

VETERINARY TOXICOLOGY

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Summary

Veterinary toxicology is a specialization in veterinary medicine focused on physical agents as the cause of disease. Animal feed safety, food safety and environmental safety are important aspects of veterinary toxicology. Residues of chemicals can contaminate food-producing animals and contaminants in feedstuffs can carry over into animal products used as human foodstuffs. Animals are monitors of environmental safety and food safety. The use of analytical toxicology and biomarkers can identify adverse effects of pollutants and contaminants in animals. Mycotoxins can contaminate feedstuffs and have adverse effects in animals. Poisonous plants are a cause of illness in

domestic animals. Animals can be poisoned by venomous insects and snakes. Toads have glands that secrete poisons from skin glands. Domestic animals can be non-target species and forensically poisoned by pesticides. Toxicological research on drugs, agricultural chemicals, cosmetics and household and commercial products document hazards of these products to animal and human health. Toxic substances can be used in terror attacks and domestic and wild animals. Veterinary toxicologists provide timely and accurate diagnosis of animal intoxications, recommend treatments and provide advice regarding residues avoidance for harmful substances in human foods.

1. Introduction

1.1. Veterinary Toxicologist Specialist

Veterinary toxicology is a specialty area in veterinary medicine. A veterinary toxicologist is a specialist in chemical and physical agents causing (etiology) disease. The professional status of the individual diagnosing disease entities, prescribing treatment and drugs, and conducting surgery and dental procedures on animals is regulated by governments under legislated veterinary practice acts or statutes. To be a veterinary toxicology specialist, the individual must first have a veterinary medical degree and must be licensed to practice within the province/state or country. Second, the veterinarian must be qualified by the American Board of Veterinary Toxicology (ABVT) or the European College of Veterinary Pharmacology and Toxicology.

1. 2. Role of Veterinary Toxicology

Veterinary toxicologists have a key role in animal health, animal feed safety, the safety of human foods, and in environmental toxicology. They diagnose animal intoxication and provide recommendations to prevent illegal residues of substances from entering the human food chain. Veterinary toxicologists recommend treatments and antidotes for animals that have been poisoned, and treat poisoned animals. Veterinary toxicologists teach in colleges of veterinary and human medicine, and schools of public health, and conduct research. This research is generally focused on causes of animal intoxication, mechanisms of actions of toxic substances, likelihood for residues of harmful chemicals in edible animal tissues, antidotes for poisoning, and other aspects of toxicology pertaining to animal and human health. Veterinary toxicologists investigate animal poisoning incidents. They study sentinel animals as early warning of harmful chemicals and physical agents in the environment. Veterinary toxicologists are employed in industry to evaluate the safety of agricultural chemicals, consumer products, surgical implants and medical devices, and medicaments. Veterinary toxicologists are employed by governmental agencies in both regulatory and proactive roles to ensure animal health, and feed and food safety.

2. Causes of Animal Diseases

A disease by definition is a condition that impairs the performance of a vital function in the living animal, or impairs its structures. Chemical and physical agents are causes of disease in animals. Diseases caused by these agents are referred to as toxicoses or poisonings. Disease conditions caused by physical and chemical agents include birth

defects (teratogenic effects), genetic damage and cancer (neoplasia). Nutritional deficiencies and imbalances can cause disease. Animal diseases are also caused by infectious organisms such as bacteria, mycoplasma, viruses, fungi, parasites, etc. All causes of disease in animals can interact and present diagnostic challenges to the veterinary toxicologist. Some diseases can have multiple causes. For example, a chemical or groups of chemicals that suppresses the immune system (immunotoxic) may increase the occurrences of infectious diseases. Trace nutrients such as copper and molybdenum can interact to cause toxicity and deficiency. Copper toxicity, for example, can be due to insufficient molybdenum in the diet.

3. Diagnosis of Animal Poisonings

3.1. Disease Diagnosis

When a disease occurs the primary concern is to obtain an accurate diagnosis. A diagnosis is used to distinguish one disease from another by describing the characteristics of the disease, and determining the cause (etiology) or most likely cause of the disease. Clinical and laboratory methods are used in determining a disease is caused by a chemical or physical agent. A veterinary toxicologist works with the referring veterinarian, the animal owner and veterinary specialists in pathology, microbiology and nutrition, and feed microscopists and chemists focused in analytical toxicologist (detection of poisons by laboratory methods). The diagnostic information is used to determine the most likely cause of disease. Some diseases can have multiple causes and the pattern of disease is important. A change in feed source, delivery of feedstuffs and switching bins, etc can provide clues regarding the time a toxic substance was introduced into the diet. Determining the epidemiology of animal disease syndrome can identify large-scale contamination of animal feedstuffs with toxic substances. These incidences are of public health importance. A recent example is the polychlorinated biphenyl (PCBs) – polychlorinated dibenzodioxins (PCDDs) incident in Belgium wherein a leaking heat exchanger contaminated recycled fats used as ingredients in feedstuffs fed food-producing animals. Identification of chick edema and linking the cause with PCBs and PCDDs in chicken feed subsequently identified market-place animal-source foodstuffs contaminated with PCBs and PCDDs.

4. Animal Sentinels of Environmental Safety

Animals can be used as sentinels of environmental safety. For example, small rodents and birds collected from contaminated sites can be studied for adverse effects of environmental contaminants. Tissues can be assayed for the xenobiotics. Tissues and body fluids can also be examined for adverse effects by pathological and biochemical methods to identify biomarkers. Use of animal sentinels shows that the pollutants in the environment are being translocated from the environment to the animal and the biomarkers are indicators of biological effect. Biomarkers and analytical toxicology can be used to monitor wild and domestic species of animals to show the effects of pollution. Applications include environmental contaminants such as PCBs and PCDDs in the food web, contaminated soil such as old industrial sites contaminated with heavy metals, and hazardous waste sites. Cattle can be used as biomonitors of environmental safety. Cattle, for example, have been used as sentinels for environmental asbestos fibers. Cattle generally live their entire lives in one area and predominately consume

locally grown feedstuffs. Foraging cattle are also exposed to natural and anthropogenic substances deposited on plants and grazing animals consume soil. Wild mammals and fish can be used to monitor the environment for effects of contaminants on endocrine functions, population dynamics and genetic up-regulation of enzyme activities. Sentinel animals can be used to monitor the impact of pesticides in non-target species. Waste products from processing foodstuffs are fed to domestic animals. Herein food-producing animals are sentinels for contaminants in the waste stream from processing foodstuffs. The PCDD incidents in Europe showed that detection of intoxication-linked disease in animals was the first alarm bell that humans were consuming these substances in their animal-source foods.

5. Animal Feed Safety

5.1. Animal Feedstuffs and Health

Feed safety ensures that animal feedstuffs do not cause disease and residues of harmful chemicals in animals. Feed safety and human food safety are linked and exemplify the convergence on the “one medicine – one health” concept. Chemical contamination of feedstuffs introduces harmful chemicals into the food web. Feedstuffs can be contaminated with harmful chemicals during growing, harvest, transportation and storages, and manufacturing operations. Feedstuffs can be contaminated during growth due to contaminated soil, wet and dry deposition of atmospheric pollutants, and plant disease. Off-label use of agricultural chemicals can result in residues of these substances in feedstuffs. Animal feedstuffs can be contaminated with harmful chemicals during harvest, for example by equipment leaking fluids, debris blown into crops, and multiple uses of transport equipment. Contamination of feedstuffs and feed ingredients during transportation generally is due to “dirty” transportation vessels and fungal growth. Contamination during storage can occur due to failure to clean the storage unit, contamination with chemicals used to control pests and fungal invasion. Manufacturing contamination of feedstuffs can occur due to the use of residual materials such as screenings, failure to read labels and miscalculations of feed ingredients. Manufactured medicated feedstuffs generally are species specific. For example, cattle feeds containing monensin can be toxic to horses and other animal species. Off label use of medicated feeds may result in illegal residues in edible animal products.

5.2. Contamination of Animal Feedstuffs

Domestic animals are also sentinels for contaminants in the human food chain. Large outbreaks of chemical contamination of animal-source foodstuffs have occurred. Chemical induced animal and human illness at the local level can have significant impact on the health system and government agencies. Removing the contaminated feedstuffs, animals and foodstuffs from commerce can have a distinct economic impact. Of particular concern is the contamination of animal feedstuffs with persistent organic compounds [POCs, also known as persistent organic pollutants, (POPs)]. The POCs are bioconcentrated by domestic and wild animals. In bioconcentration, the levels in animal tissues exceed dietary levels. In addition to the impacts on animal health, bioconcentrated POCs are health risk in persons that have consumed the animal-source foodstuffs, and can have long-term impacts on human health. These incidents have

occurred in several countries. Trace-back findings include fire retardant (PBBs) being incorporated into animal feedstuffs during manufacturing, leaking heat exchangers in a fat recycling facility (PCBs and PCDDs), ball clay contaminated with PCDDs being incorporated into animal feedstuffs, and potato by-products contaminated with PCDDs. Animals, especially small companion animals, are predominately fed feedstuffs manufactured by commercial companies under generic and proprietary brands. Recent evidence has shown that widespread pet food-linked intoxication incidents occur in the pet food industry. These are: dog food was found to contain aflatoxins and resulted in liver disease, and vegetable protein and possibly milk protein were adulterated with melamine – cyanuric acid and resulted in kidney disease.

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Biographical Sketch

Dr. Coppock graduated from Andrews University with a BS degree in Chemistry and Agriculture. He obtained his Doctor of Veterinary Medicine Degree (DVM) from Michigan State University, a MS in Animal Pathology from Oklahoma State University and a PhD degree in Toxicology from the University of Illinois. He is a Diplomate of the American Board of Veterinary Toxicology and the American Board of Toxicology. He has a private practice specializing in veterinary toxicology, and is the CEO of Robert W. Coppock, DVM, Toxicologists and Assoc Ltd. He is an adjunct professor in the Faculty of Medicine and School of Public Health at the University of Alberta, and adjunct professor of Environmental Health at Concordia University College. Dr. Coppock has over 200 scientific publications.