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TRIBUTE

DR. KABITA ROY October 30, 1959 - January 14, 2024



Dr. Kabita Roy served as the Professor and Head of the Department of Veterinary Medicine in Veterinary College Jabalpur. Specializing in Small Animal Medicine, she was an alumna of the college, holding Bachelor's, Master's, and Ph.D. degrees. Throughout her illustrious career, she guided numerous post graduate students, with their Master's and PhDs. Anticipating her retirement at the end of October this year, she eagerly looked forward to it.

Her Master's program research on Avian haemolytic anaemia and phenyl-hydrazine stands as a testament to her scholarly prowess. Published by Elsevier in international journals, from the UK and Germany, boasting an impact factor exceeding 1.89, her contributions surpass the esteemed NAAS rating in India. Among her noteworthy publications are:

"Sequential morphological changes in chicken erythrocytes after in vivo and in vitro exposure to phenylhydrazine hydrochloride" (K. Datta (Roy), JL Soni, and IC Datta, Research in Veterinary Science, Vol. 48, 1990)

"Erythrophagocytosis in phenylhydrazine-induced acute anaemia in chickens" (K. Datta (Roy), JL Soni, R.P. Awadhya, and IC Datta, Research in Veterinary Science, Vol. 47, 1989)

"An Avian model for the study of acute haemolytic anaemia in the domestic fowl (*Gallus domesticus*)" (K. Datta (Roy), JL Soni, and IC Datta, Biomed Biochim Acta., 1990)

"Haemato-clinical changes in phenylhydrazine-induced acute haemolytic anaemia in calves" (M.L. Sharma, JL Soni, and K. Datta (Roy), Arch Exp Veterinarmed., 1991)

"Pathomorphological changes in calf erythrocytes during phenylhydrazine-induced acute haemolytic anaemia" (M.L. Sharma, JL Soni, and K. Datta (Roy), Arch Exp Veterinarmed., 1991)

"Appearance of Heinz bodies in phenylhydrazine-exposed chicken erythrocytes: an overview of mechanisms" (2009 Roy, Kabita; Quadri, M.A.; Datta, I.C.; Rakshit, Sabita) Indian Journal of Experimental Biology CSRI, 33:96-98).

In 1990, she was honoured with the "Young Scientist Award," and her work continues to be cited in numerous international theses. Dr. Roy authored numerous research papers, scientific papers, and case reports in India and abroad, extending beyond the scope of this eulogy.

Notable citations include: The World Health Organization booklet on "Phenylhydrazine" chemical https://inchem.org/documents/cicads/cicads/cicad_19.htm

" The Avian Erythrocyte: Its Phylogenic Odyssey", [https://www.google.com/books/edition/The_Avian_Erythrocyte / AHWqDwAAQBAJ?hl=en&gbpv=1&printsec=](https://www.google.com/books/edition/The_Avian_Erythrocyte/AHWqDwAAQBAJ?hl=en&gbpv=1&printsec=And) And AGRIS <https://icar.org.in/sites/default/files/2022-04/AN1101AN-KK.pdf>

Dr. Kabita Roy, an indomitable spirit, faced adversity at the tender age of 18, succumbing to waist-down paralysis from a viral infection. Undeterred, she triumphed over this ordeal during her two-month sojourn at the Medical College hospital, emerging resilient and learning to walk anew. Her unwavering determination steered her towards a career in Veterinary Medicine, driven by the desire to stand independently on her own two feet and secure a livelihood.

Despite her physical challenges, Dr. Roy maintained a smiling face, built strong relationships, and regularly communicated through WhatsApp to keep up with relatives. She shared a loving relationship with her caring husband, Subol, and their genial child, Shubhojeet, who supported her throughout. Dr. Roy's positive outlook, determination, and kindness serve as valuable lessons to all.

Tragically, Dr. Kabita Roy, a true fighter, succumbed to pneumonia, on January 14, 2024. Her departure leaves a void, and her sister, Dr. Sabita Rakshit, expresses deep sorrow, promising to miss the opportunity of writing future papers together. The world mourns the loss of a noble soul who left us too soon.

With heartfelt condolences,

Dr. Sabita Rakshit

Younger sister of the late Dr. Kabita Roy

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From the Editor's desk

Technology has been at the core of the transformation for many industry sectors in recent times. The animal healthcare industry is no exception. Antimicrobial resistance and superbugs, Zoonoses, transboundary diseases with respect to One Health and climate changes linked environmental deterioration is affecting our food sources, water, and our wellbeing. You will find articles about such topics in this issue of Raksha Technical Review.

Microparticulate systems such as microparticles, microspheres, microcapsules or any particle in a micrometer scale (usually of 1–1000 μm) are widely used as drug delivery systems, as they offer higher therapeutic and diagnostic performance compared to conventional drug delivery forms. This edition of RTR, brings you an excellent article titled "*Microparticle Based Drug Delivery System*" under the Large Animal Section..

Antimicrobial resistance (AMR) threatens the effective prevention and treatment of an ever-increasing range of infections caused by bacteria, parasites, viruses and fungi. As a result, the medicines become ineffective and infections persist in the body, increasing the risk of spread to others. This edition of RTR, brings you an insightful article titled "*Antimicrobial Resistance: A Global and National Update*" highlights the trends in Human and animal health under the Large Animal Section.

Large Animal Section also brings articles *Post–Surgical Nutrition: A Review* which elaborates on the beneficial effects of nutritional support on ailing patients and *Severe Fever with Thrombocytopenia Syndrome: A review* which brings focus on the novel virus, pathogenesis, diagnosis and treatment as well as zoonotic implications.

In the Indigenous Breed Section, the article *Mountain's Pride: Arunachali Yaks of India* describes the breed and its importance.

Companion Animal Section presents various articles *Canine Babesiosis: Guidelines for the practitioners in diagnosis, treatment, prevention and control* and *An Introduction to Canine Brucellosis* includes diagnosis, treatment, prevention and control.

The articles *Clinical Management of Trypanosomiasis in A Dog* describes the treatment of protozoan parasite and *Medical Management of Extrahepatic Portosystemic Shunt in a Spayed Female Yorkshire Dog* highlights successful medical treatment with hepatic support regimens ruling out surgical intervention.

Companion Animal Section also offers articles of interest and case reports such as *Rectal Tubulopapillary Adenomatous Polyps with Severe Comorbidities in a Geriatric Female Dachshund: Complete Recovery with Advanced Diagnostics and Treatment*; *Transmissible Venereal Tumour In A Male Labrador Dog– A Case Report*; *Surgical Renovation of Ruptured Right Anal Sac in a Neutered Male Domestic Short Hair Cat*; *Delivery of Six Live Foetuses by C-section in a French Bulldog* and *Assessment of Neonatal Survival by Modified APGAR Scoring System*; and *Cushing's Syndrome and High Risk Comorbidities in a Senescent Neutered Male Lhasa Apso Dog: A Case Report*.

General Articles Section brings an article, the first of its kind on aqua culture farming, *Freshwater Aquaculture in Andhra Pradesh: Holistic Approach Needed* emphasises the utmost important aspect of farmer support measures that their issues are addressed and redressed for sustainable fish production.

We hope the readers will cherish the very purpose of the Journal.

Dr Priyabrata Pattnaik
Dy Managing Director

Managing Director's Message



Dear Patrons,

Season's Greetings!!

Yet another milestone year for IIL!

IIL has crossed the Rs 1000 Cr turnover mark. FY2023-24 is likely to end with a turnover beyond Rs 1300cr. The year also marks the launch of three new vaccines, namely, Measles-Rubella, TT+Diphtheria (Td) and Hepatitis-A vaccine. IIL is particularly proud of Hepatitis-A vaccine since this is the only indigenous Hepatitis-A vaccine in India.

IIL is working towards strengthening the vaccine manufacturing potential of the country. Several projects are underway to increase manufacturing capacities. IIL is in collaboration with multiple National and International scientific Institutions for developing vaccines of national importance. Sustained belief of the veterinary and medical professionals of India in IIL's products & services is encouraging to consistently work making India healthier.

The Summer season is setting in, and we are already noticing glimpses of the hot summer ahead. Request each one of you to adequately hydrate yourselves. Also, ensure to feed water to the flora and fauna around you. Of course, with a caution to conserve water!

ONE WORLD! ONE HEALTH!!

Cheers

Dr K Anand Kumar

Microparticle Based Drug Delivery System

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Abstract

A microparticulate drug delivery system (MDDS) entraps solids, liquids or gases in sizes ranging from 1 to 1000 μm in inert polymeric shells. This delivery system particularly aids in sustained and controlled release of the enclosed particles through gradual diffusion for prolonged periods. Microparticles enclose several macromolecules, including vaccines, nucleic acids, proteins and control their release by delivering through multiple routes. This review focuses on types and various preparative methods of MDDS along with its applications and advantages in various aspects. MDDS will continue to gain prominence as an effective and sustained targeted drug delivery system in the near future.

Introduction

Controlled drug delivery technology represents one of the frontier areas of science, which involves multidisciplinary scientific approach. It is desired to deliver the drug at right time in the right amount to minimize adverse effects, which can be done using microparticles, to attain maximum therapeutic benefits. A microparticulate drug delivery system (MDDS) entraps solids, liquids or gases in size ranging from 1 to 1000 μm in inert polymeric shells, protecting them from the harsh external environment. It overcomes the limitations associated with conventional therapy and assists in enhancing the therapeutic efficacy of the active compound (1).

They are administered either directly to the target organs or through multiple routes, including intraperitoneal, intramuscular, subcutaneous, intra-organ, and pulmonary delivery. This delivery system particularly aids in sustained and controlled release of the enclosed particles through gradual diffusion for prolonged periods. Therefore, MDDS is an intelligent approach with a strong therapeutic impact (2).

It has a great demand in medical technology due to its specific and attractive properties like biocompatibility, stability, target specificity, uniform encapsulation, better compliance and controlled and sustained release patterns that are responsible for diminishing the toxicity and dosage frequency.

Microparticles can enclose several macromolecules, including vaccines, nucleic acids, and proteins, and control their release by delivering through multiple routes (3).

Drug is gradually released on erosion and diffusion from the particles. The rate of release may be increased by decreasing molecular weight of the polymer, particle size and by controlling the nature of the polymer (4).

Microparticles increase the relative bioavailability of drugs and show taste-masking property. The microparticles have great potential for reducing the dosage frequency and toxicity of various drugs. The preparative methods are simple and can be administered into the body through hypodermic needle. Microcapsules are also used as carriers for vaccines and drugs in surgical procedures and diagnostic agents. Microparticles can be used to produce amorphous drugs with desirable physical properties (5).

Structural Composition

MDDS contain two components, a core material enclosing the active ingredient and a coating material that protects the active material from the harsh external environment and extends its release as per the requirement. Therefore, based on the disease condition, the targeted site, and the drug to be incorporated, different polymers are used accordingly to produce better therapeutic efficacy.

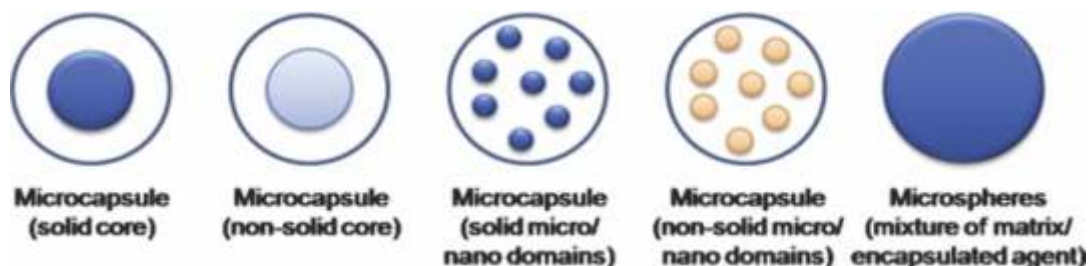


Fig. 1: Microparticles structural variation

Classification of MDDS

Microcapsules

The terms microcapsules and microspheres are often used synonymously. The term “microcapsule” is defined, as a spherical particle with the size varying between 50 nm to 2 mm containing a core substance. Microcapsules are micrometric reservoir systems. These are different from microspheres in that the drug is centrally located within the polymeric shell of finite thickness and release may be controlled by dissolution, diffusion, or both. Quality microcapsules with thick walls release their medicaments at a zero-order rate. As the domains and subdomains of active agent within microcapsules become progressively smaller, the microcapsules become microparticles (6).

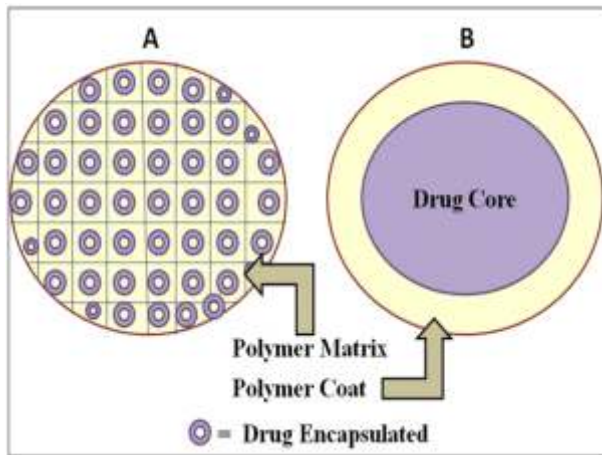


Fig. 2: (A) Microsphere (B) Microcapsule

Microspheres

Microspheres are solid, nearly spherical, micrometric matrix systems. They are made up of biocompatible and biodegradable polymers e.g.: Polylactic acid (PLA), Polylactic-co-glycolic acid (PLGA). Waxy or other protective materials such as starches, gums, proteins, fats, natural polymers as gelatin and albumin are also used in preparation of microspheres. These are characteristically free flowing powders consisting of spherical particles of size ideally less than 125 µm that can be suspended in a suitable aqueous vehicle and injected by an 18 or 20 G needle. Each particle is a matrix of drug dispersed in a polymer from which release occurs by a first order process (7).

Microparticles provide accurate delivery of potent drugs, reduce the concentration of drug at sites other than the target tissue and serve as effective delivery systems for insoluble (or) sparingly water-soluble active agents (8).

Preparation Methods

Microparticles are usually made from polymers. These polymers are classified into two types:

1. Synthetic Polymers

- Non-biodegradable like PMMA (poly methyl methacrylate), Acrolein Epoxy.
- Biodegradable like Lactides, Glycolides copolymers, Polyalkyl Cyanoacrylates, Polyamides.

2. Natural Polymers

- Proteins, Albumins, Gelatin, Collagen, Carbohydrates, Starch, Agarose, Carrageenan, Chitosan.
- Chemically modified carbohydrates like Poly (acryl) dextran, Poly(acryl)starch, DEAE (Diethylaminoethyl) Cellulose (9).

Ideal requirements for preparation of microspheres

- i. Biocompatibility with a controllable biodegradability.
- ii. The ability to incorporate high concentrations of the drug.
- iii. Release of active reagent with a good control over a wide time scale.
- iv. Stability of the preparation after synthesis with a clinically acceptable shelf life and susceptibility to chemical modification (10).

Techniques for the preparation of microparticles

The use of preparative technique depends upon the nature of polymer as well as nature of drug and the duration of therapy.

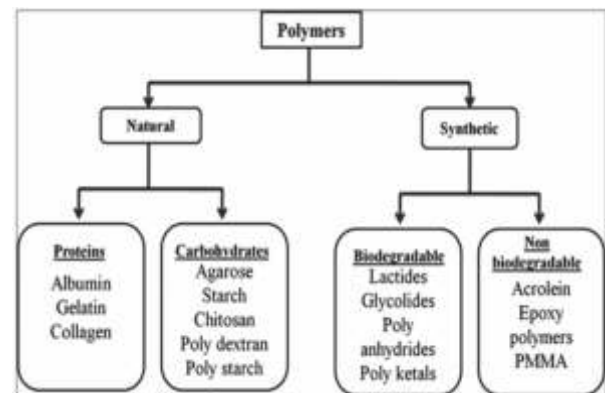


Fig. 3: Classification of polymers used in the preparation of microparticles.

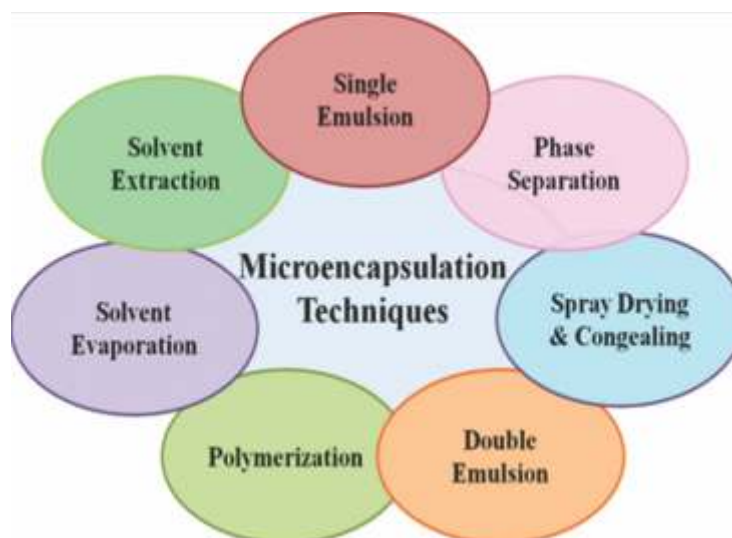


Fig. 4: Encapsulation techniques used for preparation of microparticles.

Solvent Evaporation Method

The solvent evaporation method involves the emulsification of an organic solvent (usually, methylene chloride) containing dissolved polymer and dissolved/ dispersed drug in an excess amount of aqueous continuous phase with the aid of an agitator.

Single Emulsion Technique

The microparticulate carriers of natural polymers, i.e., proteins and carbohydrates are prepared by single emulsion technique.

- i. Natural polymers are dissolved/ dispersed in aqueous medium followed by dispersion in the non-aqueous medium, e.g., chloroform or oil.
- ii. Cross-linking of the dispersed globule is carried out either by means of heat or by using chemical cross linkers. Cross-linking by heat is achieved by adding the dispersion to previously heated oil.

However, cross-linking by heat is not suitable for the thermolabile drugs. The chemical cross-linking method has an inherent disadvantage of excessive exposure of active ingredient to chemicals, if added at the time of preparation.

Double Emulsion Technique

This method can be used with both the synthetic and natural polymers. In this technique,

- i. Polymers are dissolved in an organic solvent and emulsified into an aqueous drug solution to form a water-in-oil (w/o) emulsion.
- ii. The primary emulsion is then subjected to homogenization before addition to the aqueous solution of the polyvinyl alcohol (PVA).

- iii. This results in the formation of water-in-oil-in-water (w/o/w) dispersions. The organic phase acts as a barrier between the two aqueous compartments, avoiding the diffusion of the active material to the external aqueous phase.
- iv. The emulsion is then subjected to solvent removal either by solvent evaporation or by solvent extraction.
- v. Finally, the microspheres are collected by filtration and are washed with demineralized water (11).

Coacervation Phase Separation Method

It is the simple separation of a micromolecular solution into two immiscible liquid phases. In this process, the polymer is solubilized into a solution. This process is designed for preparing the reservoir type system e.g., encapsulation of water-soluble drugs i.e. peptides and proteins, etc. Microparticles can be prepared using the following steps with continuous agitation.

- i. Formation of three immiscible chemical phases. In this method, the core material is dispersed in solution of coating polymer.
- ii. Deposition of coating polymer on core material, which takes place at interphase between core material and liquid vehicle phase.
- iii. Rigidising the coating by thermal, desolvation or cross-linking techniques to form microparticles (12).

Spray Drying and Spray Congealing Method

These methods are based on the drying of the mist of the polymer and drug in the air. Depending upon the cooling of the solution or removal of the solvent,

the two processes are named spray congealing and spray drying, respectively.

Spray drying is used to protect sensitive substances from oxidation based on the atomization of a solution by compressed air and drying across a current of warm air. The hot air causes removal of solvent from the coating solution thus causing formation of the microcapsule in size range of 1-100 μm . Microcapsules are separated from the hot air by means of the cyclone separator while the traces of solvent are removed by vacuum drying. The major advantage of the process is feasibility of operation under aseptic conditions. E.g., the spray drying process is used to encapsulate various penicillins (13).

Polymerization Method

The polymerization techniques that are commonly used for the preparation of the microspheres are broadly classified as bulk, suspension, emulsion, and interfacial polymerization.

Bulk Polymerization

In bulk polymerization, a monomer or a mixture of monomers along with the catalyst or initiator is usually heated to initiate the process. Polymer so obtained may be moulded/ fragmented as microspheres. Drug loading may occur during the process of polymerization.

Suspension Polymerization

Performed at lower temperature and also referred as bead or pearl polymerization, it is carried out by heating the monomer mixture with active drug as droplets dispersion in aqueous phase. The particle size obtained by this technique is less than 100 μm . Emulsion polymerization differs from suspension polymerization due to the presence of initiator in the aqueous phase, which afterward diffuses to the surface of micelles.

Interfacial Polymerization

Interfacial polymerization involves the reaction of various monomers at the interface between the two immiscible liquid phases to form a film of polymer that envelops the dispersed phase. Interfacial polymerization technique is one in which two monomers, one oil-soluble and the other water-soluble, are employed and a polymer is formed on the droplet surface. The method involves the reaction of monomeric units located at the interface existing between a core material substance and a continuous phase in which the core material is dispersed. In contrast, wax coating and hot melt techniques involve dispersion of polymer in a suitable vehicle and slowly cooled to form the microspheres. The polymers having low melting point formulate into microspheres by this technique easily (14).

Applications of Microcapsules and Microspheres

- Microencapsulation is most useful for the preparation of tablets, capsules, or parenteral dosage forms.
- Microencapsulation can be used to prepare enteric-coated dosage forms, so that the medicament will be selectively absorbed in the intestine rather than the stomach.
- It can be used to mask the taste of bitter drugs.
- From a mechanical point of view, microencapsulation has been used to aid in the addition of oily medicines to tableted dosage forms.
- This has been used to overcome problems inherent in producing tablets from otherwise tacky granulations and in direct compression to tablets (15).
- It has been used to protect drugs from environmental hazards such as humidity, light, oxygen, or heat.
- Microencapsulation can be used to decrease the volatility. An encapsulated volatile substance can be stored for longer times without substantial evaporation.
- Microencapsulation has also been used to decrease potential danger of handling of toxic or noxious substances. The toxicity occurred due to handling of fumigants, herbicides, insecticides, and pesticides have been advantageously decreased after microencapsulation (16).
- The hygroscopic properties of many core materials may be reduced by microencapsulation.
- Many drugs have been microencapsulated to reduce gastric irritation.
- Microencapsulation method has also been proposed to prepare intrauterine contraceptive device (17).

Advantages of MDDS (Microparticulate Drug Delivery System).

- The size of the particles direct targeted delivery of the drug as in inhalation and ocular delivery.
- They offer protection to the encapsulated drug from gastric and other external environments and aid in sustained and controlled release of the entrapped medicament and are thus useful in delivering the drugs.
- MDDS enhances the solubility profile of poorly soluble active agents, addressing their solubility.

- MDDS act as target-specific delivery system, as evident from direct intratumoral delivery of various anticancer drugs.
- It enhances the bioavailability of the loaded drug, thus achieving effective therapeutic benefits and minimizing side effects.
- It avoids repeated drug administration and masks the taste and odour of drugs, thereby imparting better patient compliance and reducing toxicity concerns.
- MDDS also assists in delivering incompatible agents by loading them in a single shell separated by encapsulation (18).

Disadvantages of MDDS

- Release kinetics of the active ingredient varies when formulated at different doses. It is governed by factors such as the presence of food, residence time and the nature of polymer.
- Sometimes, drug may be delivered at other than the target site due to polymer degradation.
- Further, the cost involved in preparing MDDS is significantly higher than the respective standard preparations and high standardization of the procedure is essential to accomplish reproducibility of the formulations.
- These disadvantages can be overcome by altering the design of microparticle preparation and using other approaches including targeted delivery, inhalation delivery, and intracranial local delivery for neurological disorders (19).

Therapeutic Applications of MDDS

- The main aim of any drug formulated as an MDDS is to achieve local targeted delivery and sustain release of the medication.
- The extent of MDDS applications vary from imaging to treating various diseases.
- Bio-adhesiveness and permeability enhancement property of polymers aid their application in formulating microparticles for ocular drug delivery systems.
- Highly efficient viral and nonviral vectors are formulated as microparticles for achieving gene delivery.
- MDDS plays a crucial role in treating diabetes because of the advantage of sustained release, thereby decreasing the frequency of administration of anti-diabetic drugs, avoiding trauma and discomfort to the patient.
- Similarly, it plays a vital role in treating almost all types of tumors by delivering potent chemotherapeutics intratumorally.

- In addition, microparticles function as effective delivery system in producing probiotics by preventing their degradation and, thus, have

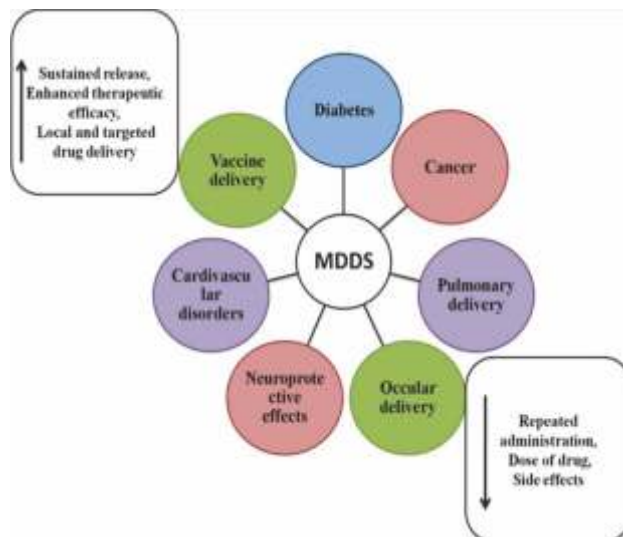


Fig. 5: Therapeutic applications of MDDS and their advantages

profound applications in many diseases (20).

Future Perspectives

In the future, inhalational application of MDDS to treat chronic disease conditions and MDDS as composite microparticles will emerge and be associated with improved therapeutic benefits. Based on the strong evidence from the literature, available marketed products and ongoing clinical trials, MDDS will continue to gain prominence as an effective and sustained targeted drug delivery system in the near future, encapsulating both natural traditional compounds and synthetically derived molecules to treat chronic diseases

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Post -Surgical Nutrition - A Review

R C Ramteke, M K Gendley, Meenu Dubey, Raina Doneria and Sonali Prusty
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Introduction

Nutritional support is important for animals during recovery from illness or surgery. Many animals will recover from mild illness or standard surgical procedures at home, but patients with more severe disease or conditions will be hospitalized during recovery. It is recommended to have a protocol for nutritional support of hospitalized patients since early nutritional support has been reported to improve outcome and to shorten hospitalization time in humans (2, 13) and dogs (8). Proper absorption of fluids, energy, and essential nutrients is of primary importance during the first 14 days after trauma or onset of illness. It is important to provide nutrients to an animal recovering from illness or surgery to ensure optimal functioning of the gastrointestinal and immune systems. Enteral feeding is preferable to parenteral feeding because intraluminal agents stimulate the gastrointestinal tract and prevent bacterial translocation (3).

Requirement/Advice of Enteral Nutrition

- Is preferred over parenteral nutrition in patients with functional GI tract disturbances.
- Should be initiated within 18 hours of injury in burn patients.
- Should be initiated within 24 hours of admission in the critically ill.
- Incompletely resuscitated patients should not receive direct small bowel feedings due to the risk for GI intolerance and possible intestinal necrosis.
- In blunt or penetrating trauma patients undergoing laparotomy, direct small bowel feeding access should be obtained and enteral feeding begun within 12-24 hours of injury.
- Intra-gastric feeding of severe closed head injury patients should be attempted within 12 hours of admission.

The beneficial effects derived from the nutritional support of diseased human patients and animal includes

- Enhanced immune function,
- Wound repair,
- Response to therapy,

- Recovery time and survival.

Despite these benefits, veterinarians frequently ignore or delay the nutritional needs of sick animals. In addition, the nutritional needs of critical patients are largely forgotten due to the intense focus on life threatening medical and surgical problems. The goal of nutritional support is to provide nutrients in proportions that can be utilized by the patient with maximal efficiency.

Metabolism of Illness

A change in metabolism occurs following injury, stress, and certain diseases and is characterized by the need for increased calories and altered fuel sources. Patients suffering from extensive burns and severe head trauma have the greatest increase in caloric requirements. The marked elevation of catecholamine's, glucocorticoids, and glucagon, in addition to peripheral insulin resistance, cause a direct increase in the metabolic rate leading to a rapid mobilization of tissue energy stores in patients not receiving adequate nutritional support. Body weight may increase initially because increased secretion of aldosterone and ADH increase sodium retention and extracellular fluid volume. If the injury is accompanied by malnutrition, there may be immune-suppression, increased bacterial translocation with increased risk of sepsis, and delayed wound healing and prolonged hospitalization.

Indicators for Nutritional Support

In general, dogs and cats that have been anorectic for > 5days or that have lost > 10% body weight should be considered for nutritional support. In addition, patients that are hypo-albuminemic or that have conditions requiring increased nutrient demands such as extensive trauma or burns are viable candidates for nutritional support. Patients with conditions causing increased nutrient losses (excessive gastrointestinal or renal protein loss) also warrant nutritional support.

The following steps should be followed when evaluating nutritional support of the sick animal.

Assess Nutritional Status

1. Nutritional support of sick animals is facilitated by obtaining a comprehensive dietary history,

performing a physical examination, and determining appropriate laboratory parameters.

2. Although body weight is routinely determined in sick animals, it is important to understand its limitations.
3. One cannot equate the appearance of the animal with its state of nourishment because body weight does not differentiate between fat, lean tissue and extracellular water.
4. Objective measurements are superior to "eyeball" measurements.
5. There is no single "gold standard" test of a patient's nutritional status.
6. In expensive determinations of nutritional status include weight loss, serum albumin concentration, and total lymphocyte count.

Estimate Proportions of Fuel Sources

The sick animal will be using primarily fat for energy, but also using protein for energy and anabolism. Carbohydrates may be poorly utilized because of peripheral insulin resistance. High carbohydrate feeding may lead to hyperglycemia, glucosuria, hyperosmolarity, hepatic dysfunction, and respiratory insufficiency. The goals for dietary intake in dogs and cats will approximate:

- Protein 30 to 50% of the metabolizable energy of the diet.
- Fat 30 to 50% of the metabolizable energy of the diet.
- CHO 10 to 25% of the metabolizable energy of the diet.

Calculate Approximate Caloric Needs

Nutritional support provides substrates for gluconeogenesis and protein synthesis and provides the energy needed to meet the additional demands of host defense, wound repair, and cell division and growth. An estimate of the animal's nutrient requirements is needed to determine the minimum amount of food necessary to sustain critical physiological processes.

Accurate, direct measurements of energy expenditure in sick dogs and cats are not available. Despite the paucity of data on energy requirements of sick animals, opinion exists that the requirements of critically ill animals are less than normal maintenance amounts, but slightly greater than RER (Respiratory Exchange Ratio). The RER is the patient's energy requirement at rest in a thermo-neutral environment and in a post-absorptive state. The veterinary literature is rife

with reports documenting various values or factors for altering initial calculations to determine the patient's final caloric requirement. This practice should be discouraged because the ability to discriminate between a patient requiring 1.2 and 1.5 times the RER is virtually impossible. One should rather view the RER as an estimate and recognize that the caloric requirements in sick animals may well increase above the RER or need to be decreased slightly below the calculated RER. Close observation of the patient's body weight changes, ongoing losses (diarrhea, vomiting, exudative wounds) and physical examination findings (decreased subcutaneous fat stores, muscle wasting, presence of edema or ascites) will help determine whether to increase or decrease the patient's caloric intake above or below the calculated RER.

A linear formula can be applied to determine the RER of patients weighing at least 2 kg. Alternatively, one can utilize an allometric formula that can be applied to dogs and cats weighing < 2 kg.

Linear formula: $RER \text{ (kcal/day)} = (30 \times BW \text{ kg}) + 70$
(Body weight > 2kg)

Allometric formula: $RER \text{ (kcal/day)} = 70$
($BW \text{ kg}^{0.75}$) (Body weight < 2 kg or > 45kg)

Calculate Amount of Diet to Feed

This requires knowledge of the energy density of the diet selected. The food dosage can be determined by dividing the animal's energy requirement (RER) by the energy density of the diet.

Select Route of Diet Administration

The preferred route of nutrient administration is by oral or enteral feeding. Enteral feeding is the safest, simplest, least expensive, and most physiologic route, and should be used whenever possible. In animals that are totally or partially anorexic, enteral feeding can be accomplished by one of several techniques: appetite stimulation, force feeding, and tube feeding.

Appetite Stimulants

Mainly utilized in cats with partial anorexia. Commonly used drugs include diazepam, cyproheptadine, and mirtazapine. Diazepam should be avoided in cats with liver disease because of the potential for inducing hepatic necrosis.

Force Feeding

This technique is of limited benefit and is stressful for cats and dogs in which it is performed. In

addition, force-feeding can precipitate a conditioned food aversion and should therefore be abandoned in favor of tube-feeding techniques if voluntary food intake does not fulfill the patient's caloric requirements.

Enteral Feeding Access Devices

Most feeding tubes today are made of polyurethane or silicone. These materials have tended to replace the older polyvinylchloride feeding tubes that tends to stiffen when exposed to digestive juices and are more irritating to patients, necessitating frequent tube replacement. Silicone is softer and more flexible than other tube materials with a greater tendency to stretch and collapse. Polyurethane is stronger than silicone, allowing for a tube of this material to have thinner walls and thus a larger internal diameter, despite the same French size. The flexibility and decreased internal diameter of silicone tubes may lead to clogging or kinking of the tube. Both polyurethane and silicone do not rapidly disintegrate or become brittle in situ, providing a longer "wear". The French (F) unit measures the outer lumen diameter of a tube (each French unit is equal to 0.33mm). Tubes that are too flexible may be chilled before placement to increase stiffness.

a) Nasoesophageal - Simple and efficient choice for the short-term (less than 10 days) nutritional support of most anorectic hospitalized patients that have a normal nasal cavity, pharynx, esophagus, and stomach. Nasoesophageal tube feeding is contraindicated in animals that are vomiting, comatose, or lack gag reflex. Polyvinylchloride (Infant Feeding Tube, Argyle Division of Sherwood Medical, St. Louis, MO) or red rubber tubes (Sovereign Feeding Tube, Monoject Division of Sherwood Medical, St. Louis, MO) are the least expensive tubes for dogs and cats, although the polyvinylchloride tubes may harden within 2 weeks of insertion and cause irritation or ulceration of the pharynx or esophagus. Tubes made of polyurethane (Travasorb Feeding Tube, Travenol Laboratories, and Deerfield, IL), or silicone (Cook Nasal Feeding Tube, Cook Veterinary Products, Bloomington, IN) are more expensive; however, they are less irritating and more resistant to gastric acid, allowing prolonged usage. A8 French × 42 inch tube (preferably with a stylet) is suitable for dogs weighing more than 15 kg. A5 or 6 French × 36 inch tube is recommended for dogs weighing less than 15kg and for cats.

A major disadvantage of nasoesophageal feeding tubes is their small diameter, necessitating the use of liquid enteral formulas. Commercially available canned pet foods that are diluted with water will

invariably clog the feeding tube. The caloric density of most human and veterinary liquid enteral formulas varies from 1.0 to 1.5 kcal/ml. Diets are fed full strength on continuous (pump infusion) or bolus feeding schedules.

b) Pharyngostomy- Although relatively easy to place, the technique has become virtually obsolete with the advent of percutaneous gastrostomy and esophagostomy tube placement. Pharyngostomy requires general anesthesia and meticulous attention when being placed to avoid interference of epiglottic movement and partial obstruction of the larynx.

c) Esophagostomy- The technique for surgical placement of cervical tube esophagostomy in dogs and cats was refined in an effort to avoid the complications associated with aspiration or laryngeal obstruction that may occur with pharyngostomy and nasoesophageal tube placement. The tubes are easily inserted, and insertion only requires light general anesthesia or heavy sedation. The only major complication that has been associated with esophagostomy tube placement is wound infection at the ostomysite where the tube exits the skin. Daily meticulous care of the ostomysite has been effective in preventing infection.

Three techniques for tube esophagostomy placement have been described. The patient should be placed in right lateral recumbency, and the left cervical region aseptically prepared for tube placement. The percutaneous (needle) technique incorporates the use of an intravenous jugular vein catheter inside a 14-gauge needle. **d) Gastrostomy**- Requires general anesthesia, with placement of the tube via percutaneous placement or during laparotomy. This procedure enables one to place relatively large diameter catheters into the patients stomach, with most dogs tolerating 24 Fr tubes and cats tolerating 20 Fr tubes.

e) Surgical (Open) Jejunostomy Technique- The needle catheter jejunostomy is a quick, easy method developed by Delany. A purse-string suture (3-0 polyglactin 910) is placed through the antimesenteric border of the proximal jejunum through which a 12-gauge hypodermic needle is directed aborally and tunneled subserosally for several centimeters before entering the bowel lumen. A 5 French polyvinylchloride tube (Infant Feeding Tube, Argyle Division of Sherwood Medical, St. Louis, MO) is introduced into the bowel lumen through the hypodermic needle and is advanced for 20 to 30 cm aborally. The needle is removed and the purse-string suture is tightened

and tied. The free end of the catheter is exteriorized by advancing it through a second sterile hypodermic needle that is passed from the prepared skin surface on the right ventrolateral abdominal wall into the peritoneal cavity. The enterostomysite is fixed to the abdominal wall with interrupted or continuous sutures passing through the intestinal submucosa and abdominal fascia.

Select diet if feeding via enteral route

The type of formula to feed the patient will depend on the selected route of feeding, the functional status of the gastrointestinal tract, and the patient's nutrient requirements. Other factors, such as cost, availability, and ease of use may also be important. Patients that are fed via nasoesophageal or jejunostomy feeding tubes are limited to receive liquid enteral formulas. Most commercially available liquid diets have a caloric density of approximately 1 kcal per ml. The protein content of an enteral nutrition product is probably the most important component. When selecting a liquid formula for feeding, one should pay particular attention to the amount of protein in the formula, the type of protein (intact proteins, peptides, and amino acids), and the quality of the protein. Protein quality is dependent on protein digestibility, absorption, and its amino acid composition. Whole egg has the highest biological value, followed by cow milk, lactalbumin, beef, soy, and casein. Most human liquid formulas contain less than 20% protein calories, precluding their use for the long-term (longer than 3 weeks) feeding of cats. The lower protein formulas should be supplemented with protein modules such as Promod (Ross Laboratories, Columbus OH), Casec (Mead-Johnson, Evansville, IN) or Promagic (Animal Nutrition Laboratories, Burlington, NJ) at 15-30 g casein or whey powder per 8 fl oz can. Almost all human liquid enteral formulas lack taurine, an essential amino acid in cats, necessitating its supplementation (250 mg taurine per 8 fl oz can) in this species. High-protein commercial human liquid formulations contain between 21% to 30% protein calories and include Impact (Sandoz Nutrition, Minneapolis, MN), Immun-Aid (McGaw, Inc., Irvine, CA), Alitraq (Ross Laboratories, Columbus, OH), Promote (Ross Laboratories, Columbus, OH), and Traumacal (Mead-Johnson, Evansville, IN).

Commercial blenderized pet food diets should be used for feeding into the stomach via pharyngostomy, esophagostomy, or gastrostomy tubes. In select cases, the feeding of a liquid enteral formulation may be indicated (nasoesophageal or jejunostomy tube feeding).

There are a number of complete and balanced veterinary enteral formulations that contain adequate amounts of protein, taurine, and micronutrients, precluding the need for supplementation in most situations. Feeding should be delayed for 24 hours after placing a gastrostomy tube, to allow gastric motility to return, and to allow formation of a fibrin seal. Jejunal feeding can be started within 6 hours of tube placement if peristalsis is present. Continuous feeding must be used with jejunostomy feeding to avoid abdominal cramping and diarrhea associated with bolus feeding via this route. Continuous infusion is recommended at an initial flow rate of 1 ml/kg/hour and increased gradually over 48 hours until the total daily volume can be given over a 12-to-18-hour period. Diet can be administered as bolus feedings or continuous infusion when feeding via gastrostomy tube. Improved weight gain and decreased gastroesophageal reflux have been reported in human patients given continuous feedings, although similar studies are lacking in the veterinary literature. A recent study completed in 10 healthy dogs revealed no significant differences in resulting body weights, serum chemistries, glucose tolerance test findings, hydrogen breath test findings, digestibility trials, or nitrogen balance between dogs fed continuously or intermittently for 10 days. Although no advantage was found with continuous enteral feeding in this study, caution should be exercised in extrapolating these results to sick patients that have been ill for a prolonged period of time and may be more susceptible to gastric atrophy and earlier satiety. If continuous feeding is employed, it should be interrupted every 8 hours to determine the residual volume by applying suction to the feeding tube. If the residual volume is more than twice the volume infused in one hour, feeding should be discontinued for 2 hours, and the rate of infusion decreased by 25% to prevent vomiting. Treatment with metoclopramide (1 to 2 mg/kg/24 hour as a continuous infusion) may be used to enhance gastric emptying and prevent vomiting.

With bolus feeding, the required daily volume of food should be divided into four to six feeds. Patients are usually fed approximately 25% of their caloric requirement on the first day of feeding, with a gradual increase of 25% of the caloric requirement per day. Most patients are able to reach their energy requirement by the fourth or fifth day of feeding. The food should be warmed to room temperature and fed slowly through the tube to prevent vomiting. Flushing of the tube with 15 to 20 ml of lukewarm water will help prevent clogging. Before each feeding, aspirate the tube with an

empty syringe to check for residual food left in the stomach from the previous feeding. If more than half of the last feeding is removed from the stomach, skip the feeding and recheck residual volume at the next feeding.

Parenteral Nutrition

Total (or central) parenteral nutrition (TPN) is the administration of complete energy and protein by intravenous infusion. Specific indications for the use of parenteral feeding include intolerance of enteral feeding as manifested by vomiting or diarrhea, severe malabsorption, severe pancreatitis, or risk of aspiration if the patient is fed via the gastrointestinal tract. The three basic components of TPN formulations are amino acid solutions, lipid emulsions, and dextrose.

Amino Acids

Amino acid (AA) solutions serve as the protein source in parenteral nutrition. There are several commercially available AA solutions with a balanced composition of essential and dispensable AA's. These solutions do not contain taurine. Hepatic and renal formulations are available, but are very expensive. These products differ in their individual AA profiles, available concentrations (4% to 15%), and electrolyte composition.

Lipid Emulsions

Fat emulsions serve two primary purposes in the parenteral nutrition regimen as a source of calories, and as a source of essential fatty acids (EFA's). Fat is the most calorically dense substrate available, having more than twice the caloric density of carbohydrate and protein, and providing approximately 9 kcal/g. The fat emulsions are typically composed of vegetable oils, phospholipids, and glycerol. As a source of essential fatty acids (EFA), fat emulsions provide varying amounts of linoleic and linolenic acids. Cats cannot convert linoleic acid to arachidonic acid, and should thus receive supplementation with an animal fat source if TPN is administered for longer than 2 weeks. Lipid emulsions are approximately isotonic.

Dextrose Solutions

Dextrose is used almost exclusively in parenteral solutions as the source of carbohydrate calories. It is an inexpensive and readily available energy source that is utilized to supply 40 to 60% of the patient's caloric intake. The provision of carbohydrate calories has been shown to suppress gluconeogenesis from amino acids and is thus protein sparing. Dextrose is commercially available in concentrations ranging from 5 to 70%.

In general, parenteral nutrition solutions with a dextrose concentration greater than 10% will necessitate the use of a central venous access to avoid peripheral vein damage.

Vitamin Supplementation

Vitamins function primarily as coenzymes of energy-yielding nutrients as well as cofactors in the storage and utilization of energy. Parenteral vitamin requirements in general are significantly less than dietary vitamin requirements because the parenteral route bypasses digestive and absorptive functions of the gastrointestinal tract. Standard parenteral doses of vitamin B complex should be provided as an additive to the TPN solution upon initiation of parenteral feeding. Concentrations greater than 10% should be administered via central vein because of the vitamins hypertonicity. Fat soluble vitamins should be supplemented if the animal is receiving TPN for > 1 month.

Peripherally infused PN is available alternative to total PN and is frequently used for the short-term (less than 1 week) nutritional support of patients unable to tolerate enteral feeding. The main advantages of peripherally infused PN over total PN include venous access and ease of provision of estimated nutrient requirements.

Because of the association of venous thrombophlebitis and catheter material, one should choose catheters that are composed of polyurethane or silicone elastomer that appear to have the lowest thrombogenicity. The osmolarity of peripherally infused solutions is generally less than 800 mOsm/L, in contrast to total PN in which osmolarity is often greater than 1200 mOsm/L. The lower osmolality can be accomplished by providing large amounts of non-protein calories from 20% lipid emulsions (virtually isosmotic), using dextrose solutions of < 20%, and using amino acid solutions of 5%. Electrolytes are typically provided as a component of intravenous fluid therapy; however, trace mineral supplements, particularly zinc at 1 µg/kcal, should be added to the PN solution. Potassium phosphate should also be added (approximately 8mM/1000kcal) because of the association of hypophosphatemia in patients receiving PN. Vitamin B complex should be added to the PN mix at approximately 2ccB complex/liter PN.

The PN solutions must be mixed in a specific order. Lipid emulsions and dextrose must not be added directly to each other, as the low pH of the dextrose solution may result in instability of the fat emulsion. Therefore, always mix in the following sequence: Dextrose then amino acids then electrolyte and

mineral solutions and finally lipids.

After determining the patient's caloric requirement, one needs to calculate percent protein for the solution. In dogs, one provides 15 to 25% of the caloric requirement as protein, whereas cats are provided with 25 to 35% of their caloric requirement as protein. The remainder of the calories is provided as "non protein calories" and the dextrose and lipid contributions are usually split evenly (50:50) in dogs, whereas cats generally receive 40% of the nonprotein calories as dextrose and 60% as lipid. The PN solution is given as a constant rate infusion which can be determined by adding the total amount of each component in ml and dividing by 24.

Parental Nutrition

Evaluate Responses and Modify as Needed

Close observation of the patient's body weight changes, ongoing losses (diarrhea, vomiting, exudative wounds) and physical examination findings (decreased subcutaneous fat stores, muscle wasting, and presence of edema or ascites) will help determine whether to increase or decrease the patients caloric intake. Weight changes often reflect fluid dynamics in the early period following injury.

Nutrition assessment determines whether there is a need for nutritional support. If it is determined that there is insufficient intake relative to need ($293 \times (\text{bodyweight}) 0.75$ in kJ/ME per day) then the (medical) cause needs to be eliminated where possible. A distinction is then made between hyporexia (decreased appetite, appetite is present but not optimal) and anorexia (complete loss of appetite). In hyporexia, a start can be made in improving the environment, palatability etc. In anorexia, a distinction must be made between patients with a functioning gastrointestinal tract (GI-tract) and patients with a non-functioning GI-tract or patients with excessive vomiting. Patients with a functioning GI-tract can be supported with the various types of enteral tubes. The choice depends on the expected duration of the anorexia. Patients with a non-functioning GI-tract or patients with excessive vomiting can be parentally supported. The choice of centrally (through a jugular catheter) or peripherally (through a peripheral catheter) depends on the expected duration of the dysfunction and/or vomiting and on what is possible for the clinic. If insufficient enteral support can be provided then partial parenteral support can be used. If the GI-tract is functioning again and/or excessive vomiting has ceased then the parenteral feeding can be phased out and replaced by enteral feeding.

Enteral vs. Parenteral Nutrition

Randomized trials of medical, surgical, and trauma patient subpopulations comparing enteral to parenteral nutrition have routinely demonstrated improved wound healing, fewer infectious complications, decreased intestinal mucosal permeability, and decreased patient care costs with the use of enteral feeding (4,5,9). Enteral nutrition is the preferred method of nutritional support as gut-associated lymphoid tissue (GALT) contributes up to 60% of total body immunity and enteral nutrition promotes mucosal viability and immunologic function (4,10,7). Patients with a nonfunctioning gastrointestinal tract, as evidenced by severe peritonitis, intestinal obstruction, short bowel syndrome, or intractable diarrhea, may benefit from parenteral nutrition as opposed to intravenous fluids alone (1). Low rate, trophic enteral nutrition should always be considered in patients receiving parenteral nutrition in order to preserve gut mucosal integrity.

Prospective, randomized trials of enteral vs. parenteral nutrition in severe pancreatitis have found that enteral nutrition is safe, feasible and superior to TPN (6). Patients who receive such enteral feedings beyond the ligament of Treitz experience fewer total complications, fewer septic complications and a decreased total hospital cost (6,11). In addition, these studies demonstrate that enterally fed patients have a decreased inflammatory response and improvement in disease severity compared to those fed parenterally (6,14).

"Early" vs. "Delayed" Enteral Nutrition

Initiation of enteral nutrition is commonly delayed until several days post-injury / post-operatively in order to ensure complete resuscitation and hemodynamic stability. Anecdotal cases of small bowel necrosis have occurred as a result of vigorous enteral nutrition and shunting of mucosal blood flow prior to adequate resuscitation of the patient. Several prospective, randomized trials, however, have demonstrated a high rate of gastroparesis and enteral nutrition intolerance in patients where initiation of enteral feedings are delayed by more than 12-24 hours post-injury (4). These findings were particularly pronounced in the severely head injured or burned patient population where decreased gastric emptying appears particularly prevalent. Early enteral nutrition within the first 12 hours post-injury has been demonstrated to be safe and highly successful. Evidence suggests that early enteral nutrition, initiated at a low rate within 24 hours of injury and gradually increased to goal rate over a several day period, may reduce the incidence of gastroparesis

and ileus that is seen when the start of enteral nutrition is delayed for several days post-injury (4). Early "trophic" feedings, begun as resuscitation is being completed, may also serve to maintain GI tract mucosal integrity and reduce the incidence of bacterial translocation, SIRS, and MOSF (12)

Conclusion

The beneficial effects derived from the nutritional support of diseased human patients and experimental animal models include enhanced immune function, wound repair, response to therapy, recovery time, and survival. Despite these benefits, veterinarians frequently ignore or delay the nutritional needs of sick and post-surgical animals. In addition, the nutritional needs of critical patients are largely forgotten due to the intense focus on life-threatening medical and surgical problems. The goal of nutritional support is to provide a formula of fuels and nutrients in proportions that can be utilized by the patient with maximal efficiency.

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Antimicrobial Resistance: A Global and National Update

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Antimicrobials are globally employed for preventing and treating diseases in both humans and animals with some countries using them as growth promoters. Widespread and improper antimicrobial use across different sectors has contributed to the emergence of antimicrobial resistance (AMR), thus posing a threat to modern medicine. The rise of AMR is fuelled by factors such as spontaneous bacterial evolution, mutations, and the transfer of resistant genes through horizontal gene transfer. Antimicrobial resistance has also given rise to "superbugs" posing challenges for healthcare workers and veterinarians by limiting effective therapeutic options to prevent, control, and treat infectious diseases.

International Trends

In the US the livestock sector accounts for about 80% of the total annual consumption of antimicrobials likely between 2010 and 2030, and global consumption of antimicrobials in the livestock sector is projected to increase by about 67% (1). In addition to death and disability, AMR has significant economic costs, The World Bank estimates that AMR could result in US\$ 1 trillion in additional healthcare costs by 2050, and US\$ 1 trillion to US\$ 3.4 trillion in gross domestic product (GDP) losses per year by 2030 (2).

AMR in Humans

The WHO Global Antimicrobial Resistance and Use Surveillance System (GLASS), was launched in 2015 to foster AMR surveillance. It has expanded to include surveillance of antimicrobial consumption, invasive fungal infection, and a One Health approach. The 2022 GLASS report has highlighted alarming resistance rates among prevalent bacterial pathogens. Median reported rates in 76 countries showed 42% for third-generation cephalosporin-resistant *E. coli* and 35% for methicillin-resistant *Staphylococcus aureus* are a major concern. For urinary tract infections caused by *E. coli*, 1 in 5 cases exhibited reduced susceptibility to standard antibiotics like ampicillin, co-trimoxazole, and fluoroquinolones in 2020 making it harder to treat common infections. *Klebsiella pneumoniae*, a common intestinal bacterium, also showed elevated resistance levels against critical antibiotics. Increased levels of resistance have potentially led to heightened utilization of last-resort drugs like carbapenems, for which resistance is in turn being observed across

multiple regions. Projections by the Organization for Economic Cooperation and Development (OECD) indicate an anticipated two fold surge in resistance to last-resort antibiotics by 2035, compared to 2005 levels.

The emergence and spread of multi-drug resistant *Candida auris*, an invasive fungal infection, is of particular concern. The emergence of drug-resistant parasites is a major threat to malaria control. Artemisinin-based combination therapies (ACTs) are the recommended first-line treatment for uncomplicated *Plasmodium falciparum* malaria and are used by most malaria-endemic countries. The emergence of partial resistance to artemisinin or partner drugs in ACTs makes selecting the right treatment more challenging. Resistance has been reported in leprosy medicines and anti-helminthics drugs (2). Demanding an urgent need for robust antimicrobial stewardship practices and enhanced surveillance coverage.

AMR Trends in Aquaculture

Globally, aquaculture contributes 8% of animal protein intake to the human diet, and per capita consumption is increasing faster than meat and dairy consumption (3). Reports have documented antimicrobial use in the rapidly expanding aquaculture industry, which may contribute to the rise of antimicrobial resistance. Bacteriophages have been shown to play an important role in harbouring and propagating antibiotic resistance genes (ARGs). Faecal matter contains high levels of phages, suggesting that faecal contamination of water bodies may lead to increased antimicrobial resistance (AMR) levels due to increased phage loading in aquatic environments (4).

Global trends in antimicrobial use in aquaculture were analysed by Schar *et al.* (2021)(3) who reported that 5 bacterial genera were isolated from samples which include *Vibrio*, *Aeromonas*, *Streptococcus*, and *E. coli* - together accounted for 68.5% of surveys. Amongst these foodborne pathogens, resistance was highest to penicillin (60.4%), macrolides (34.2%), sulfonamides (32.9%), and tetracyclines (21.5%). Resistance was also shown for human drugs like fosfomycin, polymyxin B, and Colistin. A resistance of 10.3%, 19.4%, and 5.2% was reported for Fosfomycin, polymyxin B, and colistin respectively in *E. coli*. In Gram-negative bacteria across all surveys, the mean colistin resistance was 41.3%. In *Aeromonas*

spp. across all regions, carbapenem resistance increased. *Aeromonas spp.* obtained from freshwater and marine fish in Western and Southern Asia exhibited elevated resistance compared with other subregions. In these aquatic food animals across all years, mean carbapenem resistance in *Aeromonas spp.* was 40.3%, aztreonam resistance was 56.6%, and mean resistance to third-generation and fourth-generation cephalosporins was 69.6%. (3). Another study estimated the global trends in antimicrobial use in aquaculture in terms of antimicrobial use intensity (mg kg⁻¹) for six species groups (catfish, tilapia, trout, shrimp, salmon, in pooled species group) through a systematic review of point prevalence surveys. It projects antimicrobial use in each country by combining mean antimicrobial use coefficients per species group with OECD/FAO Agricultural Outlook and FAO Fish Stat production volumes and estimated global antimicrobial consumption in 2017 at 10,259 tons increasing 33% to 13,600 tons in 2030 (5).

The Asia-Pacific region represents the largest share (93.8%) of global consumption, with China alone contributing 57.9% of global consumption. Antimicrobial consumption intensity per species group was: catfish- 157 mg kg⁻¹, trout- 103 mg kg⁻¹, tilapia- 59 mg kg⁻¹, shrimp- 46 mg kg⁻¹, salmon, 27 mg kg⁻¹ and in pooled species group- 208 mg kg⁻¹. All antimicrobial classes identified are classified as medically important. They estimate aggregate global human, terrestrial, and aquatic food animal antimicrobial use in 2030 at 236,757 tons of which aquaculture constitutes 5.7% (6). This analysis calls for a substantial scale-up of surveillance capacities to monitor global trends in antimicrobial use. It indicates that the intensity of antimicrobial use in certain species groups exceeds consumption levels in terrestrial animals and humans (7).

AMR Trends in Animals

The misuse of antibiotics in the agricultural sector and its overuse in the medicinal as well as non-medicinal sectors are the main reasons for the global prevalence of AMR. In a community, AMR is not just a medical health problem, it also significantly impacts the economy and thus hinders the progress of a society. Drug-resistant pathogens are a global threat due to their potential to acquire resistance to more than one antibiotic.

Whole-genome sequence analysis of 982 animal-derived *E. coli* samples was collected and analysed in China finding that the number of AMR genes conferring resistance for both veterinary (florfenicol and norfloxacin) and human medicine (colistin, cephalosporins and meropenem) were doubled in 50 years. Plasmids of incompatibility groups IncC,

IncH12, IncK, IncI, and IncX increased distinctly acting as highly effective vehicles for ARG spread (8). Melatonin, a neurohormone secreted from the pineal gland, substantially inhibited the horizontal transfer of RP4-7 plasmid in a dose-dependent manner. Furthermore, melatonin could also suppress the conjugal frequency of different types of clinical plasmids that carry colistin resistance gene *mcr-1* rather than *bla*NDM or *tet*(X) genes. It also disrupts bacterial proton motive force (PMF), which is an essential bacterial energy metabolism substance and is important for the conjugative process (9).

Preservatives (sodium nitrite, sodium benzoate, triclocarban) accelerate the horizontal transfer of plasmid-mediated antimicrobial resistance in *E. coli*. The results showed that certain concentrations of these three preservatives namely 0.001–0.005 mg/mL sodium nitrite, 0.1–1.0 mg/mL sodium benzoate, and 0.01–10 mg/mL triclocarban induced concentration-dependent increase in conjugative transfer of ARG. Triclocarban, which has low water solubility, induced higher efficiencies of conjugation than that of sodium nitrite and sodium benzoate. When the concentrations of preservatives were higher than the inhibitory concentration the transfer efficiencies decreased significantly (10)

National Trends

The potential consequences of AMR are expected to be more pronounced in the Indian context. This is attributed to India surpassing China in 2023 to become the world's most populous country, coupled with the fact that India bears the greatest burden of bacterial infections among nations.

In Human Medicine

In India, the per capita use of antimicrobials in humans increased from 4.40 defined daily dose (DDD) to 5.74 DDD in the period between 2010 and 2020 (11). Apart from the inappropriate and excessive use of antibiotics, several significant circumstances, including invasive surgical procedures, extended treatment for chronic infections, immunocompromised patients, and notably, the failure of infection prevention and control measures, contribute to the extensive use of antimicrobials (12). Research conducted by *Sulis et al.* (2021) (13) revealed that interrupted time series (ITS) analyses suggested that COVID-19 likely resulted in an estimated 216.4 million surplus sales of non-child-appropriate formulation (non-CAF) antibiotics and 38.0 million additional sales of non-CAF azithromycin (equivalent to a minimum of 6.2 million courses of azithromycin treatment) between June and September 2020 in India.

The Indian Council of Medical Research (ICMR) annual Antimicrobial Resistance Research and

Surveillance Network (AMRSN) report of 2022 found that *E. coli* was the most commonly isolated pathogen followed by *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Acinetobacter baumannii*, and *S. aureus* from human samples. This report also found that Imipenem susceptibility of *E. coli* has dropped steadily from 81% in 2017 to 66% in 2022 and that of *K. pneumoniae* dropped steadily from 59% in 2017 to 42% in 2022. In addition, they found that in 87.8% of study participants, *A. baumannii* infections were resistant to the broad-spectrum antimicrobial carbapenems, reducing the number of available treatment choices. Also, they reported that the susceptibility rate to minocycline was approximately 58%, establishing it as the second most effective antibiotic following colistin for *Acinetobacter baumannii*. The prevalence of MRSA has been on the rise annually from 2016 to 2021, escalating from 28.4% to 42.6%. Anti-MRSA antibiotics, such as vancomycin and teicoplanin, levonadifloxacin demonstrated exceptional in vitro effectiveness, with nearly 100% efficacy against MRSA isolates. Antibiograms of diarrhoegenic *E. coli*, *Aeromonas spp.* and *Salmonella spp.* showed high rates of resistance to fluoroquinolones which indicates the empirical use of ciprofloxacin or norfloxacin for patients with diarrhoea. Antifungal susceptibility testing in fungal pathogens indicated that over 93% of *C. albicans* and *C. tropicalis* showed susceptibility to fluconazole. However, susceptibility rates declined to 77%-85% in *C. utilis*, *C. parapsilosis*, and *C. glabrata*. This emphasizes the need for vigilant monitoring in the coming years.

The predominant *Aspergillus* species identified was *Aspergillus flavus*, followed by *A. fumigatus*. Both fungi exhibited high susceptibility, nearly 100%, to voriconazole. In terms of Amphotericin B, susceptibility rates were 87.8% for *Aspergillus flavus* and 69.2% for *A. fumigatus*.

In the Animal Sector

The global consumption of antimicrobials in the animal sector is phenomenally increasing at great proportions, especially in low- and middle-income countries. (14). India ranked among the top five countries in antimicrobial usage for food-producing animals in 2020 and is expected to maintain this position in 2030 (15). Globally, the pharmaceutical industry of India is the 3rd largest and 14th largest in terms of volume and value respectively (16). Antibiotics used in livestock are similar to those used by humans and AMR against drugs used in animal health have implications for public health also (17).

Several livestock species in India, particularly food animals emerged as important reservoirs of superbugs such as cattle, buffalo (18), pig (19),

poultry (20) and duck (21). Certain antibiotics, like carbapenem and vancomycin, are typically reserved for critical human patients in India and have not been employed in animal use. Recently, pet animals such as dogs have been identified as reservoirs for carbapenem-resistant *Enterobacteriaceae* (22) (23). Household insects, rodents, and pets serve as sentinels or bio-indicators for monitoring antimicrobial resistance (AMR). Therefore, these insects, rodents, and pets can be employed as an early warning system to detect AMR, particularly within households, before its emergence in humans (24).

In the Aquatic Animals, Wildlife, and Agricultural Sector

On a global scale, India currently holds the second rank, following China, in terms of annual aquaculture production (25). Globally, the use of antimicrobials in aquaculture was calculated to be 10,259 tons in 2017, with the Asia-Pacific region emerging as the primary consumer. Projections indicate a 33% rise in antimicrobial consumption in this sector by 2030 (26). The major antibiotic-resistant pathogens of clinical importance present in aquatic products are Methicillin-resistant *S. aureus* (MRSA), Extended-spectrum Beta-lactamase (ESBL) producing *Enterobacteriaceae*, carbapenem-resistant *Enterobacteriaceae* (CRE), Vancomycin-resistant *Enterococci* (VRE), *Acinetobacter baumannii* (27). Many reports are available on the presence of virulent MRSA from retail food fishes (28, 29), seafood and environments (30), and shrimp aquaculture farms (31). Likewise, the presence of ESBL *E. coli* and *Klebsiella pneumoniae* have been detected from retail food fishes (32), and shrimp farms (33).

Exploration of AMR in Indian wildlife is limited although the studies conducted in wild crows revealed resistance against quinolones followed by tetracyclines in *Campylobacter* isolates (34). The captive wild animals kept in different zoological gardens revealed the occurrence of ESBL-producing *E. coli* in wild birds, deer, zebra, tiger, and bear (35) multi-drug resistant, ESBL-producing/carbapenem-resistant *E. coli* in rescued sloth bears (36).

India is one of the top consumers of agricultural antibiotics worldwide, accounting for 3% of global consumption which is, estimated to double by 2030 (37) Bactericides, fungicides, and other pesticides play an important role in the management of plant diseases (38). Three groups of antibiotics (aminoglycosides, tetracyclines, and quinolones) are commonly used in plant production, which are also regularly used therapeutically in animals and humans. However, increasing resistance to fungicides and pesticides is a pressing issue in the

agricultural sector (39).

The Indian government has implemented several measures to promote awareness and address the misuse of antibiotics. ICMR has launched the Antibiotic Stewardship Program (AMSP) as a pilot project in 20 tertiary care hospitals across the country. This program aims to regulate the improper use of antibiotics in hospital settings, including wards and intensive care units (ICUs). The Drug Controller General of India (DCGI) has prohibited 40 fixed-dose combinations (FDCs) that were deemed inappropriate. The Government of India also recently banned the manufacture, sale, and distribution of colistin and its formulations for food animals, poultry, aquaculture and animal feed supplements (40).

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Severe Fever with Thrombocytopenia Syndrome: A Review

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Introduction

Severe fever with thrombocytopenia syndrome (SFTS) is an emerging infectious disease caused by a novel virus, SFTS virus (SFTSV), that is transmitted by ticks. SFTS was first reported in China in 2009 and has since been detected in several other countries. The disease is characterized by high fever, thrombocytopenia, leukopenia, gastrointestinal symptoms, and multi-organ failure, with a case fatality rate ranging up to 30%. SFTS poses a significant public health threat, especially to rural populations and people who have close contact with animals, such as farmers, hunters, and veterinarians (1, 2). Veterinarians appear to be at particularly higher risk of the disease due to greater occupational exposure (3). Through this review, we aim to capture the current knowledge and challenges of SFTS, with a focus on its etiology, epidemiology, pathogenesis, and zoonotic implications and occupational risks. This review will also discuss the potential applications of a One Health approach for SFTS prevention and control and provide some recommendations and conclusions.

Importance

SFTS is a severe and fatal zoonotic disease that affects humans and animals. Till the year 2018 SFTS was included in the WHO list of top emerging infectious diseases likely to cause major pandemics and requiring urgent research but it was excluded in the following years (4, 5). The reasons for the inclusion and exclusion of SFTS in the WHO list are not stated explicitly but they may be related to the following factors:

- The criteria and methodology used by the WHO to prioritize the diseases, which are based on the public health impact, the potential for international spread, the availability of medical countermeasures, and the level of R&D preparedness (4).
- The epidemiological situation and trend of SFTS in the affected countries, which may reflect the incidence, mortality, geographic distribution, and transmission dynamics of the disease (5).
- The scientific and technical progress and challenges of SFTS research and development,

which may include the discovery and evaluation of new diagnostics, drugs, and vaccines for the disease (5, 6).

- The political and social attention and commitment to SFTS prevention and control, which may influence the allocation of resources and the implementation of policies and interventions for the disease (6).

Although SFTS does not appear in the WHO list anymore, it continues to be classified as a Risk Group 4 pathogen i.e. likely to cause serious or lethal human disease for which preventive or therapeutic intervention is not usually available, and representing a high risk to the individual and to the community (6).

Etiology

In 2009, Hubei and Henan provinces of China reported an emerging disease of uncertain etiology in humans, characterized by severe fever with thrombocytopenia, leukocytopenia, gastrointestinal disturbances, and high case-fatality. The disease was named Severe Fever with Thrombocytopenia Syndrome (SFTS). Thereafter, in 2010, the causative agent of the syndrome, a virus, was isolated from a patient in acute phase. The virus has been named *Dabie bandavirus* (DBV) and is also known as Severe Fever with *Thrombocytopenia Syndrome virus* (SFTSV), *Huaiyangshan virus* (HYSV), *Huaiyangshan Banyang virus*, *New Bunyavirus* (NBV), or *Thrombocytopenia virus*. Subsequently, the virus has been isolated from ticks and domestic animals and has spread to several other Asian countries (1, 2, 7).

Initially recognized as a *Phlebovirus*, SFTSV has now been identified as species *Bandavirus dabieense* under the family *Phenuiviridae* (**Phenui** = **Phlebo** + **Tenui**) of the order *Bunyavirales* of Group V i.e. negative sense single-stranded RNA viruses as per the classification standards of the International Committee on Taxonomy of Viruses. The virions are spherical and enveloped, measuring about 80-100 nm in diameter. Consistent with other members of the order *Bunyavirales*, the genome is composed of three negative-strand RNA segments: large (L), medium (M), and small (S), approx. 6.4, 3.2, and 1.7 Kb in size, respectively. RNA-dependent RNA

Polymerase (RdRp) is coded by the L segment; Glycoprotein (GP), precursor of host-attachment Gn/Gc glycoproteins, is coded by the M segment; and nucleoprotein (N) and non-structural proteins (NSs) are coded by the S segment. Proof-reading mechanisms during replication and transcription

The epidemiology of SFTS is influenced by the distribution and abundance of the vector ticks and the reservoir hosts, as well as the human exposure and susceptibility. SFTS occurs in rural areas of China, Japan, South Korea, and Vietnam, where tick activity is high from March to November, with a

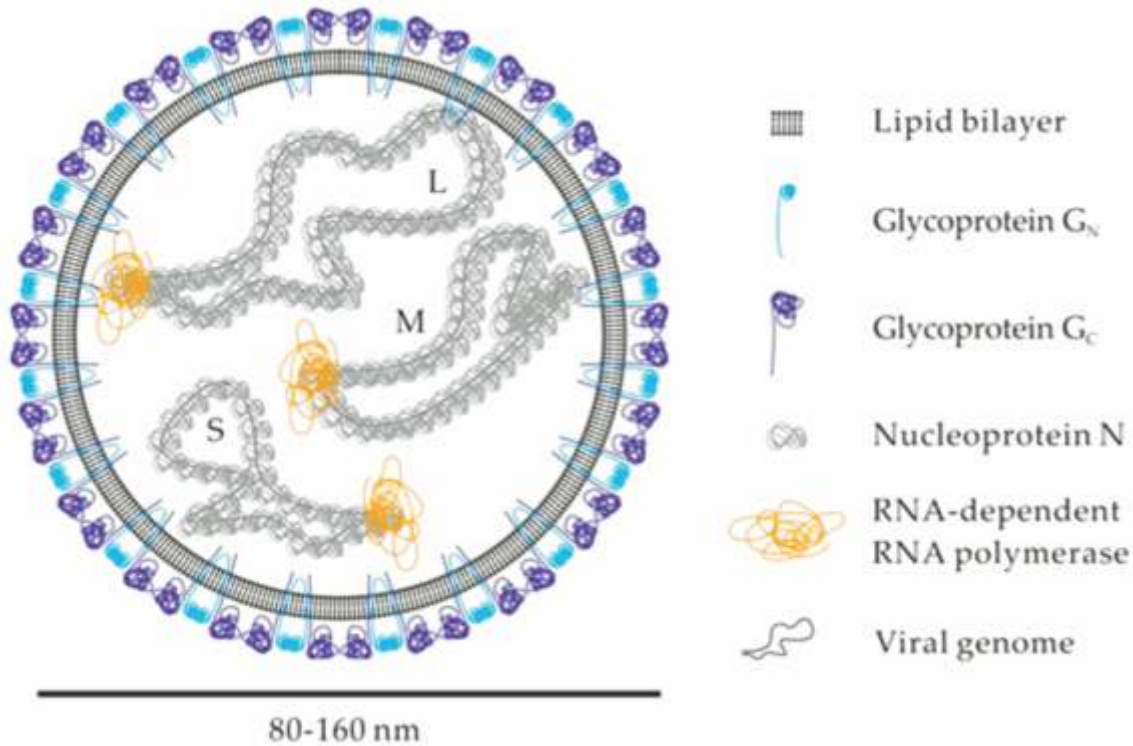


Figure 1: Structural elements of Severe Fever with Thrombocytopenia Syndrome virus (SFTSV).

are absent and mutations are high (2, 6, 7, 8). The structure of SFTSV is depicted in Fig. 1.

Transmission and Epidemiology

SFTSV is, primarily, a tick-borne disease and tick-bites have been reported to be associated with about 24% of the cases. Hence, all agro-climatic factors that favor expansion of tick populations, and increase in human activities in fringe ecosystems that favor exposure to ticks can increase the risk of the disease. Infected ticks of the species *Haemaphysalis longicornis*, which is widely distributed in Asia, have especially been associated with the transmission. Vertical transmission of the virus through transovarian route helps the virus to persist in tick populations. Many other tick species can also transmit the virus. The virus can also be transmitted through direct contact with blood or body fluids of infected animals or humans, or through aerosols generated during medical procedures (8, 9, 10).

peak from April to July. The disease affects mostly middle-aged and elderly people, with a higher incidence and mortality in males than in females. The risk factors for SFTS include farming, hunting, animal husbandry, and exposure to livestock, wildlife, or tick bites. The seroprevalence of SFTSV antibodies in humans ranges from 0.6% to 16.8%, depending on the geographic region and the population group. The seroprevalence of SFTSV antibodies in animals, such as cattle, goats, sheep, dogs, cats, and rodents, ranges from 1.4% to 67.9%, indicating a widespread exposure and infection of domestic and wild animals. The role of animals in the transmission and maintenance of SFTSV is still unclear, and further studies are needed to identify the natural reservoirs and amplifying hosts of the virus (8, 9, 10).

Cases of SFTS have been reported in China, Japan, South Korea, and Vietnam, which are some of the neighbouring countries of India (8). Seropositivity of human subjects has been

encountered in Pakistan although clinical cases have not been reported (11). There is no evidence of SFTS cases in India or other neighbouring countries such as Nepal, Bangladesh, Bhutan, Sri Lanka, and Maldives (8).

The absence of SFTS cases in India may be attributed to several poorly studied factors such as the lack of surveillance and testing, the low prevalence or absence of the vector ticks or the reservoir hosts, the genetic or environmental resistance of the Indian population, or the geographical or climatic barriers that limit the spread of the virus. Nevertheless, these factors may change over time, and the risk of SFTS introduction and emergence in India may increase due to one or more the following reasons (8, 9, 10, 12):

- The increasing trade, travel, and migration between India and the SFTS-affected countries may facilitate the movement of infected humans, animals, or ticks across the borders.
- The changing land use, deforestation, urbanization, and climate change may alter the habitats and behaviors of the vector ticks and the reservoir hosts, and increase their contact and interaction with humans and domestic animals.
- The lack of awareness, prevention, and protection measures among the Indian population and the health workers may increase the exposure and susceptibility to SFTS, especially among the rural and occupational groups, such as farmers, hunters, and veterinarians.
- The limited diagnostic and treatment capacity and the weak health system in India may delay the detection and response to SFTS cases, and increase the morbidity and mortality from the disease.

Therefore, it is important for India to be vigilant and prepared for the potential threat of SFTS.

Pathogenesis, Clinical Signs, Diagnosis and Treatment

The incubation period of SFTS ranges from 2 to 14 days, with an average of 6 days. The pathogenesis of SFTS is not fully understood, but it is likely to involve both viral and host factors. SFTSV can infect various types of cells, such as monocytes, macrophages, dendritic cells, endothelial cells, and hepatocytes, and cause cytopathic effects, apoptosis, and inflammatory responses. The virus can also evade or suppress the innate and adaptive immune responses of the host, by interfering with the interferon signaling, antigen presentation, and antibody production. The viral load, genetic

diversity, and virulence of SFTSV may affect the severity and outcome of the infection. The host factors that may influence the pathogenesis of SFTS include age, sex, genetic polymorphisms, immune status, and co-infections.

The main pathological features of SFTS are systemic vasculitis, disseminated intravascular coagulation, and multi-organ damage, especially in the liver, spleen, and lymph nodes. The vascular injury and coagulation dysfunction may result from the direct infection of endothelial cells and platelets by SFTSV, or from the excessive production of pro-inflammatory cytokines and chemokines, such as tumor necrosis factor-alpha, interleukin-6, and monocyte chemoattractant protein-1. Liver damage may be caused by hepatocyte necrosis and apoptosis induced by SFTSV or by immune-mediated liver injury triggered by the virus. Spleen and lymph node damage may be due to the depletion of lymphocytes and the impairment of lymphoid tissue architecture by SFTSV, or by the apoptosis of immune cells induced by the virus.

The clinical manifestations of SFTS vary from mild to severe, and include fever, headache, fatigue, nausea, vomiting, diarrhea, abdominal pain, myalgia, lymphadenopathy, conjunctival injection, and hemorrhagic signs. Laboratory findings typically show thrombocytopenia, leukopenia, elevated liver enzymes, and coagulopathy. The diagnosis of SFTS is confirmed by the detection of SFTSV RNA or antibodies in blood or tissue samples, using molecular or serological methods (13, 14).

The treatment of SFTS is mainly supportive, and no specific antiviral drugs or successful vaccines are currently available; however, many attempts at developing vaccines are underway (12, 15).

Zoonotic Implications and Occupational Risks

SFTS is a zoonotic disease that is transmitted from animals to humans, and from humans to humans, through various routes. The zoonotic transmission of SFTS has important implications for the emergence, evolution, and control of the disease. The emergence or introduction of SFTS in new areas where it did not exist earlier can be related to the ecological changes that have resulted in increased contact and interaction between humans, animals, and ticks. The evolution of SFTSV is driven by the genetic diversity and recombination of the virus in different host and vector populations. The control of SFTS requires an integrated surveillance of the disease and intervention in humans, animals, vectors, and the environment (8, 9, 10).

The occupational exposure to SFTS may pose a

high risk for the health and safety of the workers who have frequent contact with animals or patients, such as veterinarians, farmers, hunters, slaughterhouse workers, and healthcare workers. The occupational transmission of SFTS may occur through the bite of infected ticks, or through the contact with blood or body fluids of infected animals or humans. The occupational prevention and protection of SFTS may include the use of personal protective equipment, the avoidance of tick bites, the disinfection of contaminated materials, and the education and training of the workers (3, 6, 8, 9, 10).

Recommendations and Conclusion

SFTS is an emerging and fatal zoonotic disease that requires a coordinated and comprehensive response from multiple sectors and disciplines. A One Health approach can provide a framework and a platform for the collaboration and communication among the stakeholders involved in the prevention and control of SFTS. A One Health approach can also help to address the underlying drivers and determinants of SFTS, such as the environmental, social, and economic factors that affect the health of humans, animals, and the ecosystems.

Keeping with a One Health approach, the following measures can be taken for the prevention and control of SFTS (9, 10, 12, 16):

- Strengthen the surveillance and reporting of SFTS cases in humans and animals, and increase the laboratory capacity and quality for SFTS diagnosis and research.
- Reduce the exposure and transmission of SFTSV by implementing vector control measures, such as tick repellents, acaricides, and environmental management, and by promoting personal protection practices, such as wearing protective clothing, avoiding tick bites, and washing hands after contact with animals or patients.
- Enhance the awareness and education of the public and the health workers about SFTS, its symptoms, risk factors, prevention, and treatment, and encourage early diagnosis and referral of suspected cases.
- Support the development and evaluation of new drugs and vaccines for SFTS, and facilitate their access and availability for the affected populations.
- Strengthen the research and innovation on SFTS, such as the epidemiology, pathogenesis, immunology, and ecology of SFTSV, and the identification of the natural reservoirs and hosts of the virus.
- Foster the cooperation and communication among the stakeholders involved in SFTS prevention and control, such as the government, the academia, the industry, and the civil society, and share the best practices and lessons learned from different countries and regions.

To conclude, SFTS is a major public health challenge that requires a comprehensive and integrated response. Many neighboring countries of India have reported clinical cases and seropositivity for the pathogen, and there is a need for India to maintain a high level of vigilance for the disease. Veterinarians are at high occupational risk of contracting the disease and need to be sensitized and trained to identify its signalment in animals and humans. Finally, by applying a One Health approach, we can better understand and address the complex interactions and interdependencies among humans, animals, and the environment, and improve the health and well-being of all.

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Mountain's Pride: Arunachali Yaks of India

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Introduction

A unique species known as the yak (*Bos grunniens*) has undergone extensive natural selection as part of the process of environmental adaptation in order to withstand the harsh environmental extremes of high altitude locations. The species can withstand temperatures between 40 and 10 degrees Celsius and lives in a humid, chilly climate at an altitude of 2700 to 4300 metres above mean sea level.

There have mostly been descriptions of the Arunachali, Ladakhi, Sikkimi, and Himachali breeds of Indian yak. The first and only recognized breed of Indian yaks is the Arunachali. Yaks are primarily found in Arunachal Pradesh's West Kameng and Tawang districts. The Monpa community, which views yaks as a resource for the rural economy and raises these animals in organized farms or semi-migratory systems, predominates in West Kameng and Tawang. Yaks are raised by people in the Indian states of Jammu-Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, Arunachal Pradesh, and West Bengal who live between 3,000 and 5,000 metres above mean sea level (1). Yak pastoralism provides a significant portion of the food for tribal nomads in India's trans-Himalayan area, whose economy and way of life are strongly dependent on the effective use of high-altitude pastures (2). Seasonally cyclic transhumant yak farming involves the vertical movement of yak herders and their animals between higher rangelands in the summer and lower rangelands in the winter (3). The availability of food resources and the suitability of the weather are crucial factors in the subsistence economics of yak pastoralists (4). Modernization and shifting socioeconomic conditions have compelled widespread abandonment of pastoral yak rearing, as the younger generation is unwilling to take on this difficult life of danger and uncertainty in exchange for meagre compensation (5). Yaks are the picture of pastoral adaptability; as a result, community involvement and engagement are essential for yak conservation in India (6). Only if pastoral groups are able to reap greater benefits from the occupation can the decline in yak numbers be stopped. In turn, this can only be accomplished by prioritizing special populations for institutional and governmental support in the

form of genetic improvement programmes and the adoption of pastoral-friendly policies (7). The first step in attaining this goal would be to characterize and register unique yak germplasm as a breed (8). An exceptional yak (*Poephagus grunniens*) population raised by tribal pastoralists (or Brokpas) can be found in the northeastern Indian state of Arunachal Pradesh. This yak species needs rapid conservation and genetic enhancement measures.

Characteristics

The Arunachali Yak is a special breed with traits that set it apart from other yak breeds. Arunachali yaks are medium-sized, mostly-black cattle with dense, long hairs hanging down their bodies and gentle dispositions. They have a convex skull with ears that are horizontal and horns that are clearly curled with pointed tips. Male and female native yak calves weigh 14.2 and 13.2 kg at birth, respectively. Males and females have mean mature body weights of about 365 kg and 230 kg, respectively (9). Yaks can withstand temperatures as low as -50°C in temperate climates. In addition to having a thick coat of hair and an undercoat, yaks also have well-developed subcutaneous fat as compared to cattle and other closely related species, which enables them to tolerate extremely cold temperatures (10). The normal body temperature of indigenous yaks is 101.4 ± 0.19 ($98-104$) $^{\circ}\text{F}$. The pulse rate and respiration rate are 54.15 ± 0.87 (45-68) and 54.59 ± 1.65 (38-86) per minute, respectively (11). Black makes up the majority of the animal species. Some animals also have a white face, forehead, or dorsal stripe that extends from the hump to the tail. The yaks of Arunachal Pradesh were previously categorized into four main types by (12), notably the smaller "Common" type, "Bisonian" type, "Bare back" type, and "Hairy-forehead" type. Males' horns measure 28-35 cm in length, while females' are 18-24 cm. The ears are oriented horizontally. Poll's head is convex and conspicuous. The Arunachali Yaks have a compact physique and a medium size. These animals' average heights at the withers are 111 cm for males and 94 cm for females, respectively. The male and female animals' respective body lengths are 135 and 160 cm. The animals' male and female hearts measure 170 and 143 cm, respectively. Due to lack of fodder, both

males' and females' body weight decreases by 20–30% in the winter. Short and stocky legs. Long hair covers the brisket, belly, ribs, lateral portions, and legs. Udder has cylindrical teats and is primarily trough-shaped.

Feeding

During the summer (May to October), they are transported to high-altitude alpine pastures (4,000-6,000 m) for grazing. They are returned during the winter, where they eat iced and withered grass, herbs, bushes, lichens, and tree leaves (13). Although they receive some amounts of fodder, crop leftovers, maize grains, rice polish, flour, and salt, especially during the winter, they are mostly fed using an extensive system. Yak farmers in Arunachal Pradesh, also known as Brokpas, move their herds to higher hills for grazing during the summer season, just like in other yak-rearing regions of India. One employee works full-time in the pasture land the entire time. Tree fodder is used as a supplement for the animals' diets during the winter months when forage grasses and legumes are buried in snow and the yak has no other feed supplies (9).

Population

Yaks make up a very minor fraction of the nation's total livestock population, but they are significant to the indigenous populations living in high-altitude areas of the Himalayan mountains between 3,000 and 5,000 m (13,14). There are 57.57 thousand yaks in India, with 31.55 and 26.02 thousand being female and male, respectively. State of Jammu and Kashmir (26221) has the highest population of yaks, followed by Arunachal Pradesh (24075), Sikkim (5219), Himachal Pradesh (1940), West Bengal (61) and Uttarakhand (54). The number of yaks in Arunachal Pradesh has increased by 71.22%, from 14061 in the previous census to 24075 now.

Production performance

Yaks survive in these extremely chilly, hypoxic environments giving the local community milk, meat, hide, fiber, manure, and draught power (1). The peak milk yield per day is 1.1-1.6 kg, while the average milk yield per day is 0.98-1.04 kg milk with 7.45% fat and 11.5% SNF. With typical yields of 1.5 kg and 0.5 kg/clipping/animal, respectively, the average ages of clipping coarse hairs and down fibers are 12-18 months and 12 months, respectively. Yak milk and fiber value addition offers a special prospect for the economic revival of yak pastoralism (15). According to (16), the Arunachali yaks produce 227.27.43 (127-284) kg of milk each lactation over a mean lactation length of 255.214.93 (120-360) days. These yaks

produce 4.38 0.17 (3-6) kg of coarse wool annually. These yak-cattle hybrids have a mean lactation time of 294.28.8 (200-330 days), and they produce 530.431.14 (400-800) kg of milk.

Churpi is made from Arunachali yak milk. Yak Churpi, a naturally fermented milk product made from yak milk, has been given recognition as a Geographical Indication (GI) of Arunachal Pradesh. Churpi is a good source of protein and is widely used as a substitute for vegetables by tribal yak herders in the state's vegetation-depleted cold and steep mountainous regions. It is frequently blended into vegetable or meat curries and served with rice as a staple dish in tribal communities. It is regarded as an important aspect of Arunachal Pradesh's physical cultural and tribal legacy.

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Rectal Tubulopapillary Adenomatous Polyps with Severe Comorbidities in a Geriatric Female Dachshund: Complete Recovery with Advanced Diagnostics and Treatment

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Abstract

A 12-year-old spayed female Long Haired Dachshund was presented in the Milford Veterinary Clinic (MVC) for annual physical check-up. The bilateral turgid anal glands were relieved with digital expression. Further, colitis and cardiac murmurs were detected, and the animal was put on antibiotics. Endocrine assay established hypothyroid status, and concurrent long-term hormone replacement therapy was started. The caring owner visited the home clinic regularly for recheck of her companion animal. Taking the cue from the dog straining to defecate and passing blood in feces, colorectal polyps was detected with contrast radiography. The patient was referred to Oakland Veterinary Referral Services (OVRs) for diagnostic corroboration and treatment of rectal polyps, heart and other issues. Because curative-intent surgical excision of the mass was not possible, fractionated radiation therapy was planned and successfully conducted by the radiation oncologist in Michigan State University (MSU) Medical Center. Patient's progressive recovery is uneventful. The present communication documents successful holistic case management in the home clinic, specialized treatment in intensive care centers, synchronized multi-disciplinary approach and dedicated home care by the well-informed pet owner.

Introduction

Benign and malignant tumors appear with equal frequency in the dog's rectum. Adenomatous polyps, the most common benign tumor, is often located in the distal rectum or anorectal region. Exhibiting branching lamina propria covered with degraded epithelium, it appears as a sessile elevated mass, mostly (80%) in single and less frequently (20%) in the multiple format. Malignant transformation of rectal polyps occurs in 18-50% patients in tandem with increasing size of the mass (>1 cm), and the time lag (1). Clinical signs include tenesmus, hematochezia, dyschezia, rectal bleeding unrelated to the act of defecation, and polyps prolapsed through the anal orifice. The pathoclinical profile is well documented (2-6). Vomiting, diarrhea and weight loss are the common nonspecific symptoms. Physical examination often reveals cachexia, palpable abdominal mass, generalized tissue dehydration, increased abdominal pain perception, and complete blood count (CBC) anemia, and leukocytosis. Colonoscopy is recommended for rationalized treatment. Excision biopsy histopathology is a dependable diagnostic tool; FNA cytology may be misleading. Large biopsy is needed because samples lacking lumen lining epithelium and submucosa often lead to false negative inference (7).

Complete surgical excision of the rectal/ colorectal polyps remains the treatment of choice, though challenging because of the formidable biologic

barrier, and post-operative complications. In-depth clinical judgment of the individual case with critical analysis of diagnostic reports is emphasized (1). The common procedures include endoscopic polypectomy (8), rectal pull-through (RPT) (8, 9, 10). Occasionally, complete rectal resection followed by end-to-end anastomosis, and anocutaneous anastomosis is also employed. Fecal incontinence is uncommon if the growth is <4 cm in size. The local tumor recurrence rate is low (0-4%). With proper home care support, enhanced survival span (7-12 months) is expected. Beneficial effect of piroxicam is well-established (8). The present communication reports on the successful management of a unique case of tubulopapillary adenomatous rectal polyps with concurrent high-grade heart murmurs, associated with septal defects, ongoing hypothyroid status, and dental issues in a senescent female dog with high relevance in human medicine.

Case Description

A 12-year-old (7.5 kg.) female spayed Long Haired Dachshund was presented in the Milford Veterinary Clinic (MVC) on July 26, 2021 for annual physical/thyroid status check, and vaccinations schedule. Advanced (grade 5/6) systolic murmur was recorded. Blood-stained mucoid rectal discharge was seen. Gritty contents, expressed manually from both anal glands appeared infected, and blood drops were noticed on the attending physician's glove. Ampicillin (Polyflex®, Boehringer

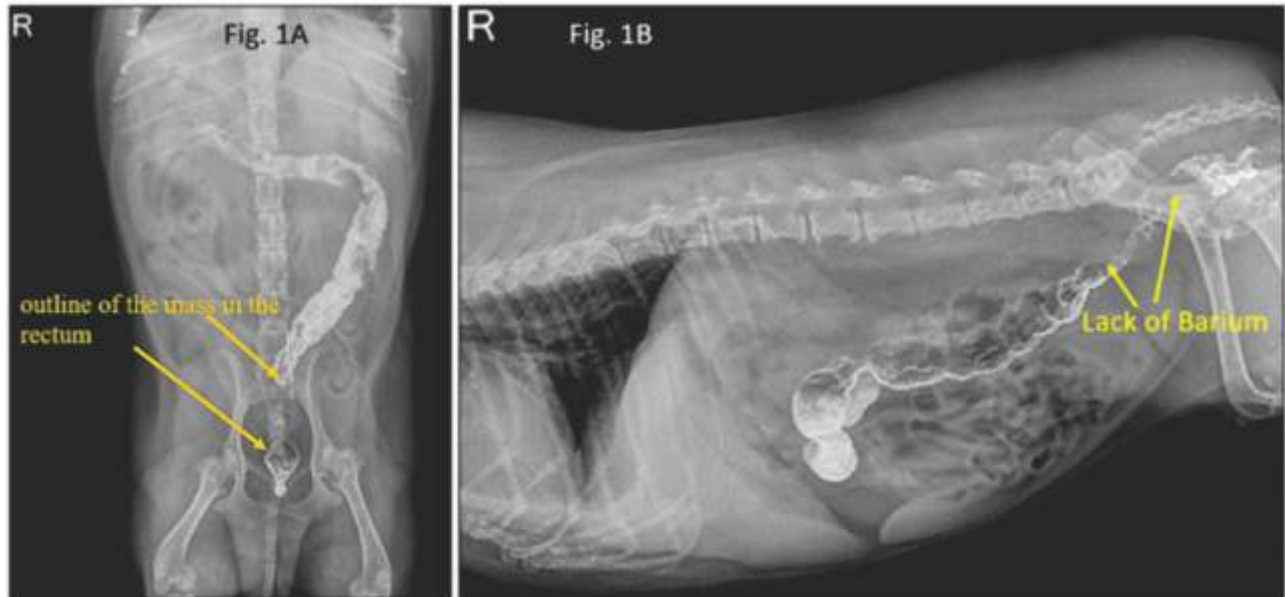


Figure 1A. VD view of contrast radiography: note the obstructed barium flow in the rectum.
1B. RL view of contrast radiography

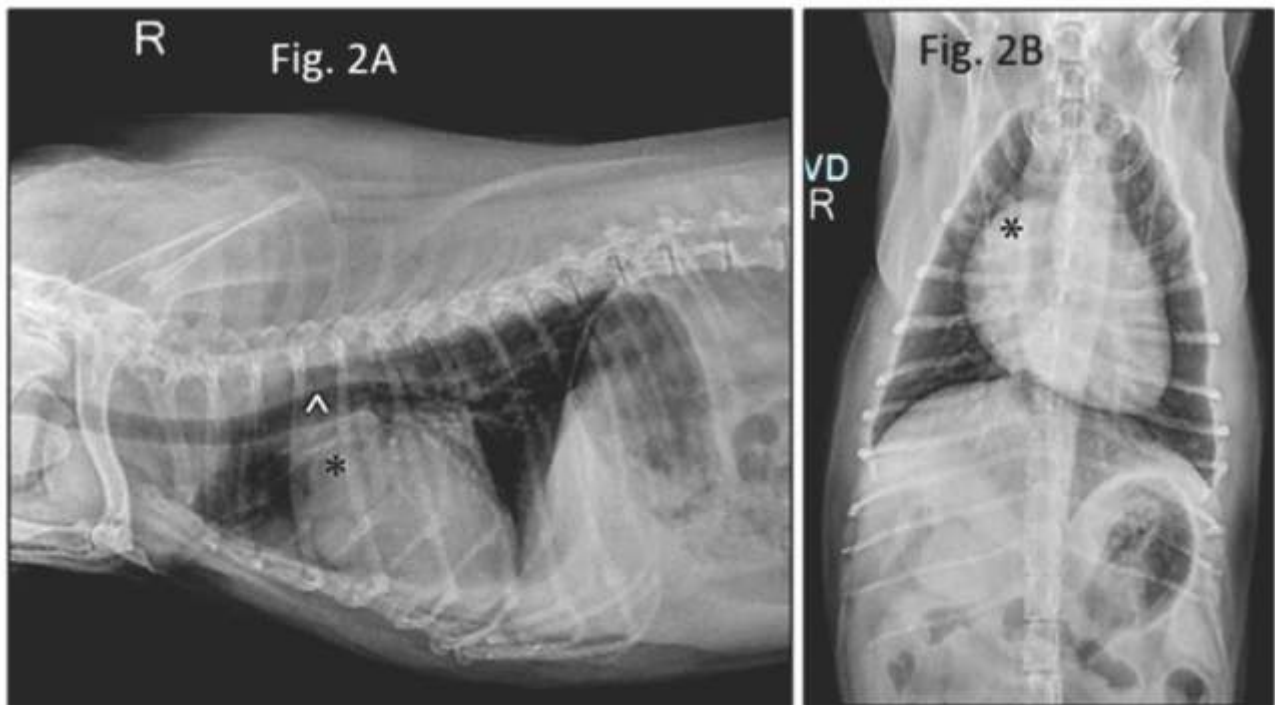


Figure 2A. R-L view: right atrium enlargement * and tracheal displacement dorsally ^.
2B. VD view: right atrium enlargement *

Ingelheim Vetmedica, Ingelheim, Germany) 1.2ml was injected S/C @ 30mg/kg, and metronidazole (Flagyl®, Pfizer, US, Inc. New York, USA) was prescribed @12mg/kg (½ of 250mg tablet) PO, b.i.d.. x 10 days. In the inflamed perineal area, topical application of combination antibiotic: nystatin-neomycin sulfate-thiostrepton-triamcilon acetamide ointment (Animax®, Dechra Veterinary

Products, Overland Park, Kansas, USA) was advised. Blood chemistry panel revealed high serum alkaline phosphatase (ALP) titer 218 (23-212 U/L), and hypothyroidism: T4 0.9µg/L (1-4µg/L). The patient passing loose stools with blood-stained mucus was brought for a clinic recheck on August 10, 2021. On rectal digital probe for the suspected obstructive growth frank blood spots were noticed.

In-house abdominal survey radiographs did not indicate malignancy in any internal organ, but revealed voluminous gas accumulated in the large intestine, suggesting some obstruction. Therefore, with the well-informed owner's consent, contrast radiography was performed forthwith. Barium contrast liquid (5 ml) was administered retrograde from the anal orifice right into the descending colon. Sequential abdominal radiographs (**Fig. 1**) indicated rectal polyps. Thoracic radiographs, August 18, 2021 (**Fig. 2**) pointed to some enlargement in the right atrium. Repeat thoracic survey radiographs revealed cardiac enlargement with marked cranial elevation without pulmonary vessels abnormality. Marginal caudodorsal cardiac-pulmonary venous distension was noticed. EKG profile normal, BP 60 mm mercury. The patient was hospitalized for 48 hr under intensive care on supportive medications: IV fluids infusion, maropitant (Cerenia®, Zoetis Petcare, US, Inc. Paripanny, NJ, USA), fentanyl generic, cefovecin (Convenia®, Zoetis Petcare, Inc. Paripanny, NJ, USA and lactulose.

Rectal mass removal preparatory protocol: detection of metastasis in any internal organ with ultrasonography, and cardiac disorders with echocardiography. Echo profiles: polypoid colonic luminal mass is located at the pelvic canal level with moderate colon wall thickening: benign or malignant, e.g. polypoid, or fibroid tissue, and colonic adenocarcinoma; mild colonic lymphadenopathy (reactive or metastatic), chronic pancreatitis, low grade hepatomegaly indicating vacuolar changes, rather than hepatitis or neoplasia, and a small nephrolith in the right kidney. Echocardiogram: marked thickening and remodeling of the mitral and tricuspid valve leaflets; right atrium perceptibly dilated, indicating RV volume overload; mild septal flattening with evidence of tricuspid septal prolapse, without left atrium enlargement. Clinical significance: myocardial function not compromised. Color Doppler profile: mitral regurgitation, moderate to large volume with marked tricuspid regurgitation. Spectral Doppler test results: TR Max PG = 37.59 mm mercury, pulmonary hypertension absent, PV max PG = 2.43 mm mercury; AV max PG could not be determined because of lung interference. Inference: advanced degenerative tricuspid valve and compromised mitral valve. Currently, there is no evidence of left heart enlargement; the mild septal flattening is secondary to volume overload in the right ventricle. The patient is at risk for right congestive heart failure. Surgical intervention is possible because most of the volume overload is confined to the right lateral aspect. For long-term cardiac risk management, pimobendan (Vetmedin®, Boehringer Ingelheim Vetmedica,

Ingelheim, Germany) @ 0.25 mg/kg, b.i.d. advised (1).

Pre-surgery medications: pimobendan 1.875 mg (1½ tablets) PO, b.i.d., flagyl ½ of 250mg tablet PO, b.i.d. San Qi Forte (herbal hemostat, generic) 1 tab PO b.i.d., lactulose 1 ml PO, q.i.d. The stable patient was discharged on August 20, 2021 with home care medications dispensed under advisory till surgical rectal mass removal is scheduled (i) cardiac: pimobendan 1.875 mg (1½ tabs) PO o.d. x 14 days (ii) nausea and digestive disorders: Cerenia 16mg tab 1 PO, OD. As needed (iii) hematochezia control: San Qi Forte 1 tab PO b.i.d. (iv) to soften stools: lactulose @ 1 ml PO q8hr. Continue flagyl as directed. If labored breathing (respiratory rate >50 breaths/minute) is observed, gums appear pale or bluish, and the pet becomes very lethargic, urgent veterinary care recommended. For surgery aimed to closely monitor the rectal mass and excise it completely with curative-intent if possible, the patient was readmitted in the OVRS on September 16, 2021. However, in the incised rectum, the growth involved the entire circumference of the inner wall, extending 3-4 inches towards the colon. The geometry and extensive nature of the growth precluded safe surgical excision. As planned in advance, the well-preserved large excision biopsy was promptly dispatched to Michigan State University (MSU) Medical Center for histopathology. The patient, on normal diet, was given medications: gabapentin (Neurontin®, Pfizer, Inc. New York, USA) 50 mg tab: 1 PO b.i.d./t.i.d. for relief from discomfort, flagyl 50mg tab 1 PO b.i.d., lactulose, San Qi Forte, pimobendan; continue thyroid supplements as prescribed earlier. No activity restrictions. September 17, 2021 the patient was released to the owner's custody. Follow-up call: patient is comfortable, not straining for defecation: little blood in the fecal excreta. Normalcy of the echocardiogram and EKG profiles is the definitive evidence of efficacy of heart medicaments.

Patient's dental cleaning under general anesthesia was scheduled in the home clinic, Milford Veterinary Clinic on September 23, 2021. Periodontal disease grade 4/4 detected, tartar chipped, scaled and polished. Dental radiographs were recorded, all loose incisors extracted, and the gingiva closed with 4-0 absorbable sutures.

The patient's biopsy histopathology report from the Michigan State Medical Center (**Fig. 3**) microscopic profile: the rectal mucosa is regionally expanded with the polypoid proliferation of neoplastic epithelial cells, arranged in ectatic tortuous tubular structures with some papillary projections. Lined with neoplastic columnar epithelium, these entities exhibit extensive pale basophilic mucoid material. Patchy pile-up of the elongated cells (up to 6-7 cells

thickness) is visible. Indistinct cell borders and moderately eosinophilic cytoplasm are the noteworthy features. Pathologist's diagnosis: Rectal tubulopapillary adenoma.

Because of the configuration and extensive nature of the rectal polypoid lesions, the preferred curative-intent surgery was not possible in the instant case. Palliative radiation therapy option was recommended by the MSU radiation oncologist following detailed online updates on the patient's case history, diagnostic findings, and supportive treatment regimen. This remedial strategy was readily accepted by the interactive owner. Accordingly, the patient was treated in the MSU Medical Center, Lansing MI for six successive days, starting from October 6, 2021. The well-prepared patient was kept under general anesthesia induced with alfaxalone-midazolam, and maintained with desflurane inhalant. Total 20 Gy radiation targeted the rectal tumor (5 fractions of 4 Gy daily): 6 MV

photon 3-D conformal radiation therapy with cone beam CT image guidance (Fig. 4). The protocol is based on the pre-contrast cone-beam CT scan, generated by the Varian Trilogy linear accelerator on-board imaging system: contoured, planned, and computed with the Varian Eclipse treatment guide portal. All phases: preparatory, treatment, and recovery were uneventful; no short term/ long-term adverse side effects observed.

Follow-up visit, MVC October 22, 2021: anal glands expressed; greenish tinge indicated infection. Ampicillin injected, and home care cephalexin oral antibiotic dispensed. OVRs cardiologist's advisory: record the animal's weight once every 3 days, and if more than 0.3 lb. increase is observed, lasix dose needs to be increased suitably. Long-term thyroid and heart care medications to be continued. Recheck: anal glands normal, the patient is doing well: no blood seen in the excreta. Discussion

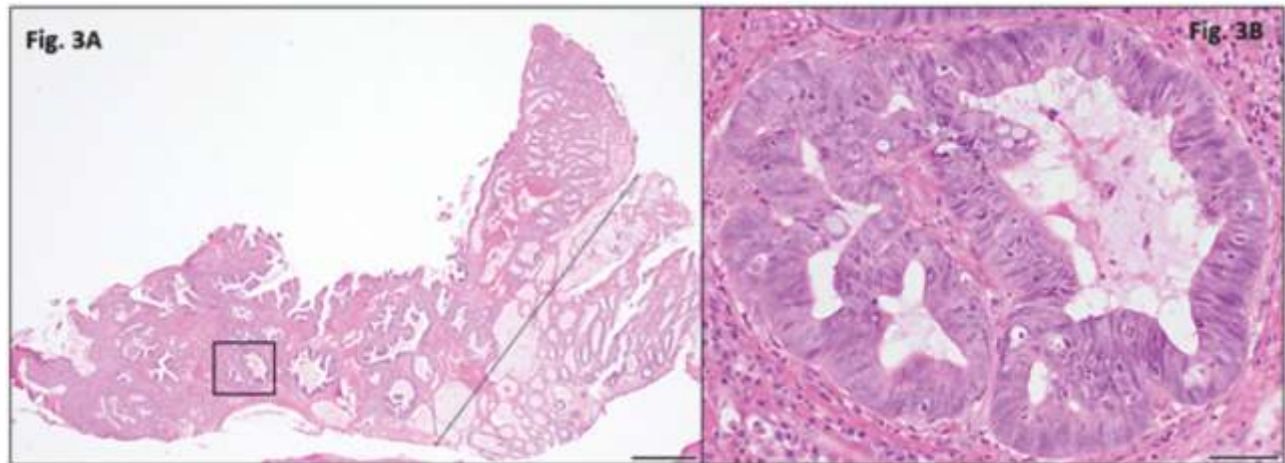


Figure 3. (A) Rectal tubulopapillary adenoma. The rectal mucosa is regionally expanded by a polypoid proliferation of neoplastic epithelial cells arranged in ectatic tortuous tubular structures with occasional papillary projections to the left of the demarcation line (dotted line). Bar = 500 µm. (B) Boxed inset. These tubular structures contain a large amount of pale basophilic mucoid material and are lined by neoplastic columnar epithelium. Neoplastic cells occasionally pile up to 6-7 cells-thick. (400X). Bar = 50 µm. Hematoxylin and eosin.

In dogs, tubulopapillary adenomatous polyps, proliferative lesions, are generally benign growths. However, it is often difficult to predict the biologic behavior in the absence of underlying submucosa and tunica muscularis in the biopsy sample. Though complete surgical excision is curative, some lesions tend to recur, often singly or occasionally in the multiple format. Malignant transformation is also observed (1). Estimated 3% tumors affect the intestines (6, 11), and 36-60% of these target the large intestine (11) mostly in the middle age or older dogs, with the highest incidence in males between 7 and 9 years age (11, 13, 14). German shepherd and

Collie breeds are predisposed to tumors of the large intestine. (13, 15, 16).

Whereas adenoma represents the most common benign tumor, adenocarcinoma, lymphosarcoma and leiomyosarcoma are the most frequent in situ malignancies (11, 17, 18). Adenoma may develop initially within an existing rectal crypt; the proliferative neoplastic cells form a growing mass, protruding into the lumen with the typical pedunculated appearance, dragging a fibrovascular stalk from the underlying submucosa in the ongoing pathomorphologic process (19). Successful management of polypoid adenoma,

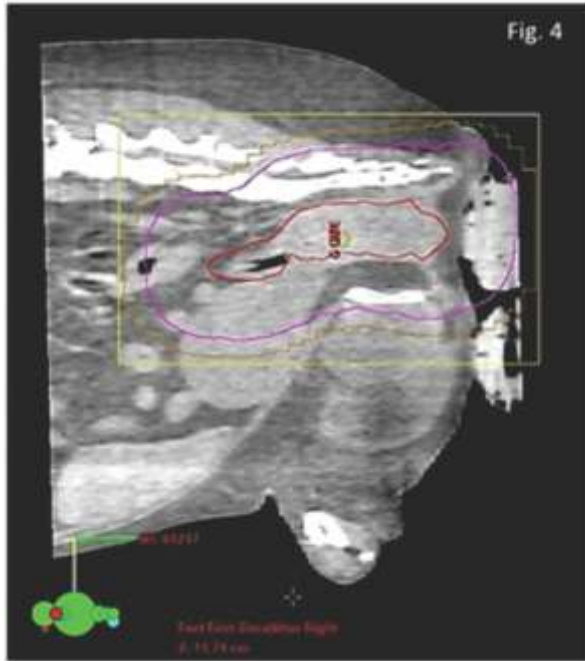


Figure 4. Diagrammatic representation of fractionated radiation therapy.

secondary to inflammatory colorectal polyps (ICRPs) in two middle age group miniature Dachshunds is on record (20). Colorectal polyps (solitary pedunculated /multiple diffuse form), located with colonoscopy, were resected with polypectomy, and the adenoma identity was established from the histomorphology profile. Repeat surgical excision was done after some weeks.

Endoscopy biopsy samples permit analysis of the histoarchitectural deformities from in-depth analysis of the lesions: ulcerative, polypoid and malignant (21). A retrospective study of RPT surgery in dogs with rectal masses documented effective local tumor control and survival time, despite complications (22). A massive growth, involving the major portion of the wall all-round is not amenable to curative surgical excision. Chemotherapy is not generally effective (1). Radiation therapy employs high energy x-rays to obliterate hyperplastic cells, responsible for polyps formation. In view of the potential risk of severe side effects: short-term or long-term, the conventional full-course therapy (20 days duration) is not recommended; palliative radiation therapy is generally effective in shrinking the rectal tumor mass, inhibiting bleeding, and permitting the patient to defecate comfortably, without straining (1). The quality of life is improved though the tumor is not completely abolished. This proven therapeutic option was adopted in the case under report. Successful management was the result of proper coordination among the field veterinarians,

oncology radiation specialist, and continuing positive interaction with the well-informed pet loving owner. The companion animal's fortitude in multiple adversities is commendable. This communication documents the positive outcome of application of advanced technology in cancer treatment, and the message is clear: close human and animal biomedical perceptions, in health and disease.

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Transmissible Venereal Tumour in A Male Labrador Dog - A Case Report

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Abstract

A 3 ½ year male Labrador was presented in the clinic for treatment of bloody discharges from penis after urination, exhibiting intermittent bleeding for nearly 2 months. Physical examination revealed normal limits of all vitals. Treatment comprising normal saline and anti-cancerous drug was initiated. However, the growth was progressively getting enlarged and turbid, surgical excision of growth was performed.

Introduction

Tumour is an excessive and uncoordinated proliferation of cells with no useful function (1). It is a common cause of death in dogs. Canine Transmissible Venereal Tumour (CTVT) is a tumour of dogs and other canines that mainly affect the external genitalia and is transmitted from animal to animal through sexual contact but may also be passed on as the dog bite, sniffs or licks the tumour affected areas (2). The tumour is usually seen in young, sexually active dogs from an environment with high concentration of free roaming dogs with uncontrolled reproduction (3).

Clinical signs of disease include friable nodule in the genitalia, accompanied by haemorrhagic discharges. It is the only known naturally occurring tumour that can be transplanted as an allograft across Major Histocompatibility (MHC) barriers within the same species and even to other members of canine family (4).

Tumour is a genetic disease. Any damage to cellular genome is common feature for all neoplasms, despite that neoplasms arise in a broad variety of tissues and diverse agents such as viruses, mutagenic chemicals and radiation induce over

growth (5).

CTVT is also known as Sticker's Sarcoma, Sticker tumour, contagious venereal sarcoma, Venereal granuloma, Infectious granuloma, canine condyloma, Infectious sarcoma, Contagious lymphosarcoma (3).

Case History

A 3 ½ year old, 35 kg male Labrador dog was presented in veterinary clinics for the treatment of bloody discharges from the penis after urination.

Physical Examination

Rectal temperature – 100.5° Fahrenheit

Heart rate -135 beats/minute

Visible mucous membrane – Pale pink

Body condition score- 4/5

Diagnosis

For the diagnosis of the case, the dog was restrained with the help of the owner. The penis was manually erected and impression smear was taken from the the small nodular mass (**Fig. 2**). The mass



Fig. 1 Labrador showing bloody discharges after urination



Fig. 2 Small nodular mass at the showing region of penis

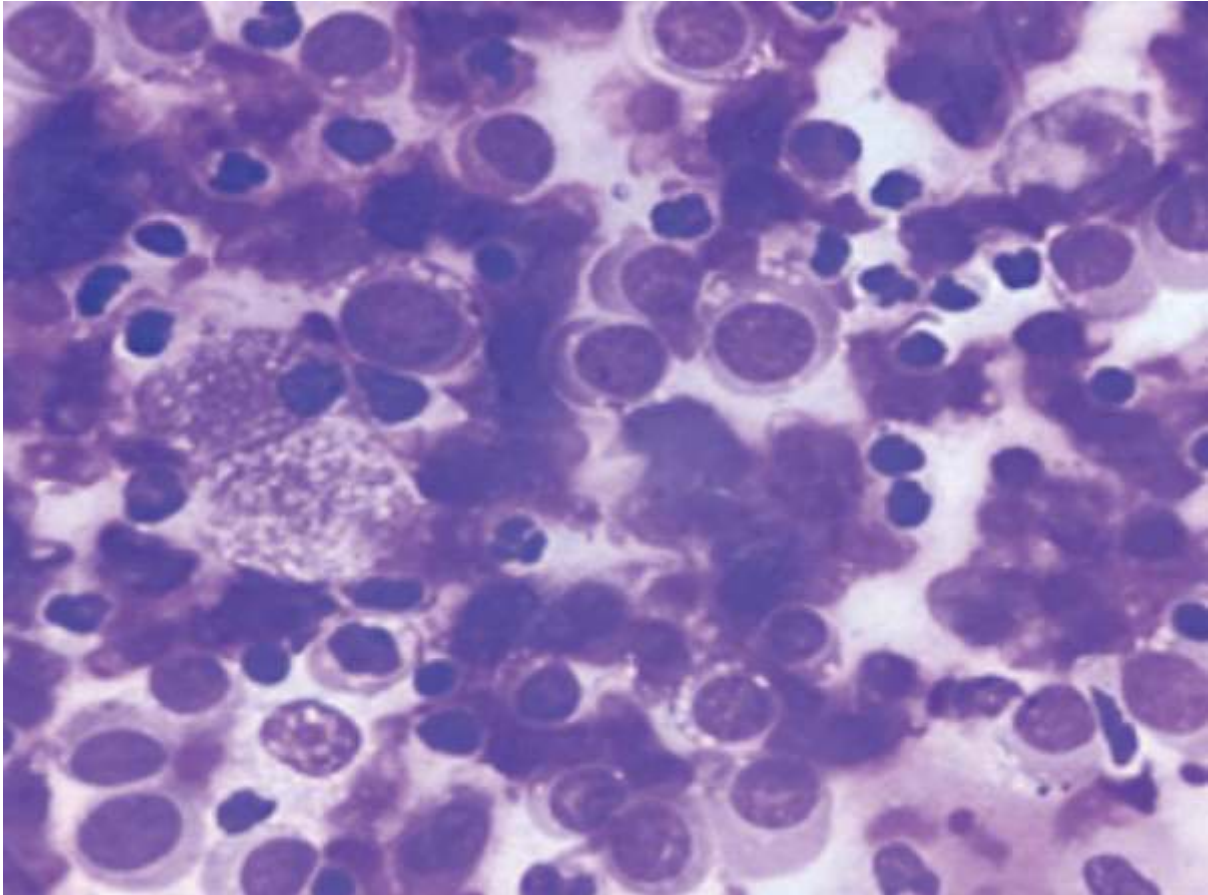


Fig. 3 Impression smear of TVT round discrete cells with enlarged nucleus

is very sensitive to touch and is bleeding (**Fig. 1**). The smear was air dried and fixed with methanol.

The smear was then stained with diff quick stain. On microscopic examination, the smear revealed round discrete cells with enlarged nucleus (**Fig. 3**). Prominent nucleus and clear pleomorphic cytoplasmic vacuoles. The cells are round and nucleus is eccentrically placed with increased granularity in cytoplasm and nucleoplasm. Few cells revealed mitotic figures in the nucleus indicating uncontrollable division.

Treatment

To treat the bloody discharges from the penis

- Normal saline – 100ml I/V
- Vincristine – 1mg
- Injection Botropase- 1ml had administered.

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Medical Management of Extrahepatic Portosystemic Shunt in a Spayed Female Yorkshire Dog

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Abstract

A spayed female 8-years-old Yorkshire terrier small breed family dog was presented in the Milford Veterinary Clinic on February 13, 2023 with the history of anorexia and ongoing bouts of vomiting. Blood work revealed microcytic anaemia, and monocytosis suggestive of chronic infection. Hypoalbuminemia and hypocholesterolemia indicated hepatic dysfunction. In-house radiographs indicated reduced liver size. Referral ultrasonography images revealed extrahepatic portosystemic shunt. On in-depth analysis of the clinical profile and diagnostic inputs, surgical intervention was ruled out. Holistic medical treatment, with hepatic support regimens, was planned and executed successfully.

Introduction

Portosystemic shunts (PSS), congenital or acquired are abnormal vessels that permit portal blood to bypass the liver with direct entry into the systemic circulation (Fig. 1). In the dog patients, congenital PSS are more common (80%), typically appearing as a single deleterious extrahepatic/intrahepatic blood vessel (1, 2). Intrahepatic portosystemic shunts (IHPSS) originate from persisting ductus venosus, or abnormal foetal development of the hepatic sinusoids (3). Nearly 33% cases of congenital PSS are intrahepatic (2, 4). Acquired PSS often develop as a secondary patho-morphological response to accentuated portal hypertension, resulting in abnormal opening of the vestigial foetal blood vessels (2, 5).

Breed predilection is well-established. The small/toy breeds include Pug Schnauzer, Maltese, Shih Tzu, and especially Yorkshire Terrier, Lhasa Apso, and Pekingese. Medium and large size breeds include Dachshund, Doberman Pinscher, German Shepherd, Golden Retriever, Labrador Retriever, Australian Cattle Dog and Australian Shepherd Dog. It is also well-established that, with no gender predilection, juvenile and young adult dogs are more vulnerable to the pathobioepisode (3, 6).

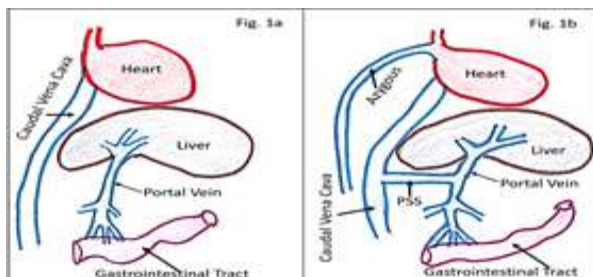


Fig. 1a. Normal hepatic and systemic circulation
Fig. 1b. Extrahepatic PSS diverting portal blood into the systemic circulation.

Case Description

A spayed female Yorkshire Terrier family dog, (DOB: April 16, 2015, bw: 2.2 kg) was presented in the Milford Veterinary Clinic on Feb 13, 2023 for health concern. The pet was not eating well, and suffered from repeated bouts of vomiting, recently. All vitals within normal limits (WNL), slightly dehydrated, lung sounds muffled in certain lung field. Throat auscultate revealed congestion. There was also a slight dehydration.

Symptomatic treatment comprised balanced isosmotic fluids 100 ml, injected S/C with vitamin B12, broad-spectrum antibiotics: Polyflex®, steroid: Dexamethasone. Take home medicaments: Amoxicillin, vitamin/mineral supplement-Nutraceutical, and protein-rich prescription food, Hill's L/D was recommended.

Diagnostics

I. Haemato - Biochemical Profile

Table 1. Patient's Haemogram (13.2.2023).

Parameter (Units)	Result	Normal Range	Status
TEC (1x10 ⁶ /µl)	7.02	5.65-8.87	
Hb (g/dl)	14.7	13.1-20.5	
HCT (%)	41.7	37.3-61.7	
MCV (fl)	59.4	61.6-73.5	Low
MCH (pg)	20.9	21.2-25.9	Low
MCHC (g/dl)	35.3	32.0-37.9	
RDW (%)	18.5	13.6-21.7	
Reticulocyte (1x10 ³ /µl)	46.3	10.0-110	
Reticulocyte (%)	0.7		
Retic-Hb (pg)	22.4	22.3-29.6	
TLC (1x10 ³ /µl)	10.19	5.05-16.8	

Neutrophil (%)	59.5		
Lymphocyte %)	24.7		
Eosinophil (%)	2.7		
Monocyte (%)	12.9		
Basophil (%)	0.2		
Neutrophil (1x10 ³ /μl)	6.06	2.95-11.6	
Eosinophil (1x10 ³ /μl)	0.28	0.06-1.23	
Lymphocyte (1x10 ³ /μl)	2.52	1.05-5.10	
Monocyte (1x10 ³ /μl)	1.31	0.16-1.12	High
Basophil (1x10 ³ /μl)	0.02	0- 0.10	
Platelet (1x10 ³ /μl)	208	148-484	

Auto Cell Counter

Table 2. Blood Chemistry Profile (13.2.2023).

Parameter (Units)	Result	Normal Range	Status
Glucose (mg/dL)	120	70-143	
SDMA (μg/dL)	5	0-14	
Creatinine (mg/dL)	0.5	0.5-1.8	
BUN (mg/dL)	10	7-27	
BUN/Creatinine ratio	22		
Calcium (mg/dL)	8.0	7.9-12.0	
Phosphate (mg/dL)	2.3	2.5-6.8	Low
Total protein (mg/ dL)	5.4	5.2-8.2	
Albumin (g/dL)	2.0	2.2-3.9	Low
Globulin (g/dL)	3.4	2.5-4.5	
A/G ratio	0.6		
ALT (U/L)	181	10-125	High
ALP ((U/L)	39	23-212	
GGT (U/L)	1	0-11	
Amylase (U/L)	436	500-1500	Low
Lipase U/L)	479	200-1600	
Total bilirubin (mg/dL)	0.3	0-0.9	
Cholesterol (mg/dL)	109	110-320	Low
Na+ (mmol/L)	150	144-160	
K+ (mmol/L)	4.7	3.5-5.8	
Cl- (mmol/L)	116	109-122	
TT4	0.8	1-4	Low

Analyzer: Catalyst

III. Abdominal Ultrasonography (6.6.2023).

Urinary System

The urinary bladder revealed mild wall thickening with sand accumulation. There was no evidence of inflammatory or neoplastic changes. Ureteral papillae were normal. The kidneys mildly swollen with normal corticomedullary definition and ratio (cortex/medullary [C/M] 1:3) maintained with subdued age-related loss of curvilinear patterns of the capsule, and C/M junction.

II. Survey Radiography (13.2.2023).



Fig. 2a. Thoracoabdominal region R/L view. Note the slight haze in the lung field.

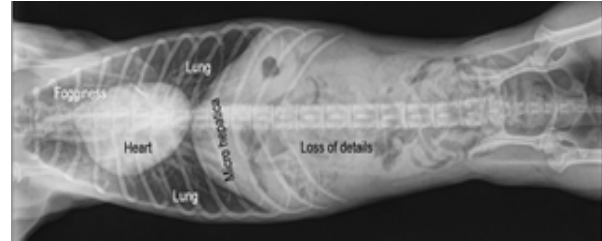


Fig. 2b. Thoraco-abdominal region V/D view: Note micro hepatica and loss of details in cranial abdomen.

The cortices presented largely uniform texture with marginally increased echogenicity, expected for this high age group patient. Medullary structure distinctly differed from that of the cortex with no evidence of pelvic dilation. Mild pinpoint mineralization noted. Both kidneys of normal size.

Adrenal Glands: Bilateral adrenal glands were identified with normal shape, size, position and echogenicity for this small breed dog. The phrenic vasculature, glandular echogenicity and details unremarkable. Capsule, cortex and medullary definition consistent with the patient's age.

Medical Treatment

Referral surgical consultation was considered. However, judicious medical management with emphasis on dietetics was decided, primarily because of the patient's advancing age and subdued clinical signs. With detailed written advisory to the well-informed owner hepatic support to prevent episodes of serum bile acid elevation (7. 8) and hepatic enteropathy (9) comprising Royal Canine diet or Hills L/D, Metronidazole [7.5mg/kg] PO, BID x 14 days, Lactulose syrup [5 ml] PO long-term aimed to ensure soft stool, high-quality protein supplement mixed with some yogurt/ cheddar cheese. Monitor serum bile acids, albumin. BUN and cholesterol concentrations periodically. High energy SAME (S~adenosine methionine) and nutraceuticals Ursodiol hepatoprotectant, and bile flow stimulant @ 15 mg/kg feed PO, OD. Serum zinc level (physiological range 200-500 μg/dL); if depleted Tx zinc acetate 1-3 mg/kg feed OD. Use GI protectants, if the patient shows signs of anorexia.

Discussion

A brief resume, of pathophysiology of the

portosystemic shunts (PSS) of varying geometric configuration and intensity is pertinent for the rationalized choice of the diagnostics panel and treatment schedule. It is recalled that PSS is an abnormal channel between the portal vasculature and systemic circulation, usually at the level of caudal vena cava. Consequently, blood from the abdominal internal organs, which is normally drained by the portal vein into the liver is instead shunted into the systemic circulation (**Fig. 1b**). A significant portion of toxins (endogenous and/or exogenous) as well as essential macro and micro-nutrient absorbed by the intestine are diverted into the systemic circulation, bypassing the hepatic parenchyma. The tropic hormones are not available, resulting in impaired growth of liver, the biochemical factory of the body. Hepatic atrophy, inevitably leads to markedly reduced rate of protein biosynthesis, deranged lipids and protein metabolism, and reticulo-endothelial dysfunction. Further, xenobiotics, accumulate exponentially in different body parts (6). Multiple clinical manifestations include hepatic encephalopathy (HE), prolonged gastro-intestinal tract and lower urinary tract signs, coagulopathies, and retarded growth of the body (2) Notably, many clinical signs reflect the primordial hepatic encephalopathy, and the associated disturbances in the central nervous system (CNS). Notably, HE results from the accelerated entry of a variety of xenobiotics in the peripheral blood circulation leading to CNS abnormalities. These toxic chemical entities: ammonia, tryptophan, glutathione, aromatic amino acids, short chain fatty acids, GABA and endogenous benzodiazepines impede normal neuronal function, induce astrocyte oedema, impair electrical conductivity, interfere with oxidative metabolism in the neurons, and activate the deleterious intracellular calcium channels (2). The diagnostic protocol and treatment regimens recommended in the dog patients with PSS, adequately summarized in a recent Veterinary Information Network (VIN) communication (6) provided useful guidelines for the successful medical management without surgical intervention in the instant case.

The client-owned 8-years-old spayed Yorkshire terrier toy breed female dog was presented in the home clinic on February 13, 2023 with the history of anorexia and recurring vomiting episodes over the last 2-3 days. Physical examination by the attending clinician (first author) revealed all vitals WNL, signs of mild dehydration, lung sounds muffled in patches, and throat auscultate suggestive of mild congestion. The patient's haemogram (**Table 1**) revealed decreased values of MCV (fL) and MCH (pg), and increased absolute count ($1 \times 10^3/\mu\text{L}$) of circulatory monocytes. These findings pointing to ongoing microcytic anaemia and monocytosis are consistent with a highly informative publication on canine PSS (6).

The patient's blood chemistry profile (**Table 2**) revealed decreased circulatory concentrations of albumin and cholesterol, amylase, and TT4 (thyroxine). Hypoalbuminemia and hypo-cholesterolemia in the dog patient with PSS testify hepatic dysfunction, and

the high circulatory titre of the clinical enzyme, ALT compromised structural and functional patency of the hepatocytes (6). In-house 2-view (R/Land V/D) thoracoabdominal survey radiograph images showing mild haziness in the pulmonary fields (**Fig. 2a, b**) is suggestive of respiratory infection. Subdued opacity in the cranial abdomen is related to decreased liver size and loss of details for possible tumor, to be corroborated by ultrasound probe. Referral imaging report: micro-hepatica, a single abnormal blood vessel consistent with extrahepatic portosystemic shunt, presumably postcaval, or gastro-azygos. Urinary bladder revealing mild wall thickening and accumulation of sand; no definitive evidence of inflammatory or neoplastic changes. No noteworthy structural abnormalities discernible in the bilateral kidneys and adrenal glands, spleen, and pancreas. The stomach is free of stasis and mucosal speckling; marginal striations in the small intestine of no clinical concern. Periodical monitoring of the serum albumin concentration is recommended, because of the known

genetic predisposition of Yorkshire terriers to protein-losing enteropathy (PLE). Further, gall bladder bile acids profiling is also recommended in view of the likely passage of renal biurate sand and calculi. Under constant clinical surveillance and proper home care the pet has recovered uneventfully.

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Clinical Management of Trypanosomiasis in a Dog

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Abstract

A 4-year-old female Shih Tzu dog presented with a history of bilateral corneal opacity in the past. The dog was previously treated for tick infestation. History of inappetence, physical examination revealed pale conjunctival and buccal mucous membranes, enlarged lymph nodes, and absence of menace reflex. Laboratory findings showed decreased hemoglobin, RBCs, hematocrit, MCHC, and MCV, along with elevated ALP, hypoalbuminemia, and total bilirubin. Ultrasonography revealed hepatic congestion and hepatomegaly. A wet smear examination tested positive for trypanosomes, confirming the diagnosis. The animal was treated with a single dose of diminazene aceturate and supportive treatment. During follow-up, the animal's condition showed significant improvement in corneal opacity and appetite. The importance of vector control, early diagnosis, and prevention through avoiding exposure to infected animals were emphasized for effective prevention. Early detection and intervention enhance the likelihood of a positive outcome.

Introduction

Trypanosomiasis is a vector-borne disease caused by the protozoan parasite *Trypanosoma evansi*. It is a major cause of illness and death in dogs in tropical and subtropical regions. The disease is transmitted by the bite of infected flies, such as *Stomoxys* and *Tabanus* species (1). After infection, the trypomastigote form of *Trypanosoma* swiftly invades host cells, proliferating without triggering overt clinical symptoms. This stealthy multiplication occurs within macrophages, evading immune detection. Parasitemia becomes evident within days and peaks around 2 to 3 weeks post-infection, coinciding with clinical disease manifestation (2). Anemia is a cardinal feature of the disease, driven by the removal of red blood cells from circulation by the mononuclear phagocytic system. Over the course of infections lasting several months, parasitemia decreases, leading to intermittent presence and subsequent partial resolution of anemia (3). For combatting canine trypanosomiasis, effective agents like suramin, quinapyramine, and diminazene exist. Yet, the singular administration of diminazene diacetate proves highly effective in eliminating natural trypanosomiasis infection in dogs (4). Dogs with trypanosomiasis typically develop an acute illness with ocular, vascular, and neurological signs. Common clinical signs include corneal opacity, fever, lethargy, anemia, enlarged lymph nodes, and neurological signs, such as seizures, tremors, and paralysis. If left untreated, trypanosomiasis can be fatal in dogs. The disease is most common in dogs that live in rural areas and have access to open areas where infected flies are present. Young dogs are more susceptible to infection than older dogs. There is no vaccine for trypanosomiasis in dogs. Treatment for trypanosomiasis is usually effective,

but it can be expensive and time-consuming. Dogs that recover from trypanosomiasis may be carriers of the parasite and can infect other dogs. If left untreated, trypanosomiasis can be fatal in dogs (5,4) Early diagnosis and treatment with appropriate medication is essential to improve the chances of survival.

History

A 4-year-old female Shitzu was presented with a history of bilateral corneal opacity (**Fig.1**), anorexia, and reduced water intake for the past 10 days. The dog's vaccination status is up-to-date, and it was last dewormed with Fenbendazole and pyrantel palmoate a month ago. On physical examination, the dog was found to have a rectal temperature of 102.1 F, a body weight of 6.2 kgs, a heart rate of 160 bpm, and a respiratory rate of 35 per minute. The dog's conjunctival and buccal mucus membranes were pale, and the dog's STT was 3 sec. There was swelling of popliteal lymph nodes. The dog also had a yellowish discoloration of the abdomen.

Laboratory Studies

The lab results highlighted changes in the dog's blood composition, including lower levels of hemoglobin, RBC, hematocrit, MCHC, and MCV. There was also an increase in ALP, hypoalbuminemia, and total bilirubin, suggesting possible liver involvement and abnormal albumin levels. Considering the information gathered from the dog's history and the findings of the physical examination, the assessment of a wet blood smear brought to light the clear presence of Trypanosomes (**Fig.3**), effectively confirming the initial suspicion of infection. This microscopic investigation enabled the accurate identification of the parasitic organisms within the blood sample, definitively establishing the diagnosis.

Treatment

The administration of diminazene aceturate at a dose of 3.5 mg/kg via deep intramuscular injection (I/M) once, proved to be effective. Supportive therapy included Doxycycline, Clindamycin, Toxol (Choline Chloride, Methionine, Inositol, Vitamin B12), Prednisolone, Orofer (Ferrous Ascorbate (iron and folic acid), Metronidazole, and Pantoprazole, each addressing specific aspects of the patient's health needs. The treatment regimen was complemented by liver tonics and oral administration of platelet and red blood cell enhancers twice daily, along with Moxifloxacin eye drops for ocular care. The treatment resulted in significant improvement in corneal opacity (**Fig.2**), as well as an enhancement in appetite, showcasing a positive response to the prescribed therapeutic interventions.

Discussion

Naturally infected dogs with *T. evansi* show severe symptoms like intermittent fever, anemia, paralysis, seizures, and lymph node swelling. Clinical signs include weight loss, edema, weakness, and cardiac problems. Blood tests reveal increased globulin levels and decreased albumin, potentially compensating for higher viscosity. Liver enzyme levels, especially AST, rise in infected dogs. Tissue studies indicate abnormalities in the spleen and lymph nodes. Central nervous system effects are infrequent, while myocarditis is observed. These cardiac lesions may result from antigen-antibody interactions (6).

Research on drug treatment efficacy in surra, especially in dogs, remains limited. Diminazene aceturate has proven effective against *T. evansi* in dogs due to its high therapeutic index and low

resistance incidence. In one case, subcutaneous administration of 7 mg/kg on the first day and 3.5 mg/kg on the next effectively treated a naturally infected dog. However, a study indicated that treating *T. evansi* in *Rattus norvegicus* with diminazene aceturate required five consecutive days for control (6). Imidocarb dipropionate wasn't effective. Control measures for *T. evansi* largely focus on curtailing vector growth.

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Fig.1. Before Treatment



Fig.2. After Treatment



Fig. 3. Wet Smear Examination

Canine Babesiosis: Guidelines for the Practitioners in Diagnosis, Treatment, Prevention and Control

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Abstract

The purpose of this article is to provide practical guidelines for veterinary practitioners in the diagnosis, treatment, and prevention of canine babesiosis. It is a haemoprotozoan disease, spread by biting of ticks. The protozoa replicate inside RBCs, causing haemolysis, immune mediated thrombocytopenia. Infected animals show signs varying with age, host's immune status, stage of infection, virulence of etiological agent. Clinically, it leads to raised body temperature, pale mucous membrane, raised heart rate, raised respiration rates, hepatomegaly, splenomegaly and petechial haemorrhage. Dissimilar antigenic properties, variety of species of tick vectors and their abundance creates a challenge in its treatment. Treatment with certain drugs shown to cause occasional to frequent relapses of disease. For positive transmission of this disease, it takes more than 48 hours; therefore, control of ticks with acaricides by dipping, spraying, or tick collars are the most effective methods for control of canine babesiosis.

Introduction

There are more than 100 *Babesia* spp. known to infect vertebrate hosts including humans. Incidence of this disease is worldwide in canines; however, the distribution, vectors, and virulence of *Babesia* spp. vary. *B. rossi* is most pathogenic, transmitted by *Haemaphysalis elliptica*. Some moderately pathogenic *B. canis* is transmitted by *Dermacentor* spp. and *Rhipicephalus sanguineus*. *B. vogeli* transmitted by *Rhipicephalus sanguineus* is the least virulent, although it can be fatal in puppies due to severe anemia. *B. gibsoni* is transmitted by *Haemaphysalis longicornis* and *Haemaphysalis bispinosa* ticks (1, 2). Clinically, the disease can be divided into simple and complex forms. Uncomplicated canine babesiosis has been associated with hemolysis, while complicated cases have been associated to the development of Multiple Organ Dysfunction Syndrome (MODS) and Systemic Inflammatory Response Syndrome (SIRS).

General life cycle of *Babesia* spp.

Tick bite causes transfer of sporozoites into vertebrate host's RBCs, and there sporozoites differentiate into trophozoites. Then trophozoites form two or four merozoites via asexual reproduction. These merozoites invade new RBCs, while some merozoites get transformed into gamonts. When a tick bites an infected animal then these gamonts get ingested by a tick, later differentiate in the gut of the tick into gametes and then diploid zygote. The zygote then later forms motile haploid kinetes. Haploid kinetes multiply via

sporogony and move to tick organs. Thenafter kinetes get transformed into sporozoites and infect the vertebrate host (3).

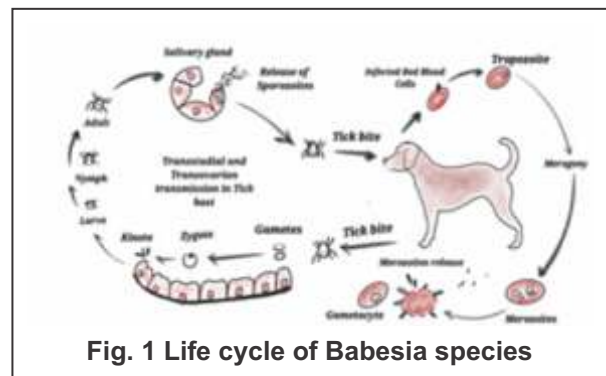


Fig. 1 Life cycle of *Babesia* species

Clinical Signs

The infecting species, signalling, and host immunity all play a role in the clinical signs and prognosis of canine babesiosis. The wide spectrum of clinical symptoms is heavily influenced by the species of *Babesia* that causes infection as well as other factors that influence disease severity, such as age, splenectomy, immunological competence, and concurrent infection or disease. The clinical manifestations of *Babesia* spp. infections range from subclinical infections to multi-organ failure with a risk of death. Apathy, weakness, anorexia, pale mucous membranes, and a poor general state are common clinical indicators linked with canine babesiosis. All *Babesia* species can lead to fever, spleen and lymph node enlargement, jaundice,

pigmenturia, anaemia, and thrombocytopenia. In all species of *Babesia*, anaemia develops by a combination of intravascular and extravascular hemolysis caused by parasite-driven injury and rupture of red blood cells, enhanced osmotic fragility of the cells, and the activity of secondary immune-mediated mechanisms (4). Not all clinical abnormalities in some dogs may be attributable to hemolytic anaemia and hypoxia; such dogs have been associated with complex canine babesiosis. Dogs with complicated babesiosis have immune mediated hemolytic anemia (IMHA). Metabolic acidosis and renal disease are most common during acute infection. Systemic inflammatory response syndrome (SIRS) and multiple-organ dysfunction syndrome (MODS) occur frequently in



Fig.2 Dog infected with canine babesiosis showing yellowish mucus membrane of the eye



Fig.3 Dog infected with canine babesiosis showing haemoglobinuria

complicated canine babesiosis (5). Hepatopathy, acute kidney injury (AKI), cerebral babesiosis, acute respiratory distress syndrome (ARDS), relative hemoconcentration ("red biliary"), pancreatitis, rhabdomyolysis, and cardiac failure are abnormalities reported in complex canine babesiosis cases (4). Dogs with complicated forms of babesiosis

Diagnosis

Microscopic examination of Giemsa or Wright's stained blood smears is a useful diagnostic tool for clinical babesiosis. Generally, in dogs, *B. canis*, *B. vogeli* and *B. rossi* are classified as a large form measuring between 2.5 and 5 µm, whereas all small forms measuring 1–2.5 µm are classified as *B. gibsoni*, *B. conradae* and *Babesia vulpes*. With negative blood smears, the blood or splenic tissue is reassessed by PCR. Ultrasonography can be used to diagnose hepatomegaly and splenomegaly.



Fig. 4 Microscopic view of canine Babesia species in erythrocyte (Large form)

Clinical biomarkers such as: blood cell parameters; mild to moderately regenerative normocytic and normochromic anaemia, coagulopathies, TNF concentration, acidemia to alkalemia, hypoglycemia, icterus, increased ALT activity, urea and creatinine imbalances. For diagnosis, indirect fluorescent antibody testing, PCR and serological examination are done (1, 2). Thrombocytopenia is a consistent finding in canine babesiosis, because of the severity and rapid recovery of platelet counts, it has been suggested that immune-mediated mechanisms are at work (5).

Treatment

Treatment for canine babesiosis includes the treatment to eliminate the parasite, blood transfusions to treat severe anaemia, and the supportive care for the complications and metabolic derangements.

1. Imidocarb Dipropionate

Imidocarb dipropionate is effective in the treatment of large *Babesia spp.* infecting dogs, more than for

the small form *Babesia spp.* (6, 7, 8). Intravenous injections should be avoided in dogs. The therapeutic dose of imidocarb dipropionate is 6.6 mg/kg of body weight, intramuscularly or subcutaneously in 2 doses at 14-day intervals. The animal may show some signs such as drooling, hyper salivation and vomiting. Atropine at 0.05 mg/kg can be used to alleviate the signs (9). An overdose of imidocarb dipropionate can cause

nephrotoxicity.

2. Diminazene Aceturate

It is the main drug used against canine babesiosis caused by *B. rossi* (10). One injection of Diminazene aceturate intramuscularly if effective in large form *Babesia spp.* Diminazene aceturate has low therapeutic index and may produce some unpredictable neurological signs, and

Table 1 Treatments used for infections with the various species of Babesia

Babesia species	Drug	Dose	Response
Large form (2.5-5 µm) <i>B. canis</i> , <i>B. vogeli</i> , <i>B. rossi</i>	Imidocarb dipropionate	5-6.6 mg/kg Intramuscular; may be repeated in 2 weeks	Good to fair
	Diminazene aceturate	3.5 mg/kg intramuscular single dose	
<i>B. gibsoni</i>	Azithromycin + atovaquone	10 mg/kg PO SID + 13.3 mg/kg PO TID; both for 10 days	Fair to poor with clinical relapses
	Clindamycin	12-25 mg/kg PO BID for 10 days	
<i>B. microti-like Spp.</i>	Imidocarb dipropionate	5-6.6 mg/kg IM once; may repeat in 2 weeks	Poor

gastrointestinal disturbances even at prescribed therapeutic doses (9).

3. Atovaquone and Azithromycin

Atovaquone acts on mitochondrial electron transport causing inhibition of pyrimidine and ATP synthesis [11, 12]. Azithromycin acts on apicoplasts of *Babesia spp.*; however, *B. gibsoni* known to develop resistance against Atovaquone in infected dogs (9). It is considered as the first-line therapy for *B.gibsoni* infection in most countries worldwide. Atovaquone should be administered with fatty food to maximise drug absorption.

Combination therapy of Buparvaquone and azithromycin or clindamycin, doxycycline and metronidazole can also be used as alternative treatment strategies. Antiprotozoal drugs such as parvaquone, pentamidine and some antibiotics having antiprotozoal actions such as enrofloxacin, clindamycin, minocycline, metronidazole and doxycycline show various degrees of effectiveness. Mortality rates can be as high as 30 % to 45 % in complicated cases associated with IMHA (9). The

preferred course of treatment for piroplasmosis is not antibiotics. Even so, doxycycline has been reported to lower the severity of clinical symptoms and to be linked to a decline in morbidity and death for *B. canis* and *B. gibsoni* infections (13, 14). The most popular dosage is 10 mg/kg/day, which can be given orally (PO) or (rarely) intravenously (IV). It is advised to divide the dose into 5 mg/kg administered every 12 hours in the event of vomiting (13). Clindamycin has been used to treat *B. gibsoni* infection at a dose of 25 mg/kg, delivered orally once every 12 hours for 14 days, and it has been demonstrated to lessen clinical symptoms and abnormal test results (15). It's crucial to keep in mind that antibiotics by themselves won't cure the infection. Combinations of various antibiotics, however, can be somewhat effective in treating dogs infected with *B. gibsoni*. Examples are enrofloxacin (2.5 mg/kg every 12 h PO), metronidazole (5-15 mg/kg every 12 h PO), and doxycycline (7-10 mg/kg every 12 h PO) (14, 17). Another example is the combination of clindamycin (11 mg/kg every 12 h PO), metronidazole (15 mg/kg every 12 h PO), and doxycycline (5 mg/kg every 12

h PO). In conclusion, the use of antibiotics in the treatment of canine babesiosis should be restricted due to the paucity of scientific data supporting this practise (4).

Supportive therapy is required to help control the severity and restore normal physiology of animals. Animals showing respiratory distress should be given oxygen therapy. Animals in shock, skin tenting, renal abnormalities should be provided adequate fluid therapy; 150ml/ kg body weight in severely dehydrated patients. Animals having poor haemoglobin percentage and poor total erythrocyte count can be provided with whole blood transfusion or plasma transfusion. Animals not responding to treatment protocols or in case of immune mediated hemolytic anemia (IMHA) prednisolone therapy can be used at the dose of 2 mg/kg/day. Other complications such as vomiting, tachycardia etc. should be treated with proper medications (2).

Prevention and Control

Primary focus for control of Babesiosis should be controlling tick population in endemic areas. A large number of topical products are currently available for the control of ticks on dogs. For this, acaricides can be used as spray or dipping on animals and its surroundings. Spot on preparations and tick collars are also available. As there is minimum to no cross-protection among various *Babesia spp.*; hence animals with a history of infection with *Babesia spp.* may again get infected with another species of *Babesia*. Animals from endemic areas should be screened for infection by PCR or serological examination before they get used as donors for blood transfusion as merozoites of the protozoa will get transmitted to healthy animals. Animals should be vaccinated for the zones where there is availability of vaccines such as; Pirodog® (Merial) derived from the culture of *B. canis* and *B. rossi* supernatant known to be effective. Although this vaccine can be given starting at age 5 months and must be repeated every year, it does not provide cross-protection against other *Babesia* species (18). Vaccine is having the effect of shortening the disease duration and reducing the severity of clinical signs. It has no effect against other *Babesia spp.* (19). Immuno-compromised animals are exposed to risk of infection, thus they should be separated from other dogs and should not be involved in dog fighting.

Conclusion

Response of particular drug and drug combinations is affected by particular species, and resistant strains as well as clinical status of affected dog, immune status and age. In cases of infection with small *Babesia spp.* the parasite does not get eliminated completely, and animals may act as carriers to spread infection or suffer from relapses.

World wide availability of vectors, lack of cross protection among different *Babesia spp.* and the severity of disease in canines pose a bigger challenge in treatment and prevention of this disease. Vaccines are in development for different species; however, availability at various places still poses a challenge in prevention of canine babesiosis. Some prevention measures can be ensured with use of acaricides such as flumethrin, permethrin and fipronil to control tick population as well as regular screening of animals suspected or animals in endemic zones should be done to avoid transmission to healthy pets. Dog fighting should also be avoided. Dogs should also be screened before travelling to non-endemic zones. This disease has shown no evidence of being zoonotic. Last but not least, accurate detection and species recognition is crucial for selecting the most appropriate treatment and determining the most accurate prognosis.

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An Introduction to Canine Brucellosis

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Introduction

Pet animals currently in our society occupy an important position and amongst them the dog population is increasing constantly day by day. Amongst the dog population canine brucellosis is emerging as an infectious disease caused by *Brucella canis* which is zoonotic in nature and a major public health concern due to close contact between human and dogs (1). Canine brucellosis is seen in reproductive age of dogs (2).

Etiology

Brucella canis was first recognized the year 1966 by Leland Carmichaelin. It is a gram-negative, aerobic, intracellular bacterium (*coccobacillus*) with colony size ranging from 1-1.5 mm in diameter, which can affect almost all breeds of dogs. It belongs to the family *Brucellaceae*.

The growth media required for the organism is blood agar supplemented with 5% fetal calf serum or tryptose agar or Thayer-Martin media and unlike other species of the genus, *B. canis* does not require carbon dioxide (CO₂) for its growth (3). The organism is non-spore forming, non-capsulated and lacks flagella, which makes it non motile (4).

Transmission

Canine brucellosis is especially common among stray dogs, in shelter kennels, in commercial breeding kennels, or in places where they live in large groups. The most common route for transmission is via placenta, fetal tissues and vaginal discharges resulting from abortion due to *B. canis*. Vaginal discharge can contain more than 10¹⁰ microorganisms per ml, and elimination by this route can continue for several weeks after abortion. Most of the puppies are infected either in the uterus or through their mother's milk which serves as potential source of infection. In male dogs the seminal fluid and urine serves as the major source of infection. The organisms are found in male semen in high concentration for 6-8 weeks and low concentration for up to 60 weeks. Urinary elimination begins a few weeks after the onset of bacteremia and continues for at least three months (5).

Human infections with *B. canis* were first reported in 1968, affecting individuals who had contact with infected dogs. Human infection with *B. canis* is considered self-limiting and occasional. It has been estimated that only 1% of the diagnosed human

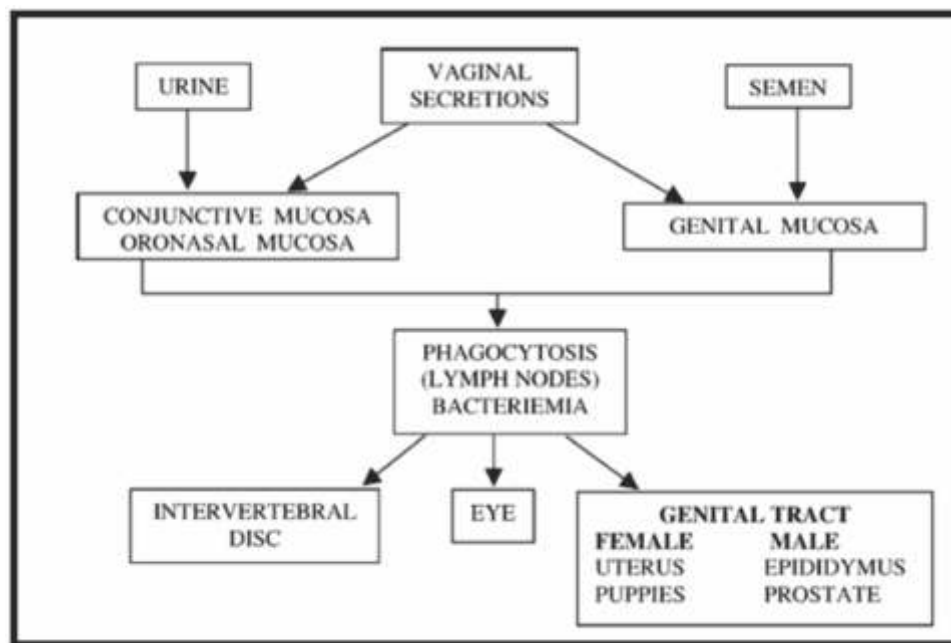


Figure 1: Pathogenesis of Canine Brucellosis (Wanke, 2004) (3)

brucellosis are due to *B. canis* infection. Humans are mainly infected via oronasal route by direct contact with infected dogs, particularly by contact with aborted fetal material or secretions. Children's are mainly affected by playing with infected puppies. Human brucellosis is considered an occupational disease, so veterinarians, pet store workers, kennels employees and owners, dog caretakers, dog trainers, and laboratory technicians are professionals with the higher risk of occupational exposure to infection (1).

Pathogenesis

The pathogen enters via genital, oronasal or conjunctivae mucosa. After entry into host, they are phagocytized by macrophages and other phagocytic cells and taken to lymphatic organs (lymph nodes and spleen) and genital organs. Bacteremia develops within 1–4 weeks of infection and lasts for at least 6 months and then remains intermittent for 64 months. Bacteria reaches to the target organs via blood and produce the pathological changes in the body (Figure 1) (3).

Clinical Signs

Dogs: Most of the dogs do not develop clinical signs except enlarged lymph nodes. Some may face loss of vigor, reproductive failure or abortion between 45-55 days although in some cases it can occur in initial phase (between 10-35 days). Vaginal discharges are common after abortion which may be serosanguineous or viscous or greyish green. Stillbirths or birth of weak puppies is often associated with *B. canis*. Male dogs often develop orchitis or epididymitis. Chronically infected dogs may be oligospermic or azoospermic (1).

Humans: Infection in people causes flu-like signs (fever, night sweats, shaking chills, malaise headaches, back pain, weight loss, lymphadenopathy and hepatosplenomegaly). In chronic cases arthritis (joint pain), spondylitis, osteomyelitis or genital changes such as orchitis, epididymitis glomerulonephritis or kidney abscess may be observed. Rarely, cases of brucellosis can involve the nervous system, eyes, or heart (6).

Diagnosis

Sample collection: Isolation of *B. canis* is possible from blood, fresh samples (vaginal discharged material, placental and fetal tissues, urine, semen, milk) and samples taken from necropsy (lymph nodes, spleen, prostate, epididymis, uterus, bone marrow, eye) (5).

Culture and Isolation

The isolation of *B. canis* is difficult. It cannot be cultured normally like other organisms. Blood samples are best for culture and isolation of *B.*

canis. As the bacteriemia phase is seen after 7 days of infection, therefore blood should be collected 2-3 weeks post infection for positive results (5). Samples of fetal membranes, aborted and stillbirth fetuses should be cultured if available, because they contain high bacterial loads. Vaginal and uterine secretions can be sampled during the proestrus or estrus in aborted bitches, when there is an increased risk of bacteremia. Semen samples could be cultured between 3 and 11 weeks after infection for higher bacterial count. Urine samples can be used for isolation between 8 and 30 weeks post infection (1). The culture grows on blood agar supplemented with 5% fetal calf serum or tryptose agar or Thayer-Martin media without carbon dioxide and optimum pH ranging between 6.6 to 7.1 (7).

Serological Tests

Agglutination Tests

- Rapid slide agglutination test (RSAT)- Agglutination is done with monospecific anti-A, anti-M sera. *B. canis* is a rough strain therefore cannot be agglutinated by smooth strain antisera-anti-A, anti-M (8).
- Tube agglutination test (TAT)- This test detects IgM and is suitable for diagnosis of infections at acute stages but the test is not specific for *B. canis* as it lacks O specific polysaccharide (OPS) on their surfaces (9).
- Rose Bengal Plate Test (RBPT) – It measures both IgG and IgM. This test is considered as the screening test but the disadvantage is that it lacks standardization of antigen i.e. it contains smooth strain antigen but *B. canis* is a rough strain, thus give false positive results due to cross reactivity (10).

Complement Fixation Test (CFT)

The most specific and OIE recommended test for the diagnosis of brucellosis, but it is not used routinely. Though it is a rapid and accurate test but the main drawback is- it cannot differentiate between the antibodies due to infection and vaccination (11).

Agar Gel Immunodiffusion (AGID)

This test relies on surface proteins because antigens are capable of detecting precipitins between 5 and 10 weeks after infection. Two types of antigens – sonicated antigens (SA) and hot phosphate buffer saline extract (HPBSE) were used in this test where it was observed that HPBSE was more specific and considered for AGID (12).

Enzyme Linked Immune Sorbent Assay (ELISA): Competitive ELISA is used.

Molecular Tests

Polymerase chain reaction (PCR) is used routinely for the diagnosis of *B. canis* and it targets specific genes such as bcsp31, recA and 16s ribosomal subunit specific to *B. canis*. PCR has been applied for detection of *Brucella canis* in semen of naturally infected dogs (13). Molecular probe sequencing can also be done (14).

Treatment

As *B. canis* are intracellular bacteria the antibiotics cannot reach to it adequately. Many different antibiotics have been tried either alone or in combination but none of them have been proved 100% effective in eradicating the disease.

Treatment in Humans

The treatment of brucellosis in humans is based on the use of antibiotics capable to act on organism for an adequate length of time. This includes doxycycline, streptomycin, rifampicin, gentamicin, trimethoprim-sulfamethoxazole, ofloxacin, ciprofloxacin, tetracycline, ampicillin, sulfadiazine, ceftriaxone and cephalothin (1).

Treatment in Dogs

In dogs, the treatment with antibiotics is not encouraged because of high rates of relapse, and the cure for the disease is still questionable after antibiotic treatment. Also the treatment is expensive as well as do not eliminate *B. canis* completely. *B. canis* isolated from dogs are found susceptible to doxycycline and tetracycline but some strains are found resistant to streptomycin and tetracycline (15). Also enrofloxacin and streptomycin when used together shows synergic activity in vitro against the bacteria, while doxycycline and rifampicin shows antagonistic effects (16). Treatment with oxytetracycline for 4 weeks and streptomycin in the 1st week of treatment showed 79% positive results in dogs where elimination of bacteremia and absence of *B. canis* in lymph nodes, spleen and reproductive organs was noted (17). Enrofloxacin have good results in preventing abortion, but due to its toxicity not indicated during pregnancy (18).

Prevention and Control

- Unfortunately, there is not any commercially available vaccine for prevention of canine brucellosis till date therefore prevention control measures should be followed (1).
- In kennels, routine serological testing of animals should be carried out twice to thrice per year and those diagnosed positive should be isolated from healthy once and treated or culled (1).
- In case of pet dogs infected with *Brucella*, the owners must be informed about the zoonotic risks of the disease before choosing treatment

or euthanasia (1).

- Quarantine – All new animals should be quarantined for 8-10 weeks, prior to their entry in the kennel. They should be introduced in the kennel only after two negative test results with 30 days' interval (3).
- Testing of males and females compulsorily before mating (3).
- Dogs showing any symptom of brucellosis should not be purchased. Also, the people with high occupational risk like – owners or workers employed in kennels should be made aware about the disease as it has zoonotic significance (19).
- The source of infection should be identified and its removed, following proper disinfection.
- Orchiectomy or ovary-hysterectomy of stray dogs is one of the best methods to control unwanted natural mating and transmission, thus controlling zoonotic risk to a greater extent (1).
- Maintaining strict hygiene and periodic disinfection and carrying out proper monitoring and surveillance.
- Thus development of novel diagnostic method and safe vaccine is highly desirable for control of this disease (1).

Public Health Significance

The incidence of the illness in human beings is not exactly known. The humans can be infected by *B. canis* through direct contact with bodily discharges of infected dogs, their bodily discharges or through accidental laboratory exposure. Other possible sources of infection may be contact with wild canids (**Figure 2**). Also, the survival of *B. canis* in the environment has not been tested (although it is known that other members of the *Brucella* genus can survive in the environment for up to eight months under favorable conditions). In humans the illness starts with prolonged fever, enlarged lymph glands, pharyngitis, joint pain, shivering and weight loss (20).

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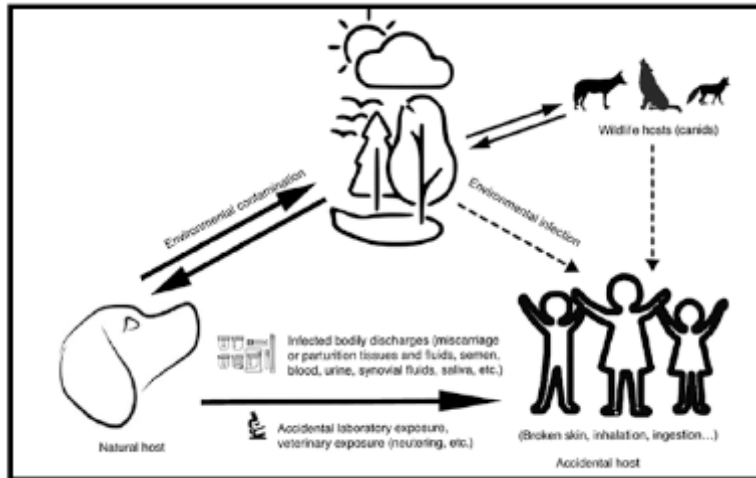


Figure 2: Currently known *B. canis* transmission routes for human infections. Proven sources of human infection are linked by full line arrows, while possible sources are presented by dotted line arrows (20).

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Surgical Renovation of Ruptured Right Anal Sac in a Neutered Male Domestic Short Hair Cat

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Abstract

A neutered male 12 years old indoor-outdoor Domestic Short Hair (DSH) cat was presented in the Milford Veterinary Clinic on July 19, 2023 for the treatment of abnormal behavior, anorexia, and the ongoing postural anomaly (drooping tail). The fractious feline patient mandated sedation for physical examination, diagnostics and treatment. Close monitoring of the anal region revealed bleeding ruptured right anal sac and swollen turgid left anal sac. Since the holistic medical treatment of the damaged right sac proved ineffective, surgical intervention was meticulously planned and executed successfully. The gaping wound healed uneventfully within a few weeks. The left sac was emptied with digital compression under antiseptic cover. The patient recovered completely with markedly improved body condition and behavioral profile. Proper home care by the owner, in contact with the attending clinician, was a major contributory factor.

Introduction

The anal sacs in the sphincter fibers are a paired adnexal, cutaneous appendage. Lined with squamous epithelium containing modified sebaceous and apocrine tubular glands these bioentities serve as a reservoir for odorous, viscous secretions, discharged through ducts during normal defecation and extreme excitement. Forceful contractions of the inner and outer anal sphincter muscles promote anal sac evacuation. However, sac impaction results from accumulation of degraded biomass, following inflammation (anal sacculitis), infection (anal sac abscess), or obstruction of the ducts.. Anal sacculitis in nearly 10% of companion dogs is caused by infection, or anal sac duct obstruction leading to exponential multiplication of pathogenic microorganisms. Chronic fistulation may occur. Malfunction of the anal sphincter biomechanism, secondary to frequent bouts of diarrhoea, anal laxity, constipation, and obesity contribute to anal sacculitis through retention of the anal sac contents. Untreated abscess, or impaction may result in anal sac rupture and a draining lesion, usually in the ventrolateral region (1,2). During physical examination, palpation of the perineal tissue mass may locate an enlarged, indurated, and painful anal sac. Digital expression releases aqueous, or slightly viscid, or granular, pale brown or black secretions, and differently coloured (whitish/gray/yellow/green), blood-stained, purulent, gritty, turbid, opaque discharge. Untreated debilitated animals may also exhibit perianal, or rectal abscess, or anal stricture. Anal sacculitis is diagnosed when moderate to severe pain is evinced on palpation, and the anal sac contents are serous, yellowish, blood-tinged, or purulent. The

cardinal symptoms of anal sac abscess formation are distention with leakage of purulent exudate, cellulitis in the surrounding tissue, erythema in the surface skin, pain, and pyrexia. Anal sac rupture is confirmed with the detection of an open draining track (3, 4).

Choice of the optimized treatment regimen depends on the well-judged stage of infection. Manual expression, use of topical antibiotics, and suitable dietary changes effectively manage most anal sac problems. Resolution of coexisting dermatoses facilitates the treatment of anal sacculitis. Low-grade sacculitis, or impaction is treated with manual expression, lavaging with isosmotic saline solution, and gentle flushing with an antibiotic-corticosteroid preparation. Dry secretions may be softened through the use of saline lavage, or a cerumenolytic agent infusion. In infected anal sacs, 0.5% chlorhexidine, or 10% povidone-iodine preparations may be added in suitable dose to the saline flushes for better response. Adding edible fibres, e.g., w/d Hill's Pet Products, pumpkin, bran or psyllium in the pet's diet makes the faeces bulky, which promotes stretching of the annual muscles during defecation. The anal sacs compress in tandem with smooth evacuation of the contents. In more severe cases, weekly clinical evaluation, expression, and lavage with a dilute antiseptic, or isosmotic saline solution lavage may be needed. Chronic cases may necessitate the use of appropriate antibiotics, based on the sensitivity test results. Anal sac abscesses should be lanced, drained, and flushed out. Hot compresses applied for 15-20 minutes 2-3 times daily are highly beneficial. Oral antibiotics are administered to the individual patients on clinical judgment.

Case History and Diagnostics

A 12 years old neutered male Domestic Short Hair (DSH) cat was presented in the clinic on July 19, 2023 with the complaint of shirking physical contact with the owner, loss of appetite, and continuous drooping of the tail towards the floor. Anamnesis revealed that the indoor-outdoor feline patient, involved in a cat fight earlier, was bitten and treated for the traumatic injury. The attending physician (first author) soon realized the need for careful handling of the fractious feline patient with ethical chemical restraint for physical examination, blood sampling, in-house survey radiographs and rationalized treatment. An effective cocktail of sedative preparations, named 'Kitty magic': Dexmedetomidine (Dexdomitor®), Ketamine and Butorphanol (Torbugesic®) in equal proportion commonly used by the pet practitioners in the United States. In the instant case, 0.07ml of each agent was injected intramuscularly (IM).

Physical examination: Patient's weight 3.1kg, vitals within normal limits (WNL), apparently dehydrated, advanced dental tartar (stage 3.5/4), advised a dental cleaning, lung sounds muffled, advised blood work and X-ray investigation. The thoracic survey radiographs revealed fogginess in the lung fields, suggestive of infection (**Fig. 1**). Numerous spinal arthritic changes were also noticed.

Patient's X-rays

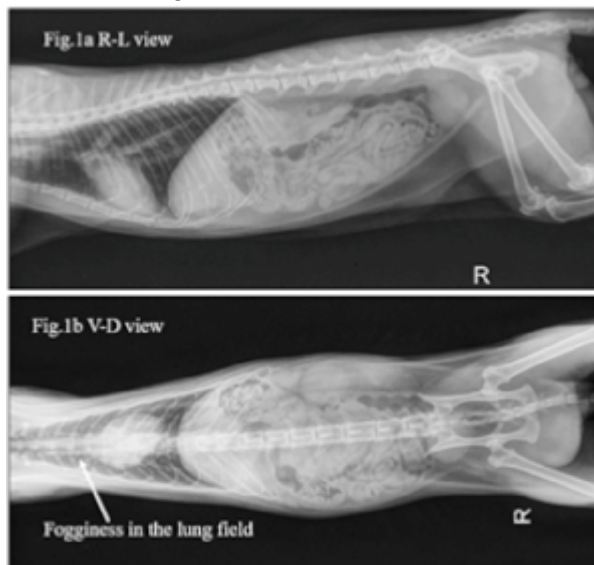


Fig. 1a. R-L view Fogginess in the lung seen in the anterior lung lobes

Fig. 1b. V-D view Lung fogginess better appreciated, spinal arthritis seen

The patient's haemogram (**Table 1**) clearly revealed marked leucocytosis, neutrophilia, lymphocytosis, and monocytosis, The blood chemistry profile (**Table 2**) indicated hyperglobulinemia, suggestive

Patient's Blood work

Table 1. Patient's haemogram on 19.07.2023.

Parameter (Units)	Result	Range	Status
TEC (1x 06/µl)	6.66	6.54-12.2	Normal
Hemoglobin (g/dl)	10.3	9.8-16.2	Normal
Hematocrit (%)	33.7	30.3-52.3	Normal
MCV (fl)	50.6	35.9-53.1	Normal
MCH (g/dl)	15.5	11.8-17.3	Normal
MCHC (%)	30.6	28.1-35.8	Normal
TLC (1x 103/µl)	27.64	2.87-17.0	High
Neutrophil (1x103/µl)	16.94	2.9-17	High
Lymphocyte(1x103/µl)	9.10	0.92-6.88	High
Eosinophil (1x103/µl)	0.59	0.17-1.57	Normal
Monocyte (1x103/µl)	0.96	0.05-0.67	High
Basophil (1x103/µl)	0.05	0.01-0.26	Normal
Platelets (1x 103/µl)	289	151-600	Normal

Table 2. Blood chemistry panel on 19.07.2023.

Parameter (Units)	Result	Range	Status
Glucose (mg/dL)	173	74-159	High
SDMA (µg/dL)	10	0-14	Normal
Creatinine ((mg/dL)	1.3	0.8-2-4	Normal
BUN (mg/dL)	24	16-36	Normal
Phosphorus (mg/dL)	4.0	3.1-7.5	Normal
Calcium (mg/dL)	8.5	7.8-11.3	Normal
Total protein (mg/dL)	8.4	5.7-8.9	Normal
Albumin (g/dl)	2.5	2.3-3.4	Normal
Globulin (g/dl)	5.9	2.8-5.1	High
A/G ratio	0.4		
ALT (U/L)	42	12-130	Normal
ALKP (U/L)	17	14-111	Normal
GGT (U/L)	1	0-4	Normal
TBil (mg/dL)	0.3	0.0-0.9	Normal
Chol (mg/dL)	118	65-225	Normal
Amylase (U/L)	903	500-1500	Normal
Lipase (U/L)	254	100-1400	Normal
Sodium (mmol/L)	164	150-165	Normal
Potassium (mmol/L)	3.2	3.5-5.8	Low
Na/K	51		Normal
Chloride (mmol/L)	130	112-129	High
TT4 (µg/dL)	1.9	0.8-4.7	Normal

Catalyst One: CBC and Chemistry Analyzer, IDEXX, USA

of ongoing infection. Moderate hyperglycemia is the outcome of stress. Electrolyte imbalance is attributable to generalized tissue dehydration.

Reversal of sedation was done with Atipamezole (Antisedan®), 0.07 ml IM.

I. Medical Treatment

On presentation in the clinic on 19.07.2023 the combination medical therapy comprised isosmotic saline solution (100ml) Sub-cut (S/C), Vitamin B12 0.5 ml S/C, Buprenex [0.3mg/ ml] 0.1ml S/C, Polyflex® 0.4ml S/C, and Dexamethasone [2mg/ml] 0.25ml S/C. For the follow-up home care, Clavamox liquid [50mg/ml] 0.7ml PO BID x 10 days, Prednisolone [10mg/ml] 0.3ml SID x7 days, EOD PO x 7 days, and Buprenex [0.3mg/ml] 0.1ml PO BID were dispensed to the owner under detailed advisory. On the scheduled recheck visit on 21.07.2023, the patient appeared to respond well to medications, lifting the tail normally. However, about 10 days later, the vigilant owner noticed dark red angry looking, bleeding wound near the anal orifice. The owner was advised to bring the patient to the clinic. The cat was sedated again with the 'kitty magic' consortium to facilitate close monitoring. The visibly ulcerated right lateral anal sac revealed two openings: the upper big gaping hole and the lower smaller one (Fig. 2).



Fig. 2a. Right anal sac visibly ruptured
Fig. 2b. Close-up

The turgid left sac, carefully emptied by digital compression with the slow release of highly viscous exudate, was sanitized with diluted antiseptic solution (chlorhexidine). The right sac, on compression, released blood-tinged, and straw-coloured pus-like exudates, and was sanitized similarly. Both empty sacs were packed with Animax ointment. Convenia, Buprenex, isosmotic saline solution injected S/C. To prevent licking E-collar was placed on the patient's neck, securely. Sedation was reversed with Antisedan.

II. Surgical Treatment

In three consecutive recheck visits to the clinic (July 28 -August 4, 2023) the sanitized emptied ulcerated

angry looking right anal sac appeared refractory to the natural healing process (Fig. 3).



Fig. 3a & b. Sanitized with diluted betadine solution, note the gaping hole with deep cavity

Therefore, it was decided to close the gaping hole (Fig. 4) with sutures. After debridement of the necrotic mass, dead epidermis flap between the larger upper and smaller lower ulcers was carefully excised to create one large opening with raw fresh margins to facilitate healing. The surgical wound was closed with 2-0 nonabsorbable sutures, leaving the lower margin open for unimpaired drainage.



Fig. 4a. The necrotic tissues debrided, margins freshened and sutured

Fig. 4b. Closeup view. Note the lower margin is left unsutured for drainage

The highly interactive owner was advised to send online photographs of the recovering lesion, every week. The three-weeks post-surgery profile indicated complete recovery, the gaping hole no more visible (Fig. 5). Therefore, the sutures were removed in the clinic, carefully. The crater will be filled-up, mostly with adipose tissue.

Discussion

In the instant case, the visibly ulcerated right lateral anal sac in a middle age group indoor-outdoor cat is certainly the end-result of unrelieved constipation



Fig. 5a. the apposed sutured skin edges fused, day 21 post-surgery

Fig. 5 b. Sutures removed

and pyogenic infection, leading to undetected abscess formation. This contention is supported by the evidence-based highly pertinent published clinical reports (1-4). It is reiterated that anal sac impaction anal engorgement result from unrelieved accumulation of functional epithelial glandular secretions, aggravated by a consortium of voluminous deleterious excretions, leading to sequential inflammation (anal sacculitis) pyogenic infection (anal sac abscess) anal sac duct obstruction.

The paired anal sacs; located between the internal and external anal sphincters, contain small lining epithelial modified sebaceous and apocrine tubular anal glands. These small bioentities synthesize and release a malodorous substance, needed for scent-based tracking, individual recognition, and avoiding predators, a legacy of highly challenging wild life existence. This secretion is temporarily stored in the anal sacs (also named perianal sinuses), which empty instantly when the cat senses danger, or gradually in tandem with the normal bowel movements. However, if the anal sacs are not evacuated periodically, the glandular secretions get desiccated and extremely hard, leading to impaction. The cascading bioepisode may cause increased pain perception during defecation, occasional tenesmus, and abnormal behavior: the patient attempting to lick/ bite the affected region (1). It is recalled that the fractious feline patient necessitated sedation for physical examination, diagnostics and treatment. Close monitoring of the entire anal area revealed covertly ulcerated bleeding right anal sac, and swollen turgid left anal sac. Since the symptomatic medical treatment of the biodegraded (ulcerated) right anal sac proved ineffective, aggressive surgical intervention was planned and executed successfully. The gaping wound healed uneventfully within three weeks. The left anal sac was emptied with careful digital

compression under effective antiseptic cover. The patient recovered completely with visibly improved body condition and behavioral profile, consistent with the earlier published reports (5,6). Proper home care by the watchful interactive owner, in ongoing consultations with the attending pet clinician, regular recheck visits in the clinic, and suitable dietary changes (fiber supplementation with pumpkin) were highly beneficial.

Future Perspectives

1. Laser therapy (6-8 J/ cm²) twice weekly, in combination with digital compression of the affected anal sac, is expected to minimize inflammation and the associated discomfort arising from accrue, or chronic anal sacculitis (7).
2. Novel fiber-rich food supplement is highly beneficial in preempting the anal sac disorders in the pets, and also mitigating the severity of the disorder (8). In United States of America, currently a proprietary food supplement, Glandex® (Vetnique) is in high demand. This formulation incorporates natural anti-inflammatory ingredients, omega-3 fatty acids and digestive enzymes.. There is need to develop and promote such food supplements, globally.

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Delivery of Six Live Fetuses by C-section in a French Bulldog and Assessment of Neonatal Survival by Modified APGAR Scoring System

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Abstract

A four-year-old French bulldog bitch in its second parity delivered six live fetuses by C-section after failure of whelping induction and the survival of all six pups was evaluated by modified Apgar scoring system. All the six pups and bitch remained healthy after 24 hours.

Introduction

The prevalence of caesarean sections (CSs) in some dog breeds such as English bulldogs and French bulldogs approaches 100% (1). Properly timed cesarean section is an appropriate therapeutic modality to be used in small animal reproduction. The use of planned cesarean sections will result in favorable outcomes for the bitch and her litter (2). Small brachycephalic breeds, large breeds due to, for example, uterine inertia and primigravid dogs are at the risk of dystocia and more likely to undergo the surgery (3). In 1952, the physician and anesthesiologist Virginia Apgar developed a simple, reliable scoring system for evaluating the health of babies immediately after birth (4). In humans, the Apgar score encompasses five parameters that are easy to determine without interfering with the care of the infant. This score is particularly useful in assessing the clinical status of newborns. Although the score was originally named after its creator, in 1963 the acronym APGAR was coined as a mnemonic learning aid to easily remember these signs: Appearance, Pulse, Grimace, Activity, and Respiration. Each of these is evaluated on a scale from 0 to 2, with the sum of the five values resulting in an Apgar score that ranges from 0 to 10. The purpose of this case report is to discuss C-section delivery of live fetuses in a French bulldog bitch with an assessment of neonatal survival by modified Apgar scoring system.

Case History and Treatment

A 4-year-old French Bulldog bitch in its second parity was presented to Veterinary Clinical Complex of Post Graduate Institute of Veterinary Education & Research, Jaipur with the history of completion of 60 days post breeding. As per earlier owner's bitter experience of first whelping about two years ago in which all fetuses died within uterus, an emergency C-section was performed which lead to over

consciousness of himself this time. The bitch was in good health and alertness with normal feed intake. On USG examination of the abdomen, multiple heartbeat more than 220 beats per minute with movements of fetuses were observed within the uterus. The amniotic fluid also seemed sufficient as per the movements of fetuses with in the sac. The owner willingly accepted for elective C-section, but looking to the normal physiological parameters, as the rectal temperature was in between 101-102°F without any deviation in alertness of the bitch, waiting for a week was advised to the owner. After a gap of 5 days, the owner again reported to the clinic for examination, and this time, the rectal temperature had gone below normal i.e. 100°F, while all other parameters were normal. This time, it was again advised to the owner to keep a close watch on the animal with monitoring of rectal temperature at an interval of every two hours. On the next day, when rectal temperature had gone below 99°F with vomiting and off feed, the owner reported to the clinic for elective C-section. The USG was performed again and heartbeat of more than 220 beats per minute with good fetal movements was observed within the uterus. On per vaginal examination, cervix was felt open and the fetus was touching on the fingertip, but slight white waxy type discharge was noticed. Keeping this fact, the induction of whelping was attempted with Injection Oxytocin (1 IU) and Injection Calcium Sandoz (05 ml) through intravenous route and advised the owner to wait for half an hour. The bitch showed no uterine contractions and the same therapy was repeated once again. The animal did not show any vaginal discharge and contractions, and normal movements were observed. As there was progression in induction, finally it was decided to shift for the C-section of bitch, as more waiting might lead to the uterine inertia condition (multiple fetuses) in the bitch. Under Atropine sulphate and Isoflurane with Propofol combination the C-section

was performed in right lateral side of abdomen. Uterus was approached to incision line and the fetus was taken out one by one with proper care (Fig 01). The incision line of uterus and abdomen was closed in routine pattern. Six live fetuses were recovered and observations as APGAR scoring system were recorded for all the fetuses (Fig 02).

Assigning a rate from 0-2 to each parameter, the total sum provided a final APGAR score. The scores were used to identify three levels of newborn distress: 7-10, no distress; 4-6, moderate distress; and 0-3, severe distress. The APGAR score was calculated within 5 minutes of birth.

Among the six puppies, APGAR scores of more than 7 were recorded in 2 puppies, whereas, a score between 4-6 was recorded in 4 puppies. These 4 puppies in moderate distress at birth were given supportive therapy by rubbing the thorax, removing the mucus from nostrils and mouth by using Baby Nasal Aspirator and wrapping in warm clothes to avoid cold. This neonatal assistance was found successful in all the 4 puppies, and they survived. All 6 puppies (3 male and 3 female) were alive and viable at 24 hours (Fig 03). Post-operative routine antibiotic (Ceftriaxone @20 mg/Kg body weight), NSAIDS (Meloxicam @40 mg/Kg) and supportive therapy (Antihistaminic Chlorpheniramine maleate @1 mg/ Kg body weight) was administered intramuscularly daily for 7 days. The French bulldog bitch recovered uneventfully within 7 days.

Conclusion

Caring for newborn pups is a challenging task in veterinary medicine, and to provide optimal care to puppies in a pediatric intensive care situation, a veterinarian should be familiar with normal and abnormal vital signs, nursing care and monitoring considerations. The economic value of pure-breed puppies, as well as the increasing emotional attachment of owners in their pets' whelping process, has escalated interest in improving neonates' viability and for survival prognosis.

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The modified APGAR scoring system was used in this study (proposed by Virginia Apgar for babies)

Parameter	Score		
	0	2	3
Heart rate	<180 bpm	<180 bpm	<180 bpm
Respiratory effort	No crying	No crying	No crying
Reflex irritability	Absent	Absent	Absent
Motility	Flaccid	Flaccid	Flaccid
Mucus colour	Cyanotic	Cyanotic	Cyanotic

Cushing's Syndrome and High Risk Comorbidities in a Senescent Neutered Male Lhasa Apso Dog: A Case Report

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Abstract

A 14-years-old neutered male dog was presented in the clinic on August 18, 2023 for health check with all the “P-sounding” symptoms: Polyuria, Polydipsia, Pot-bellied appearance, Polyphagia, and Panting, highly suggestive of hyperadrenocorticism (Cushing's syndrome). Physical examination revealed high grade (3 to 3.5/ 4) dental tartar, and painful joints, suggestive of arthritis. Blood work revealed leukocytosis, presumably related to bilateral eye infection (reddish mucous membranes) and poor oral hygiene. High circulatory titres of the clinical enzymes were highly suggestive of hepatitis, and pancreatitis. Markedly increased urine cortisol concentration pointed to ongoing Cushing's syndrome, corroborated with Low Dose Dexamethasone Stimulation test (LDDST). Abdominal survey radiographs revealed impacted gall bladder and mass in the cranial abdomen, Referral ultrasound probe revealed a plethora of severe comorbidities: hepatic mass, extensive pancreatitis, gall bladder distension, enlarged adrenal glands, urinary bladder cystolithiasis, keratoconjunctivitis sicca (KCS) and hyperbilirubinemia (jaundice). Symptomatic treatment proved ineffective, and prognosis was poor. Therefore, on the owner's formal request the dog was euthanized as per the norms.

Introduction

Clinical condition hyperadrenocorticism (HAC) results from persistent excessive synthesis and release of glucocorticoids in peripheral blood circulation, and for this endocrinopathy the preferred term, recommended by the Project Agreeing to Language Learning in Veterinary Endocrinology [ALIVE] is Cushing's syndrome, in place of Cushing's disease (1). Secondary comorbidities with wide-spectrum clinical symptoms in different body parts/ internal organs in the companion animals: cats and dogs may be encountered by the field veterinarians, globally. Pancreatitis (acute/ chronic) is often detected, concurrently. Reduced pancreatic blood flow and leukocyte exfoliation may promote intestinal bacterial translocation and infection, leading to necrobiosis (2). Peripheral vasoconstriction and leakage of the unprocessed pancreatic digestive enzymes into the abdominal cavity and vascular compartment may cause extensive degradation in the internal organs: liver, pancreas, kidneys, lungs, heart, and abdominal lymphatics (3, 4, 5, 6). Extrahepatic biliary tract obstruction may also occur (7). Multi-dimensional clinical syndrome with poor prognosis in a geriatric, genetically predisposed dog is reported in this communication.

Case Description

August 18, 2023: A 14-years-old neutered male Lhasa Apso dog was presented in the Milford Veterinary clinic for annual physical wellness

Haematobiochemical profile

Table1. Patient's sequential haemogram

Parameter (Units)	2.1.24	8.12.23	19.8.23	Normal Range
TEC (1x10 ⁶ /μl)	8.39	6.32	7.25	5.65-8.87
Hb(g/dl)	17.3	13.8	16.5	13.1-20.5
HCT (%)	51.0	42.5	47.3	37.3-61.7
MCV (fl)	60.8 L	67	65	61.6-73.5
MCH (pg)	20.6 L	21.8	22.8	21.2-25.9
MCHC g/dl)	33.9	32.5	34.9	32.0-37.9
RDW (%)	21.3			13.6-21.7
Reticulocyte (1x10 ³ /μl)	36.1	57	51	10.0-110
Reticulocyte (%)	0.4	0.9	0.7	
TLC (1x10 ³ /μl)	14.92 H	18.2H	16.5	5.05-16.8
Neutrophil (%)	84.6	83.8	81.5	
Lymphocyte %)	6.2	10.0	10.9	
Eosinophil (%)	0.3	1.6	3.5	
Monocyte (%)	8.0	4.5	4.0	
Basophil (%)	0.9	0.1	0.1	
Neutrophil (1x10 ³ /μl)	12.62 H	15.25 H	13.44 H	2.95-11.6
Eosinophil (1x10 ³ /μl)	0.05 L	0.29	0.57	0.06-1.23
Lymphocyte (1x10 ³ /μl)	0.92 L	1.82	1.79	1.05-5.10
Monocyte (1x10 ³ /μl)	1.19 H	0.81	0.66	0.16-1.12
Basophil (1x10 ³ /μl)	0.14 H	0.01	0.01	0.0-1.0
Platelet (1x10 ³ /μl)	598 H	697 H	567 H	148-484

Auto cell counter H=High L=Low

Table 2. Patient's parallel blood chemistry profile

Parameter (Units)	2.1.24	8.12.23	19.8.23	Normal range
Glucose (mg/ dL)	95	97	81	70-143
SDMA (µg/ dL)	16 H	9	8	0-14
Creatinine (mg/ dL)	0.7	0.4	0.4	0.5-1.8
BUN (mg/ dL)	8	10	9	7-27
BUN/ Creatinine ratio	11.0	25.0	22.5	
Calcium (mg/ dL)	10.0	10.4	10.3	7.9-12.0
Phosphate (mg/ dL)	6.2	6.3	6.0	2-5-8.2
Total protein (g/ dL)	7.3	6.0	7.1	5.2-8.2
Albumin (g/ dL)	2.5	2.7	3.4	2.2-3.9
Globulin (g/ dL)	4.8 H	3.3	3.7	2.5-4.6
A/G ratio	0.5	0.8	0.9	
ALT (U/L)	Too H	234 H	145 H	10-125
ALP (U/L)	Too H	466 H	259 H	23-212
GGT (U/L)	309 H	61 H	32 H	0-11
Amylase (U/L)	469 L	476 L	406 L	500-1500
Lipase (U/L)	690	415	284	200-1600
Total bilirubin (mg/ dL)	8.2 H	0.1	0.1	0-0.9
Cholesterol (mg/ dL)	>520 H	500 H	325 H	110-320
Na+ (mmol/ L)	147	150	153	144-160
K+ (mmol/ L)	4.6	5.5	4.8	3.5-5.8
Cl-mmol/ L)	109	103 L	103 L	109-122
Total T4(µg/ dL)	<0.5	1.3	1.0	1.0-4.0

Blood chemistry analyzer

examination and vaccines update. Anamnesis revealed no coughing, sneezing, vomiting or diarrhea. A green discharge from both eyes was noticed. Schirmer tear test showed reduced tear production (5mm in 30 seconds). Fluorescein dye staining test positive indicated bilateral corneal ulcer. All 'P-sounding' symptoms of Cushing's syndrome: Polyuria, Polydipsia, Pot-bellied appearance, Polyphagia and Panting were noticed, Advanced dental tartar (3-3.5/ 4), right front paw and left lateral lumbar area skin tags, reddish tinged ears were noted. Painful joints indicated chronic arthritis in the geriatric patient. For the orthopedic problem, joint supplements, fish oil, pain medicines and Adequan with advisory were prescribed. Rabies, Bordetella, DA2PP with Lepto vaccines were updated Heartworm test negative.

Complete blood count (**Table 1**) revealed neutrophilia, presumably related to eye infection and compromised oral hygiene. The blood chemistry profile (**Table 2**) revealed high serum Na+ concentration, possibly resulting from tissue dehydration. Elevated circulatory titres of alanine aminotransferase (ALT), alkaline phosphatase (ALP) and gamma-glutamyl transferase (GGT) clearly indicated hepatitis. High serum lipase value attested to pancreatitis. Dispensed with advisory

take home medicines: ocular 0.2% cyclosporine for management of chronic keratoconjunctivitis sicca (KCS) and superficial keratitis (CSK), Optimune ¼ inch on each eye b.i.d. X 7 days and arthritis pain relief preparation, meloxicam with food o.d. X 5 days; then as per need. Follow-up on August 19, 2023: Patient doing well: eye inflammation cleared and body movements markedly improved. On December 8, 2023, increased serum ALP and cholesterol values were noticed. Alternative pain medicine, Galliprant was prescribed.

December 14, 2023: In view of the pathoclinical scenario decided to explore the possibility of Cushing's syndrome. Urinary Cortisol/ Creatinine ratio (UCCR): Estimation of urine cortisol levels reflects cortisol secretion over several hours. Since creatinine excretion is relatively constant when renal function is stable, dividing urine cortisol with creatinine concentration negates the effect of urine volume in interpreting urine cortisol concentration. In the unstressed patient's early morning mid stream, free-catch urine sample. IDEXX Diagnostic Lab report **UCCR=292** is highly suggestive of hyperadrenocorticism (Cushing's syndrome). Guidelines: UCCR = or >34 Hyperadrenocorticism highly possible; <34 endocrinopathy is unlikely.

To confirm pituitary-dependent/ adrenal-dependent, Cushing's syndrome:, highly dependable endocrine screening test: Low Dose Dexamethasone Suppression Test (LDDST) was conducted on the patient on December 20, 2023. As per the protocol, Dexamethasone was injected in the patient I/V @ 0.01mg/kg, and Cortisol circulatory concentrations (nmol/L) were estimated at 0 hr. pre-injection, and at 4 hr. and 8 hr. post-injection time intervals. The baseline value (0 hr.), 148 (Reference range 15-110 nmol/L) was high. The 4hr and 8 hr. values were 73 and 290, respectively (Reference range 0-30 nmol/L) also high, corroborating the endocrinopathy.

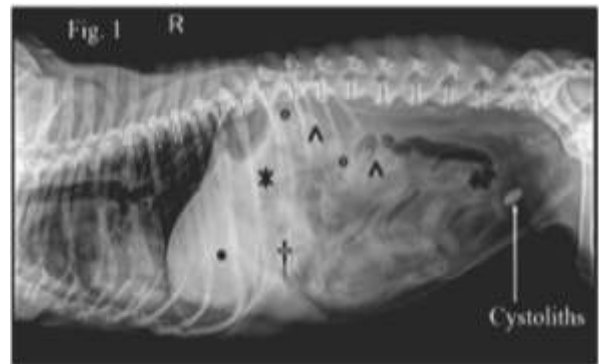


Fig 1 R-L View showing the abdominal mass effect. *enlarged Pancreas, enlarged Liver, °enlarged Adrenals, ^Kidney, †huge Gall bladder. Note the stones (Cystoliths) in the urinary bladder.



Fig. 2 V-D View showing abdominal mass

Endocrinologist's inference

Pituitary-Dependent Hyperadrenocorticism (PDH). Therefore, treatment of Cushing's syndrome was started with trilostane, brand name Vetoryl® @ 2-8mg/kg , i.e. 30mg PO o.d., minimum dose in the recommended range. Polyuria and polydipsia symptoms subsided after day one of the treatment regimen. The patient's arthritic condition did not improve with Adequan, as per the regular feed-backs from the owner. The patient became gradually off-feed and lethargic. The body condition deteriorated. On a recheck visit in the clinic on January 2, 2024, blood work was done (Table 1, Table 2). Abdominal RL and VD survey radiographs

(Fig. 1, Fig. 2) revealed a shadow of impacted gall bladder shadow in the cranial abdomen presented a mass effect. Yellowish mucous membranes indicated jaundice. Patient was sent to the Animal Emergency Center referral for abdominal ultrasonography for further investigations.

I. Abdominal Ultrasound Echoprofile

- (i) Liver/ Gall bladder: Ovoid mass (2.5 cm x 1.23 cm) in the right liver lobe, hyperechoic to the surrounding tissues. Gall bladder conspicuously enlarged with organized hyperechoic material in the lumen. The bile duct appeared dilated.
- (ii) Pancreas: Notably, the left and right lobes are enlarged with the tissues hypoechoic to the surrounding hyperechoic tissues; evidence of nodular lesions (up to 0.9 cm in size) in the parenchyma.
- (iii) Bladder: engorged with urine and a large hyperechoic shadowing stone in the lower portion (Cystoliths), and a hyperechoic irregular structure (0.45cm) protruding from the wall near the trigone.
- (iv) Spleen: Normal in size and shape with smooth homogeneous diffuse parenchyma.
- (v) Kidneys: normal in size and shape. The capsules appear collapsed bilaterally with discrete contrast between the cortex and medulla. The structural patency remains uncompromised
- (vi) Adrenal glands, bilateral enlargement
- (vii) Gastrointestinal tract: Normal in histomorphology, wall thickness and layering, lumen



Fig. 3a Enlarged and nodular Pancreas, 3b. Enlarged liver, 3c. Urinary bladder stone visualized, 3d. Normal Kidney Fig. 3e Enlarged left adrenal, 3f. Enlarged right adrenal, 3g. Distended Gallbladder and mucocoele visualized, 3h. Normal stomach.

patency is intact (Fig. 3a-h).

Discussion

Cushing's syndrome, in the contemporary biomedical parlance, is the umbrella term for a wide range of clinical disorders, caused by persistent excessive glucocorticoid pathobioresponse produced by various steroid hormones, endogenous or exogenous (1). Common clinical signs in dogs include polydipsia, polyuria, polyphagia, panting, abdominal distension, hepatomegaly, alopecia, muscle weakness, and hypertension (1,2). Certain breeds including Jack Russel terrier, Lhasa Apso, Miniature schnauzer, Yorkshire terrier exhibit genetic predisposition. There is no gender predilection. Mature, middle-aged and geriatric dogs are more susceptible.

The primary diagnostic work-up includes haemato-biochemical panel, urinalysis with emphasis on determination of urine cortisol: creatinine ratio (UCCR) in freshly collected midstream free-catch morning sample, from unstressed dog (9,10), abdominal radiography,

endocrinopathy screening tools like Low Dose Dexamethasone Suppression Test (LDDST), and the most dependable: Abdominal Ultrasonography provides validated diagnosis (1).

The primary diagnostic work-up includes haemato-biochemical panel, urinalysis with emphasis on determination of urine cortisol: creatinine ratio (UCCR) in freshly collected midstream free-catch morning sample, from unstressed dog (9,10), abdominal radiography, endocrinopathy screening tools like Low Dose Dexamethasone Suppression Test (LDDST), and the most dependable: Abdominal Ultrasonography provides validated diagnosis (1).

Treatment is not mandatory; well-judged evaluation of the individual case is very important. The ultimate goal is to improve the companion animal's quality of life and foster the bond with the owner (1). In perspective, judicious judgment of the clinical symptoms presented by the patient and diagnostic inputs is crucial in deciding whether to treat, or not to treat with the concurrence of the well-informed owner. This guiding principle was strictly followed in the case under report. To address the primary endocrinopathy, Cushing's syndrome the proven therapeutic medicaments are mitotane, brand name Lysodren® (Bristol Myers Squibb), and now increasingly preferred alternative, a synthetic steroid analogue, trilostane brand name Vetoryl® (Dechra Veterinary Products, KS, USA), which promotes a positive bioresponse through inhibition of 3-β-hydroxysteroid dehydrogenase, the enzyme involved in the biosynthesis of several adrenocortical steroids, including stress-inducing

Cortisol (1,8). The efficacy of Vetoryl is well-established from laboratory investigation and case records (11, 12, 13, 14). In the instant case, the case history, signalment and the diagnostic protocol firmly established pituitary-dependent hyperadrenocorticism (Cushing's syndrome). The consortium of high-risk comorbidities comprised mass in the liver in cranial abdomen, hepatitis, extensive pancreatitis, gall bladder impaction, enlarged adrenal glands, urinary bladder cystolithiasis, keratoconjunctivitis sicca (KCS), and hyperbilirubinemia (jaundice). Advanced age, compromised immunity status, irreversible biodegradation of many internal organs, mainly pancreas with ongoing accumulation of endotoxins, coupled with genetic predisposition are certainly the major contributory factors. Multi-dimensional symptomatic treatment was given to alleviate the suffering and bring comfort to the affected companion dog. However, the patient developed total anorexia during the endocrinopathy remedial therapy. and the prognosis was poor. Therefore, as desired by the owner the animal was put to rest, conforming to the statutory an ethical norms.

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Freshwater Aquaculture in Andhra Pradesh: Holistic Approach Needed

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Introduction

It is an acknowledged fact that freshwater aquaculture has become the mainstay in the economy of the state of Andhra Pradesh in India. The development of the freshwater aquaculture sector from the late 1970s to the early 2020s is notable and phenomenal with Indian Major Carps are, the predominant cultivable species. The production has also seen a spectacular increase from mere 300-500 kgs/ha from traditional culture to more than 5000 kgs/ha from improved extensive culture in Andhra Pradesh. The vast freshwater resources like the serpentine riverine systems of Krishna, Godavari and Penna with several crisscrossing creeks, canals and the largest freshwater lake, Kolleru offered a lot of scope for the aqua farmers to forge ahead with their innovative farming practices. Due to the importance of the Kolleru region as a predominant center for carp culture, it is aptly called as the **“Carp Pocket of India”**. This has resulted in the great opportunity in aquaculture development to improve nutritional and food security to the teeming masses. Many farmers have demonstrated that the productivity levels are as high as 8000-10000 kg/ha/yr. Scientific research coupled with farmers’ innovation has been the contributing factors in the huge development of freshwater fish culture.

With the rapid strides that have been taken place for the past 4 decades, freshwater aquaculture is considered to be a profitable venture in the state of Andhra Pradesh with occasional impediments due to fluctuations in the market price. Of late, this very sector has also witnessed a shift from fish culture to shrimp culture in view of the ever-lurking greediness towards the rich dividends from shrimp culture. This has become a double-edged sword with many benefits and losses. People started converting the fishponds into prawn ponds and gradual shift towards prawn culture has been seen. Very few farmers are now doing exclusive fish culture. The once polyculture activity of fish is now paving way for polyculture of fish and prawn. This transformation is now putting the farmers in a state of confusion and dilemma whether to stay in fish farming or resort to shrimp farming. Several farmers are stocking both prawns and fish in polyculture system.

A look into nitty-gritty of this freshwater aquaculture since inception in mid-1970s to date will reveal how the transformation in various activities has been taken place.

Supreme Support

The rapid infrastructure development in the rural areas in the state can often be attributed to the large-scale expansion of coastal aquaculture practices. More important is the contribution of the aquaculture sector towards employment generation. Aquaculture has shown immense opportunities to many unemployed youths to eke out their livelihoods. Further aquaculture offered excellent economic growth opportunities and entrepreneur development with ample investments. With the dwindling agriculture production, people started investing in aquaculture that has generated more income, reduced poverty and thereby improved human health as well. Alongside, several ancillary industries have been established to support aqua farmers in a big way.

All the activities of Inland Fish Culture viz., Seed Production, Seed Rearing, Fish Farming, Harvesting, Packing and Transport have been well developed in the state. With the potential and prospects of freshwater fish culture, unproductive and low productive agricultural fields are slowly converted to aquaculture farms and new farms as well were constructed by big entrepreneurs in the coastal districts. Now, aquaculture has become the major activity and prime source of livelihood. As many improved fish culture technologies are available in the Kolleru region, a host of scientists, researchers, officials and enthusiastic aqua farmers have initiated and ignited the interest in carp culture boom in the Kolleru region. As a result, the Kolleru region has become the “Nucleus” of Fish Culture Activity in Andhra Pradesh.

Fish Seed Industry

Fish seed farms are regarded as the building blocks for the development of fisheries in Inland Fisheries

Sector. As the fish seed is being one of the major inputs and a pre-requisite for fish farming, there is always a great demand for quality fish seed. The seed produced at the fish seed farms (Hatcheries)

is used for rearing in grow-out ponds and also for replenishing the rivers or reservoirs. Keeping in view of the rich and variegated nature of water resources, the Government of Andhra Pradesh through the Department of Fisheries has set up fish seed farms. Several fish seed hatcheries have been well established in private sector also. The mandate of these farms was to produce the seed of Indian Major Carps for encouraging fish culture in the state. Kolleru region of Krishna district has been the hub of fish seed trade in Andhra Pradesh. The major breakthrough in fish seed production can be attributed to the induced breeding technique which has revolutionized the entire freshwater fisheries sector. The nurseries and rearing ponds are present covering an approximate area of 3000 acres in the state. This advantage has given this region a monopoly over the supply of seed not only within the state but also to other states. Fish seed is being exported to neighbouring States like Tamilnadu, Maharashtra, Karnataka, Chhattisgarh etc. As part of biosecurity, fish seed as well as stunted fish are protected from bird predation by nylon string mesh in the rearing ponds.

In Andhra Pradesh, as a farmer's innovation, fingerlings are stunted for a year and sold as yearlings more than 100 gms to 250 gms fish are sold as "Zero Point". This novel technique has a cosmic effect in freshwater fish culture since it has reduced not only the crop period and diseases but also enhanced the yield and income of the farmers. This Zero Point culture has triggered the rapid growth in fish farming.

Diseases - Health Care

The poor water quality, high stocking density, eutrophication and harmful algal blooms in the pond have a drastic effect on the health of fish in the ponds. As a result, diseases like protozoan infections, Gill flukes, red disease, Columnaris, Fish Lice and Epizootic Ulcerative Syndrome (EUS) are the major impediments for successful harvest. Sudden depletion of Dissolved Oxygen in fishponds due to climatic fluctuations is also resulting in huge crop losses. Some of these diseases are of seasonal occurrence in the initial years, are now occurring throughout the year. Farmers are habituated to use a lot of chemicals, drugs, disinfectants, pesticides and probiotics to control/prevent fish diseases. In addition, aqua farmers periodically use commercial vitamin and mineral supplements as feed supplements to enhance the immunity of cultivable organisms. A fish disease surveillance programme is also being implemented in the state. Several disease diagnostic labs are in operation in both public and private sector.

Good Management Practices

Fish Farmers in Andhra Pradesh are adopting good management practices in small sized ponds through proper pond preparation viz., drying, liming, manuring, water filtration and low stocking density @ 2,000-2,500 per acre and water quality management, stocking of quality fish seed of 50-100 gm size and usage of pelletised feed (Sinking pellets and floating Pellets and farm made feeds) for achieving higher production of fish. However, in larger fishponds (over 5 Ha), where farmers do not have assured supply of water, they could not go for pond drying and preparation and are stocking in the same pond after harvesting with the usage of disinfectants and probiotics.

As a general practice, traditional feeding in the form of dough in gunny bags with holes hung at different places in the pond. Feeding preferably once a day is advocated. FCR in case of mash feed is around 3:1 whereas for pelletised feeds, it is less (about 1:1.5). Fish farmers are aware that good water quality will produce good and healthier fish. As a measure of good management practice, they maintain a pond depth of 2-3 mts and get the water quality checked regularly in the aqua labs.

Marketing

For freshwater fish culture in Andhra Pradesh, the biggest market is the Howrah Wholesale Fish Market, West Bengal though other fish markets in the country are also being supplied with the fish from Andhra Pradesh state. The fish are also sent to other states including Bihar, Orissa and North-Eastern states and to the Delhi market. As there is a great scope for improvement in domestic fish marketing in India, the present marketing system in this region is to be studied in detail for evolving strategies for development of efficient fish marketing system in future. Now Government has focused serious attention on domestic marketing of aqua produce.

Ancillary Industries

Close on the heels of fish culture development in the state, a host of subsidiary activities such as hatcheries, seed tanks, seed transport, feed mills, disease diagnostic laboratories, aqua medicinal shops, fish harvesting drag nets, ice plants, procurement centres, fish transport vehicles, processing plants have been set up and providing a lot of gainful employment to the rural youth in eking out their livelihoods. Several feed mills were established in the state and large-scale production of different grades of floating and sinking feeds that will suit to the various culture practices. Seed Packing polythene bags, sintex tanks, plastic crates, oxygen cylinders, thermocol boxes, Galvanized Iron/ fibre feed boats, tarpaulin sheets,

bird fencing nets have made their entry emphatically supporting the fish farmers and thereby getting their returns from the sector. The whole gamut of the freshwater fish culture scenario is boosted up with these ancillary activities.

Diversification

Concomitant with the increased cropping of Indian Major Carps (Catla, Rohu and Mrigal), other species of fish viz., Exotic Carps (Silver Carp, Grass Carp, Common Carp), Catfishes (Magur, Singhi, Pangasius), Murrels (Channa sps) and Freshwater Prawns (Scampi) have also been brought into the culture practices in inland water bodies in the state to enhance the yields and profits to the farmers. Among all these, Pangasius culture has been taken up extensively by the farmers in the state. Though some scientific institutions have successfully bred Magur, the culture of this species has not been picked up as expected. The culture of giant freshwater prawn, *Macrobrachium rosenbergii*, which is the fastest growing species has been taken up as part of diversification of freshwater aquaculture and also as an alternative to Tiger Shrimp. In early 2000s, scampi culture has become a dominant activity till vannamei has replaced it. But repeated viral diseases brought a halt to this scampi culture activity. GIFT Tilapia (*Oreochromis niloticus*) that has proved to have good market in other countries has also been introduced in our country, but culture is on a lower scale in the state of Andhra Pradesh. Government has made pilot studies of Tilapia in cages which proved a futility. Pacu, popularly called as Roopchand (*Piaractus brachipomus*) is also having good market potential though it was not officially been given permission by Government for culture in India.

Research and Development

Genetic improvement of some of the freshwater species has been initiated with "Jayanti Rohu" and GI Scampi as well as Amur Carp. Though Jayanthi Rohu culture has been tried with varying success, the performance of these genetically improved stocks is not up to the full expectations of the farming community for adoption. Once this issue is redressed by the R&D wing of the government, an increase in culture of these GI species will pick up. Taking feedback from farmers and continuing further research will yield fruitful results. For this, a "Bottom Up" approach in R&D is required to help the farmers in a better way. Research Institutes should zero in on these aspects.

Regulations

With increasing aquaculture activity in Andhra Pradesh, there is a growing concern over the impact of aquaculture on environment since in some areas there is conversion of agriculture lands into

aquaculture. Cognizant of these facts, the Government of Andhra Pradesh has taken the initiative of registrations and regularizing the existing freshwater aquaculture tanks and permitting for setting up of new aquaculture units in freshwater lands by formulating comprehensive guidelines and by constituting different committee in the State.

Now an apex regulatory authority has been constituted "Andhra Pradesh State Aquaculture Development Authority, 2020" [APSADA] with wide array of functions viz., regulatory, promotional and development of aquaculture activities in the state. Against this backdrop, there is no denying fact that freshwater aquaculture in Andhra Pradesh has been an appealing and profitable choice and many aqua farmers have taken up this activity with gusto in areas that were hitherto unproductive or low productive and achieved fruitful results that enhanced their livelihoods. The increasing expansion of aquaculture in coastal districts in recent years has put forth certain issues of concern for sustainable development of fish culture in future. An incisive analysis on the recent trends in fish culture needs to be made in view of the present prawn culture dominance in inland areas. The state of Andhra Pradesh in general and the Kolleru region in particular is undoubtedly the 'El Dorado' for freshwater aquaculture in India. Freshwater fish culture sector has been slowly paved way polyculture of fish and prawn. This activity perhaps masked the glory of exclusive fish culture operations that was once dragged the attention of the whole world. No doubt prawn culture in inland areas brought about a metamorphosis in the ways of life and in the styles of life of the farmers who ventured into this arena. A quick look into this aspect may reveal some interesting features that are to be tackled by the authorities.

Ground Truth

- There is a gradual paradigm shift from polyculture of fish to polyculture of fish and prawn. Exclusive fish farmers are now almost negligible. Only first-generation aqua farmers were more interested in fish culture. Some farmers have converted fishponds into shrimp ponds for better yields and profits. Recent entrants are either interested in shrimp farming or resorting to polyculture of fish and prawns based on circumstances. Most of the farmers are forced to convert their ponds into polyculture of fish and prawn in view of the better returns in terms of money as the market price of fish is not economically feasible. Moreover, two crops of prawn can be taken up as against one crop of fish. This is giving the farmers a chance to take risk in aquafarming.

- As management of large ponds is an uphill task for shrimp culture, many large fishponds particularly in the vicinity of Kolleru region (>10 Ha) are downsized to suit to the shrimp culture.
- With a view to obtain successful crops in polyculture of prawn and fish, low saline waters are being tapped from bore wells. This is being done with the hope of lowering the disease outbreak as drain waters are pathogen-loaded and eutrophicated.
- Other inland states of the country viz., Punjab, Bihar, Telangana have picked up fish culture along with other top fish production states like West Bengal, Karnataka, Kerala, Orissa and Tamilnadu are making significant contribution in the national fish production. This might have been the problem as the supply exceeds the demand for fish from Andhra Pradesh. It again has a telling effect on the instability of price for fish produced from the state.
- Land lease has been escalated in the coastal districts to take up only fish culture along with prawn. So people started venturing into upland areas not only due to lower rates of lease but also due to low disease occurrence.

Way Forward

No doubt the BLUE REVOLUTION has its eminence because of the greater contribution of freshwater aquaculture in the initial years contributing to the economy and nutritional security of the nation. The newly formed APSADA should start focusing on issues of farmers in freshwater region also as many fish farmers are of the opinion that scant attention has been shown on freshwater fish culture when compared with shrimp culture. The issues of the fish culture farmers are to be addressed and redressed to erase their misapprehensions.

Time is ripe to conduct frequent meetings – with stake holders, with scientists and technicians, scientist-farmer interactions so as to evolve strategies for sustainable fish production in the state of Andhra Pradesh. People connected with aquaculture should have a thorough, deep thinking towards fish culture sector, which is once a highly prioritized sector and is somewhat sidelined by the commercial predominance of shrimp culture sector. As fish is an important choice of protein food to meet the demands of a growing population, proper governance, awareness-raising, participatory decision-making processes and best aquaculture practices in fish culture needs to be promoted. Policies and schemes offered by the Government should be properly implemented. Insurance coverage and institutional finances should be initiated for easing of doing business. All

stakeholders and multinational

companies should extend cooperation for rational use of water and land resources in an environment-friendly way for the sustainable development of freshwater fish culture sector in the state of Andhra Pradesh. There is also needed to promote and to diversify the fish species or long-term sustainability with novel farmer-friendly technologies. New technologies developed should be properly adopted by the farmers. A holistic approach is the need of the hour.

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3. Information and content

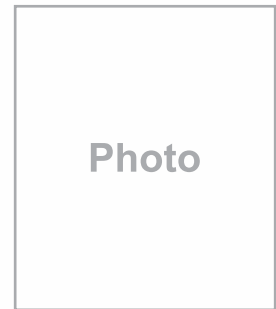
1	2	3	4	5
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4. Language and vocabulary

1	2	3	4	5
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5. Quality of photographs

1	2	3	4	5
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- **Appearance:** Color combination, design and layout
- **Article:** Reputation of the author, relevance of the topic of the column and value addition to you.
- **Information and content:** Order of articles, quality of articles and relevance of the information
- **Language and vocabulary:** Spelling, grammatical correctness and appropriateness of vocabulary
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Suggestions, if any:

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(Cypermethrin - the Acaricide in Powder Form and Liquid form)

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(Amoxicillin Sodium + Sulbactam Sodium Inj)

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(Chelated Minerals & Coated Vitamins)

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(Herbal Uterine Syrup)

TIKKIL RAZ
(Amitraz)

ZUSPRAY
(A Herbal Spray for Open wounds)

ELP
(Toldimfos sodium)

GLUFLU
(Flunixin Meglumine Inj)

MORBAXIN
(Morbfolaxacin Inj)

TIKKIL POWER
(Flumethrin Pour-On Ectoparasiticide)

GYROFLOX
(Enrofloxacin - Oral, inj.)

GYROFLOX BH DS
(Combi. of Enrofloxacin and Bromhexine hydrochloride)

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PROZOFF
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(Bcomplex Inj with liver extract and Choline Chloride)

Calgonate Inj
(Calcium Borogluconate Inj)

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(Cypermethrin with conditioner shampoo)

FOLYSON Inj
(Human Chorionic Gonadotrophin Inj)

IVECTIN-T
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MIPHOCAL
(Calcium Magnesium Borogluconate Inj)

VETALBEN R
(Albendazole and Rafoxanide Suspension)

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RAKSHA OVAC ULTRA
(NSP Free Foot and Mouth Disease Vaccine)

RAKSHA TRIOVAC
(FMD, HS & BQ Combined Vaccine)

RAKSHA BIOVAC
(FMD & HS Combined Vaccine)

RAKSHA HS
(Adjuvanted Vaccine of Pasteurella Multocida)

RAKSHA HS BQ
(Combined Vaccine for HS & BQ)

RAKSHAVAC T
(Theileriosis Vaccine)

BRUVAX PLUS
(Brucellosis Vaccine S19)

RAKSHARAB
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STARVAC 7
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MEGAVAC 6
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(Brucellosis Vaccine RB 51)

RAKSHA ET+TT
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RAKSHA
(Gel vaccine against FMD)

CYSVAX
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RAKSHA Class
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(Area specific mineral mixture)

GouMix TM Chelated
(Chelated trace minerals)

Gousac
(Rumen specific probiotic live yeast culture)

Gousac Power
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