analysis is concerned, in the year 2013 and 2012, most prevalent diseases found were associated with gastrointestinal tract, whereas, total number of diseased stock in both years was 129 and 87 respectively. In 2011, respiratory tract infections were more dominant than other diseases. Total 83 animals were affected this year. In year 2010 and 2009, the most prominent factor affecting zoo animals, health was weakness, whereas, number of diseased stock recorded was 59 and 32 respectively.

In 2013 among ungulates, the maximum number of suffered animals was that of Mouflon sheep. In the year 2012, Punjab Urial was affected the most. In year 2011, 2010 and 2009, highly suffered stock was of Chinkara. Among carnivores, lions suffered highest in year 2013. In 2012, white tigress were found to be suffering. Asiatic wolf and white tigress suffered at highest ratio in 2011 whereas White tigress and Lioness Rani suffered at highest ratio in the year 2010. White tigress, Lioness Rani and black leopard suffered at highest ratio in the year 2009.

Among herbivores, Guinea pigs and African elephant exhibited maximum diseased proportion of animals in 2013 whereas no disease occurred in 2012 in herbivores. Maximum diseased stock in 2011 was of Rabbit and Guinea pigs. In 2010, highest suffered ratio was of Guinea pigs and African elephant. In 2009, Wallaby and Rabbit suffered at maximum. Guinea pigs and African Elephant were suffered most from 2009 to 2013.

In 2013, 2012 and 2010 among primates, Chimpanzee showed maximum diseased ratio whereas in 2011 highest diseased ratio was shown by Olive Baboon. Languor exhibited highest proportion of diseases in year 2009. Chimpanzee was the one who suffered a lot in the duration of last five years. In Birds during year 2013, 2012 and 2011 maximum diseased stock belonged to white peafowls. In 2010, ostrich showed maximum diseased ratio. In 2009, emu possessed highest diseased ratio.

Overall analysis of the data from year 2009-2013, among ungulates, showed that most affected animals were that of Mouflon sheep (31 species) (table 1). On comparing with Moscow Zoo, Trofimov (1940) reported about 8 *Ovis vignei* to be died of 8 species of nematodes and 2 of cestodes. In Central Spain, Gomez-Bautista *et al.* (1996) described that ten mouflons and their five offspring had coccidial infection. During the same time period from 2009-2013, among carnivores, tiger family (22 species) was highly diseased (table 2). Similarly, among primates, most affected animal was chimpanzee (7 species) affected (table 3).

Of the birds' group, 22 species of white peafowls gave the highest diseased stock ratio at Lahore zoo from 2009-2013 (table 4). Further comparison revealed the appearance of Mycobacteriosis in birds of the San Diego Zoo (Schrenzel *et al.* 2008). The presence of Neoplasia was reported at necropsy in 2.75% of 3,127 mammals, 1.89% of 5,957 birds, and 2.19% of 1,233 reptiles by Effron *et al.* in 1977.

Moreover, the most diseased species among herbivores were that of guinea pigs followed by elephants (table 5). Comparison with other zoos showed that in herbivores of North American zoos, endotheliotropic herpesviruses caused highly fatal disease in nine Asian (*Elephas maximus*) and two African (*Loxodonta*

africana) elephants with huge mortality (Richman *et al.* 2000).

In the duration from 2009-2013, mortality rate was highest and equal among ungulates and birds i.e. 36 species died totally. Out of these 36 species of both groups, 4 species of ungulates and 17 species of birds died naturally. Whereas only 6 species of carnivores died due to diseases and other 2 died naturally. Among primates all of the 5 species died due to diseases; no natural death was recorded. Minimum mortality rate was recorded among herbivores of which only 2 species died due to certain diseases; no natural death was documented.

In short, for the data recorded for the diseases at Lahore zoo when subjected to analysis for five years, showed the statistics as; 195 ungulates (18 species), 102 birds (33 species), 19 primates (6 species), 70 carnivores (13 species) and 8 herbivores (4 species) to be diseased. Total diseased stock was 390 (74 species) in number.

Conclusively, from 2009-2013, most affected group found was that of ungulates and most prevalent factor affecting health of zoo animals was weakness followed by RTI and GIT disorders. In these five years, a total frequency of 87 (22.30%) deaths was counted, out of which deaths due to diseases were 63 (72.41%) and natural deaths were 24 (27.58%). Mortality rate due to diseases was highest among ungulates and birds but natural death ratio was highest among birds only (Table 1-5).

All the prevalent diseases can be caused by a number of factors that an animal can face in captive conditions. Animal can get injured or diseased in the natural ecosystem as well, but when at zoo, they expect a quick diagnosis and follow up of the disease. As for the discussion of the reasons behind getting any of the above diseases, it may be due to food or environment. If it comes out to be food, it may be the non-hygienic or unsuitable food that may cause a reaction in the form of intestinal compaction or diarrhea. The weakness, limping, general dullness, paralysis and paraplegia are less likely to be caused by some unhygienic diet; rather it may be caused by some deficiency in the nutritional value or the amount of the supplied diet. It may also cause the animal to be anemic if it is least interested in eating or if its food preferences are not fulfilled appropriately.

As far as the environment is concerned, it may cause the diseases like fever, cough, nervous disorders, and skin infections and to a lesser extent the reproductive tract infections. It may also be the reason behind some eye infections if the environment is polluted or dusty. As some behavioral studies about the HAR indicate, the nervous disorders as well as depression can be caused by the restlessness of the animals due to daily encounter of the unfamiliar masses of the people. The polluted environment also accounts for the proper management and maintenance of the cages and sitting stations of the animals.

Table 1. Disease records vs. death records from 2009-2013 of Ungulates

Common name	No. of diseased animals	Diseases and symptoms	Treatment	Survival/Death
Punjab Urial <i>Ovis vignei punjabiensis</i>	30	Dehydration, weakness of hind quarter, Ectoparasitized, Weight loss, Stomach disorder, Paraplegia, tick infestation, diarrhea, theleresis, enteritis, blindness, eye-infection and pus oozing out.	Methycobal ,Neurobion, injection of Ringer Lactate (100ml), Atropine inj., Dextrose inj., Aminovil inj., Ivomec inj., Butalex inj., Vitamin E-Selenium inj., Multivitamins inj., Inj. of LRS 100ml + Gesiton 50ml +inj. of Otrex +Dexafar 20 ml+ inj. of Butalex 2ml (Morning) Glucose powder licking (Noon at 12 p.m.) Gesiton 100 ml +Dextrose 10% (Evening at 6 p.m.)LRS 100ml+ inj. of Multivitamin 20ml (Night at 11p.m), Dextrose 10 % + Glucose powder lick (Early morning), Suspension hunter, Biodyl, Tygent Seguvan powder,½ Neurobion, inj. of Vorea ½ Suspension hunter, Scour-X 5ml, Stomach powder treatment, Farmox-LA inj., Sulphadimidine, brufin, qplex, dextrose, aminovital	Six died
Mouflon sheep <i>Ovis musimon</i>	31	Enteritis, RTI, Stomach disorder, Weakness, Pneumonia, Diarrhea, , Alopecia, cocci, tympany, conjunctivitis	Suspension hunter, cypoxin inj., biodyl inj., Stomach powder treatment, myogester inj., tylosin, farbenda suspension, butalex inj., ivomec inj., AD3E inj. Kapromec inj., Farmox-LA inj., Augent inj., Flagyl, fucidin ointment, Soda Bicarbonate, Sulphadimidine, velosef, ASD, MgSO4, LRS inj., Oextra-LA inj, ketoject inj., valbazine suspension, Vit E inj., Tylosin inj.	Three died
Camel <i>Camelus dromedarius</i>	10	Enteritis, Limping, Weakness, paraplegia, Maggot wound, theleria,	Sulfademadin, kaolin, injection of Tygent, Floximine inj. Deworming by Suspension hunter, ASD, Jetipar, methycobal, decadron inj., dextrose, pritap, neurobion tab., CaC inj., Nova-CaC inj. ASD done, butalex inj.	Three died
Spotted Deer <i>Axis axis</i>	21	RTI,TB, lameness, enteritis, Dystocia, diarrhea, emaciated, avitaminosis, , pneumonia, TB	Tylosin, Z.koff syrup, Ciprosel, Cravit tablet, Tylosin syrup, hepamerz, mineral mixture, Led riff tablet, z.koff syrup, Phlogen capsule, flagyl, Ciprocin, Entrotil, dexafar, neurobion inj., dextrose 20 %, farmox la, hepamerz, dicloran, methycobal, Cerbix-z, led riff, leflox, pulmonal, jetipar, rocephine, biodyl, oligovit,	Five died.
Rhinoceros <i>Ceratotherium simum</i>	2	RTI,Heat stress, Limping, Bed sores, Cold stress, hypothermia	Arinac tablets, Multivitamin & mineral supplements, Vaseline, Panbiotic inj. Farmox inj. Megasulf inj., MgSO4soln, Gurr, figs, ciprocol,brufin Dalmavital Vit. E inj. Neurobion inj.	One died
Chinkara <i>Gazella bennetti</i>	28	Tympany, eye infections, sinusitis, fever, conjunctivitis, Pruritis, Ruminant acidosis, Enteritis,	Magsulf & soda bicarbonate, Decadurabulin inj. +Depomedral inj. Antiseptic dressing, farmox-LA, neurobion, loxin +Oxidil inj. 250mg + Vitamin E-Selenium inj., Injection of Trioxyl, injection of neurobion, injection of Hepagen, Loxin inj., Ivomec inj., Suspension hunter, Multivitamin E-Selenium inj. Rocephen inj., Butalex inj. Soda Bicarbonate,	Three died

		Hemorrhage, alopecia, hygroma, diarrhea, theleria, Weakness , C. pseudo TB, osteoporosis, paralysis of Pneumonia	atropine, kaolin powder, rocephine, flagyl, ivomec, Vit E inj. Drainage of ivomec, synovial fluid, qplex syrup., Ivomec, farmox, dextrose, decadron, led riff, methycobal, dextrose, polyfax, cravat inj., enervit inj., KCND inj.	
Fallow deer <i>Dama dama</i>	8	Placental disorder, C-pseudo TB, Scours, Lymph node enlargement	Injection of L-spec to retain palcenta, Pharmox inj., loxin inj., N/S inj., KCND inj. Lysovit, farmox la inj, myrin-p, neurobion, hepamerz, ciproxin, Led riff, leflox, serbix-z, DCP, mineral mixture,	One died
Burchell's zebra <i>Equus burchelli</i>	8	Strangles, Fever, TB, Hematoma, Limping, Diarrhea, colic signs	Profenid inj., Trioxyl inj., ivomec inj., MgSO4, farmox-LA inj., decadron inj., Biodyl, aagent inj., Dexafar inj., Multivitamin, mayogaster inj. panadol extra, Loxin, brufin tablet	Two died
Blue bull <i>Boselaphus tragocamelus</i>	7	Stomach disorder, Weakness, TB, Rib fracture, Weakness	Suspension Farbenda 180ml, Stomach powder, Myogaster inj., Hepagen inj., Multivitamin inj. Suspension Farbenda 180ml, Stomach powder, Myogaster inj., Hepagen inj., Multivitamin inj.	Two died
Hog deer <i>Hyelaphus parcinus</i>	11	Elbow wounds, Weakness, Liver toxicity, Lameness, Skin infection, paralysis, Pneumonia.	1.Inj. of Trioxyl-LA 5ml, inj. of Biodyl 5ml, inj. of Vitamin E-Selenium 5ml, inj. of Loxin 1ml, inj. of 2.Meloxi-10 1ml Jetiper-20 capsule, capromec inj., AD3E, Ivomec inj., farmox-LA, augmentin tablet, Rocephen, voltral, decadron	One died due to pneumonia
Red deer <i>Cervus elaphus</i>	12	Alopecia, Pruritus, Anthrax, Dystocia, C. pseudo TB, Lameness,	Inj. of Dectomax 2-3ml, Inj. Of Oxylene 20 ml or inj. Of Doxycycline 20ml, Neurobion, Augent, Farmox, Dextrose, Aminoval, hepamerz, MgSO4, Rociphen. Serbix-z, and encephabol inj, neurobion, led riff, leflox	Four died Three natural death)
Sika deer <i>Cervus nippon</i>	12	Weight loss, anemia, intestinal compaction, diarrhea, Lameness, paraplegia, paralysis, cocci	Dewormed by Suspension hunter, Ivomec, Methycobal, hepamerz, encephabol inj. Excenel inj., methycobal inj.	One died
Black buck <i>Antilope cervicapra</i>	8	Weakness, High fever, RTI, TB, worms, lameness, Abscesses under eye	L-Spec + vitamin E-Selenium inj, (5ml), Pyrosil 2cc + Ringer lactate 1000ml +Biodyl 5cc+ Otrex 1g + CaC injections Farmox inj., Farbenda suspension, Valbazen suspension, galacsoze-B, Loxin, gentafar, decadron	Two died
Hippopotamus <i>Hippopotamus amphibious</i>	2	Weight loss, anemia, and intestinal	Dewormed by Suspension hunter, 500 ml	Survived

Giraffe <i>Giraffa giraffa</i>	4	compaction diarrhea.	Tapeworms dewormed by Peritap-21 tablet, Flaygyl	Survived
Wild boar <i>Sus scrofa</i>	1	Weight loss, anemia, Diarrhea	Decadron, ketoject, dexafar, tylosin, vorex inj.	One natural death
Addax <i>Addax nasomaculatus</i>	1	Rhinitis, RTI	Neurobion, Augent, Farmox, Dextrose, Aminoval, hepamerz, MgSO ₄ , Rociphen. Serbix-z, and encephabol inj, neurobion, led riff, leflox	Death
Sambar deer <i>Rusa unicolor</i>	1	Tuberculosis, dystocia	Neurobion, dicloran tablet	Survived

Table 2. Disease records vs. death records of Carnivores from year 2009-2013.

Animals	No. of diseased animals	Diseases and symptoms	Treatment	Death/ Survival
Asiatic wolf <i>Canis lupus</i>	7	Tick infestation, chronic otitis media, weight loss, anemia, intestinal compaction, diarrhea	Kapromex inj., multivitamin inj., amoxil inj., loxin inj., ivomec inj., augent inj. depomedrol, ASD done. Dewormed by Vermox 500mg, inj. of Melonac, Farmox, cepoxin, Loxin inj. H ₂ O ₂ , Ivomec, frontline spray	Survived
White tiger <i>Panthera tigris tigris</i>	7	Fever, Weak hind quarter, Lameness, Paraplegia	Profenid, rocephin, neurobion, Frontline spray on whole body repeated after 7 days. Methycobal, Meloxi cam inj, Multivitamin tablet Xobix inj., Trioxyl inj. Biodyl inj. Methycobal, encephabol	Survived
White tigress <i>Panthera tigris tigris</i>	15	Pruritis, Diarrhea, rickets, Alopecia on lateral sides of trunk, Liver disorders, Thigh wounds, Hemobartonell, cough, hematoma, mange	Furacin ointment, rigix tablet, Bath by pyodin scrub, liver tonic, polyfax ointment, Injection of Enrofloxacin, injection of Epperex, iron supplements. Vermox tablet, Liver tonic supplementation, Hepamerz (0.25), Trioxyl inj., Profenid inj., Ivomec inj., Ceriflax inj., polyfax, Sancos, dextrose 10%, Farmox la inj., Fucidin ointment	Survived
Lioness Rani <i>Panthera leo</i>	8	Loss of dentition, weakness, fever, Lameness, paralysis, paraplegia.	Theragram tablet, Evion, dextrose, amivicom, neurobion inj., decadron inj., Methycobal, Neurobion, brufin, methycobal, encephabol tablet, encephabol, dichloran	One died
Common leopard and black leopard <i>Panthera pardus</i>	4	Pruritus, loss of dentition, Weakness, Fever, dull	Inj. Dectomax 2ml, Dextrose milk, Clafron inj., dextrose, koplex syrup	One died
Ricky lion, jumbo lion and cubs <i>Panthera leo</i>	7	Rickets, Liver disorders, Head injury, Enteritis, Weight loss, anemia, diarrhea	Walked outdoor to avoid rickets, Vitamin-D & calcium supplementation, intracal-D, Deworming by Pritap-12, Liver tonic supplementation, Hepamerz (0.25) ASD Trioxyl, inj. Of Dectomax, Gentamycin inj.	One died
Otter <i>Lontra felila</i>	1	Lameness	Encephabol, methycobal inj.	Survived
Puma <i>Puma concolor</i>	10	Rickets, Body stiffened, Lane, dehydrated, no suckling reflex, wound on left fore-paw, anemia,	Lysovit syrup, CaP syrup, Calcium sandoze syrup, indrop-D, one-alpha syrup, Vitamin-D supplement orally, inj, Indrop-D, antibiotic prophylaxis powder, Tylosin, Micro-anemia colic drops, Nido milk, inj. of paracetamol/ detamol, tablet toximil, Vermox 500mg,	2 cubs died naturally

Jackal <i>Canis mesomelas</i>	2	intestinal compaction, and diarrhea. Enteritis, tick infestation	Cambentrin tablet, methycobal, Brufin, Sulphadimidine, dicloran, sodium 500ml Flagyl tablet	Survived
Black bear <i>Ursus americanus</i>	6	Rickets, Alopecia, Lameness of fore limb, cocci	Walked outdoor, Dicloran, methycobal, osanate, encephabol, dextrose, ESB3 via distilled water	Two died
Jungle cat <i>Felis chaus</i>	2	Scabies, fever, sluggishness	Inj. of Dectomax 1ml, neurobion,	One died

Table 3. Disease vs. records of Primates from year 2009-2013

Primates	No. of diseased animals	Diseases and symptoms	Treatment	Death/ Survival
Rhesus monkey <i>Macaca mulatta</i>	1	Scabies	Ivomec spray	Survived
Colobus monkey <i>Colobus angolensis</i>	1	Fever	Glaxo-D, leflox, cerelac	Died
Languor <i>Semnopithecus schistaceus</i>	2	Cough, fever, Leg injury, limping	Brufen, dexta, gentafar, sancos injections	Both Died
Olive baboon <i>Papio anubis</i>	4	Maggot wounds, Avitaminosis, alopecia	Dexafar inj., gentafar inj., polyfax, oxyfalin, Vidalyin via food, enervit syrup, DCP supplementation,	Survived
Vervet monkey <i>Chlorocebus pygerythrus</i>	1	Pneumonia	Loxin inj, clafon inj.	Died
Chimpanzee <i>Pan troglodyte</i>	7	General cough, Rhinitis, Coughing, refused oral medication, liver disorder, Cold, flue, cough, chest infection, Alopecia, Enteritis	Prophylactic treatment, Z.koff, Atarax tablet, johar joshanda, Oxidil Decadron, trimeabol, calpol, novidat, hepamerz, Vidaylin, hepamerz inj., liver tonic, Mineral supplement, lysovit	One died

Table 4. Disease record vs. death records from 2009-2013 among birds

Birds	No. of diseased animals	Diseases and symptoms	Treatment	Death/ Survival
Common duck /Pelicans <i>Tadorna tadorna</i>	5	Lameness, Bone fracture Limping, reduced appetite reflex	Neurobion inj., ASD, Dellacortil Suspension hunter, decadron, xubix, disprin,	One died
Carolina duck <i>Aix sponsa</i>	1			Natural death of one Carolina duck
Blue gold macaw <i>Ara ararauna</i>	1	Paraplegia of legs	Encephabol neurobion, brufin	Died
Mallard <i>Anas platyrhynchos</i>	1	Weakness	Augmentin, neurobion	Survived
Ostrich <i>Struthio camelus</i>	7	Conjunctivitis, Eye-infection, lameness	Farmox la inj. washing by normal saline,, tobradex drops, Washing with NACL, neurobion, aminoval, methycobal, DCP	Survived
Pigeon <i>Columba livia</i>	2	Cold stress	Ciprosol, liver oil, tylodox via	Survived

White pea fowls <i>Pavo cristatus</i>	22	Neuritis, Enteritis, anorectic, weight loss, Anorexia, Emaciation, Worm infestation, lameness, CNS disturbed, cocci Digestive tract abnormalities, ND, Conjunctivitis, RTI ,Sluggish, limping	distilled water, liver tonic Encephabol tablet, Azomax capsule, deltacortil inj., methycobal, flagyl inj., hepamerz inj. Cerelac, Dewormed, dusted by Suspension hunter, vaccination against ND, Revrobion inj., Dexafar inj. ,Gentamycin inj. ,Hepamerz syrup, Cypoxin inj., Aminoliban powder, Loxin inj, clafron inj., neurobion inj. Brufin, floracid, jetipar, encephalobol, vermoz, amprolium 2 drops of pyodin locally, lysovit via distilled	Three died
Ring-necked pheasant <i>Phasianus colchicus</i>	5	Glossitis, stomatitis, muscle stiffness	2 drops of pyodin locally, lysovit via distilled	Survived
Flamingo <i>Ruber phoenicopterus</i>	1	Pinconning	Surgery, xylolene, ASD	died
Love birds <i>Agopornis rosellcollis</i>	1	Cocci	Amprolium via distilled water	One natural death
White pheasant <i>Crossoptilon crossoptilon</i>	4	Nervous disorder	Encephabol, lysovit	All Died
Yellow golden pheasant <i>Chrysolophus pictus</i>	4	Enteritis, RTI, GIT and Infectious diseases, cocci, Corneal opacity	Tylosin inj., dellacortil, Aminovil inj. Cerelac, Antibiotic prophylaxis, ESB3, (Sulfachlropyrazine), 30%, Tobradex drops, Vidalyin via food, enervit syrup, DCP supplementation	Three died (Natural death of two golden pheasants and one due to disease)
Green golden pheasant <i>Chrysolophus pictus</i>	1	RTI	Tylosin inj.	Survived
Emu <i>Dromaius novaehollandiae</i>	5	Rickets, Corneal opacity, nervous disorder, neck Wound	Powder farminavit, Tobradex drops, neurobion inj, ASD, local anesthesia	One died due to neck wound
Black shouldered pea fowl <i>Pavo cristatus</i>	6	General debility, Fever, limping, Enteritis, emaciation	Hepamerz, Theragen-W tablet, Brufen, encephabol, neurobion, Enaxabiol tablets, flagyl tablet	One died
Pied pea fowl <i>Pavo cristatus</i>	1	Lameness	Methycobal inj.	Survived
Rosella <i>Platycercus eximius</i>				7 natural deaths
Java green peafowl <i>Pavo mutcus</i>	1			3 natural deaths
Turkey <i>Meleagris gallopavo</i>	9	ND, Weight loss, anemia, failure to thrive, intestinal compaction or blockage, diarrhea, or general unthiftiness	Vibramycin, antibiotic prophylaxis, Dewormed and dusted by Suspension hunter, vaccination against ND	Survived
Crane <i>Anus strepera</i>	3	Nutritional disorder, Ruffled feathers, bumble foot of chronic origin, Paralysis, Enteritis	Injection of neurobion 0.2ml, injection of CaC 1000ml, 0.5ml S/C, CNC, lysovit	2 died
Black partridge <i>Melanoperdix niger</i>	1	Enteritis	CNC via distilled water	Two died (One died due to disease, One

White fronted goose <i>Anser alvifrons</i>	1	Pinning, nervous disorder	Benzoic tincture, methycobal, brufin	dies naturally) Survived
Buzzard <i>Buteo buteo</i>	2	Eye infection, corneal opacity	Tobradex drops	Survived
Blue ringed-neck parakeet <i>Psittacula krameri</i>	1	Fungal infection	Ivermectin injection, Fungivicin tablets, farmox-la, osanate tablet, neurobion tablet	Survived
Budgerigar <i>Melopsittacus undulates</i>	1	Cocci, enteritis	Cocoban, CNC via distilled water	Survived
Olive ringed neck parakeet <i>Psittacula krameri</i>	1	Alopecia	Fungivin inj., osanate inj.	Survived
Tawny eagle <i>Aquila rapax</i>	1	Swelling of eyes	Tobradex drops	Survived
African grey parrot <i>Psittacus erithacus</i>	3	Cocci, Paralyzed, Alopecia	Cap-600, Encephabol, brufin, Oasate tablet, cerelac	Two died
Silver pheasant <i>Lophura mythemera</i>				One natural death
Common pheasant <i>Phasianus colchicus</i>	6			Natural death of one
Finch <i>Geospiza fortis</i>	1	Cocci	Cocoban, CNC	Survived
Amazon parrot <i>Amazona collaria</i>	1	Heat stroke	Jetipar	Died
Peacock <i>Pavo cristatus</i>	2	Cocci	Aminoval via distilled water	Survived

Table 5. Disease records vs. death records from 2009-2013 among herbivores

Animals	No. of diseased animals	Diseases and symptoms	Treatment	Death/survival
Guinea pigs <i>Cavia porcellus</i>	3	Alopecia, Rough hair coat, lack of appetite, dental pain, delayed wound healing, lameness, and an inability to fend off infections	Inj. Of Dectomax, inj. Of Vitamin E-Selenium 15ml, Inj. of Velocef, Pink spary, (Myogaster), inj. Biodyl 20ml, Vitamin C , Mineral supplement, lysovit supplementation, Pourton(3ml)	Survived
African elephant <i>Loxodonta africana</i>	2	Trunk wounds, Elbow wounds, Edema of abdominal region, emaciated	ASD done, dewormed by valbazen, ASD, Vaseline, penicillin, Megasulf inj. Oxanil, herbal medicine, aminovital, NACL, dextrose, dexa, enrotil, neurobion	Survived
Rabbits <i>Lepus curpaeums</i>	2	Cocci, Pneumonia, Marge, Rickets	Cap-600, Injection of Ivomec, seguwon, pink spray, injection of oxylene, Multivitamin inj	One died naturally
Wallaby <i>Macropus rufogriseus</i>	1	Paralysis, blindness	Farmox-LA, dexa, neurobion	Dead

Conclusion: Diseases in animals under captive conditions is a common issue which can result from unhygienic conditions of the enclosures, inappropriate diet provision, psychological stress, absence of environment enrichment techniques, injuries and many others. In the past five years a number of diseases in 390 animals (74 species) have resulted in 63 deaths while 24 deaths were due to natural causes leading to a mortality rate of 17.4 deaths per year. Efforts should be made to

reduce the disease burden in the zoos and ensure a healthy environment for the animals. For this purpose, individual animal treatment record by Veterinary department must be refurbished. Deliberate feeding of animals by visitors must be prohibited. Environment and food enrichment techniques must be engaged in addition to appropriate housing facilities. To control the diseases good preventive medicines for pest control and vaccination must be provided on time.

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