UDC.619:576.88

THE USE OF GEOGRAPHIC INFORMATION SYSTEMS (GIS) IN VETERINARY MEDICINE

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ABSTRACT

This article is devoted to an overview of the possibilities and potential use of the Geographic Information System (GIS) in the field of veterinary surveillance and monitoring of natural focal zooanthroponotic cestodosis.

Keywords: monitoring, anthropozoohelminthiasis, geographic information system, GIS, epizootology, geospatial processing, cestodoses.

АННОТАЦИЯ

Настоящая статья посвящена обзору возможностей и потенциального использования Географической информационной системы (ГИС) в сфере ветеринарного наблюдения и мониторинга природноочаговых зооантропонозных цестодозов.

INTRODUCTION

From year to year, the populations of farm animals in all regions of Uzbekistan show a high level of parasitic infestations, despite planned preventive measures. This significantly reduces the quality of livestock products and economic sectors. Among these parasitic diseases, anthropozoohelminthiasis is of great importance for veterinary medicine and medicine, and at different stages of the life cycle it affects both animals and humans. The relevance of these diseases is evidenced by the fact that echinococcosis, which belongs to helminthozoonoses, is included in the OIE List of Diseases, which currently includes 119 of the most dangerous and economically significant animal diseases [1]. One of the tasks in the field of control and prevention of parasitic diseases is the choice of an effective strategy, and it is necessary to have complete information about various aspects of the problem of improving the effectiveness of the epizootic surveillance system based on the widespread use of modern information and telecommunication technologies [2, 4].

Characteristics of the pathogen that causes echinococcosis.

According to the modern classification, echinococci belong to the supertype of lower worms (Scolecida), the type of flatworms (Plathelminthes), and the class of tapeworms (Cestodes). – Cestoda, order – Cyclophyllidea, suborder – Taeniata, family – Taeniidae, genus – Echinococcus, including several species – Echinococcus canadensis, Echinococcus equinus, Echinococcus felidis, Echinococcus granulosus, Echinococcus multilocularis, Echinococcus oligarthrus, Echinococcus ortleppi, Echinococcus shiquicus, Echinococcus vogeli Echinococcus Echinococcus granulosus in the taxonomy of eukaryotes According to the taxonomy of the National Center for Biotechnology Information of the United States National Center for Biotechnology Information (NCBI), the species Echinococcus granulosus belongs to the group of species Echinococcus granulosus, the genus Echinococcus (Latin Echinococcus), which is part of the family of Tapeworms (Latin Taeniidae), the order Cyclophyllida (Latin CyLophotrochozoa, a group without rank Spiralia, a group without rank Protostomia, a group without rank Bilaterally symmetrical (Latin Bilateria), a sub-kingdom of Eumetazoi, or true multicellular (Latin Eumetazoa), the kingdom of multicellular animals (Latin Metazoa), <a group without rank Posterior gutician (Lat. Opisthokonta), a super-kingdom of Eukaryotes (Latin Eukaryota). NCBI identifies the subspecies Echinococcus granulosus in the Echinococcus granulosus species. Previously, echinococcus was classified as Taenia echinococcus.

The causative agent of echinococcosis in humans and animals is the larval stage of Echinococcus granulosus. After larvocysts (the larval, vesicular stage of echinococcus) enter the bodies of carnivorous animals—the final hosts of the parasite—echinococcus develops to the sexually mature stage slowly, in 70–100 days. The final hosts of E. granulosus are representatives of the canid family: dog, jackal, wolf, dingo, fox, coyote, hyena, etc., in whose intestines mature echinococci are parasitized. 3.4–6.2 mm long, 0.47–0.98 mm wide, consisting of a head (scolex) having 4 suckers and a double crown of hooks (38–40 hooks), necks, and 3–4 segments. The latter, a mature segment, has a uterus containing 400–800 eggs of a rounded or oval shape with a diameter of 0.030–0.036 mm. Inside the egg is an oncosphere with a thick shell and a six-pointed embryo. Mature segments leave with excrement; some of them crawl out actively. The segments that have departed with excrement are mobile and can spread out within a radius of 20–30 cm, seeding the environment with oncospheres. Intermediate hosts are various ungulates and humans. In humans and animals (most often sheep), the larval stage of Echinococcus develops. When parasite eggs enter the gastrointestinal tract, their outer shell dissolves under the action of digestive juice. The released oncosphere, with the help of hooks, penetrates into the mucous membrane of the stomach or intestine, from where it is transferred to the portal system with the flow of venous blood or lymph and lingers in the liver. About 70% of the embryos settle in the liver; the rest pass through the liver and enter the small circle of blood circulation. About 20% of embryos are retained in the lungs, and the rest fall into the large circulatory circle and are introduced into other organs (muscles, spleen, kidneys, spongy bones, etc.). The oncosphere settled in the tissues for 5 months and turned into a larva (larvocyst, echinococcal cyst) with a diameter of 5–20 mm and two shells. The outer cuticle shell is opalescent and milky-white in color and consists of many concentric, layered hyaline plates, which are well determined under a microscope and serve as a diagnostic sign of an echinococcal cyst. The inner shell—germinative—has a cellular structure. Its main function is to produce scolexes. The number of scolexes in one bubble can range from several dozen to several hundred. They float in the liquid and form the so-called hydatid sand. Sometimes "daughter" bubbles are found in the echinococcal bladder, and "grandchild" bubbles are found inside them, having the same structure as the main bubble. A dense fibrous capsule is formed around the echinococcal bladder as a result of the reaction of the host tissues. The source of the invasion is infected animals: carnivorous animals in nature (wolves, jackals, etc.), dogs in synanthropic foci. Mature segments of E. granulosus, filled with eggs, break away from the body of the parasite and, during defecation, or crawl out of the anus independently, getting on the animal's fur and polluting grass or water sources. Herbivorous animals, including agricultural ones (cows, goats, and pigs), become infected with echinococcosis by eating grass contaminated with the feces of carnivorous animals, which, in turn, by eating meat and entrails (especially liver and lungs) of ungulates containing larvocysts, become infected with echinococcosis with the development of its ribbon stage, completing the biological process and the cycle of development of the parasite The community of habitat and alimentary connections according to the predator-prey scheme with a constant change of hosts in the community of wild ungulates and carnivores determine the existence of natural foci of echinococcosis. The main functions of epizootological supervision of echinococcosis are identification, registration, certification, and constant monitoring of the sanitary and veterinary conditions and manifestations of epizootic activity in permanently disadvantaged persons (SNP). Information about the problem of echinococcosis, first of all, makes it possible to build a differentiated system of anti-echinococcosis measures, the complex of which should differ for territories with different degrees of concentration of disadvantaged points and manifestations of their activity. The amount of information available today requires appropriate processing, which is impossible without the use of special research and registration methods. Geographical Information

Systems (GIS) are one such method for epizootiological surveillance of echinococcosis. GIS is a system for collecting, storing, analyzing, and graphically visualizing spatial (geographical) data and related information about the necessary objects. GIS is also considered a tool that allows users to search, analyze, and edit digital maps, as well as obtain additional information about objects. The use of GIS technologies allows for a comprehensive analysis of infectious or parasitic diseases, especially when studying factors affecting the development of the epizootological process in a particular region [3].

Principles of creation and construction of geographical information systems GIS appeared thanks to satellite image acquisition technologies originally developed for the purposes of the military-industrial complex in the 1960s of the XX century, which later began to be used in other fields of knowledge [14]. In the 80s and 90s, after the advent and mass use of personal computers, GIS methods gradually became widely used by specialists in various industries in everyday practice [6, 7]. GIS combines traditional database operations, such as querying and statistical analysis (retrospective and prospective), with the advantages of full-fledged visualization and geographical (spatial) analysis provided by the map. The creation of maps and medico-geographical analysis is not something completely new; however, GIS technology provides a more efficient, convenient, and operational approach to analyzing problems and solving tasks facing a specific organization or group of people united by a target program [8, 9, 13]. A functioning GIS consists of five interrelated components: hardware, software, source data, performers, and methods. Hardware includes a computer and/or computers connected to each other by a network, on which the possibility of operational use of GIS is created. GIS software contains functions and tools necessary for storing, analyzing, and visualizing geographical (spatial) information [15, 17, 18]. The key components of the software products are:tools for entering and operational use of geographic information; tools to support spatial queries, analysis, and visualization (mapping); - A graphic user interface (GUI) for direct access to tools and functions The main component of GIS is spatial data (geographical data) and related tabular materials that are prepared by the user or purchased on a commercial basis. In the process of spatial data management, GIS integrates this information with other types and data sources and can also use a database management system (DBMS) used by various organizations. Information about terrain objects can be processed by computers only when it is presented in digital form. GIS works with vector (objects are represented as points, polygons, and lines) and raster (a photo consisting of pixels or colored dots) data types. Depending on the software, GIS can work with two types of data at once or separately [19, 20]. Methods of using GIS allow the latter to create automated thematic maps in accordance with the specifics of the tasks and work of the organization. The basis of thematic maps can be data on territorial coverage (global, national, regional, and local) and problem-thematic orientation (general geographic, environmental and natural, and industrial). [9,16]. Cumulative GIS data is output in the form of reports in text, graphic, cartographic, and tabular forms using printers and data export [9, 10, 11, 12]. Thus, GIS combines the methodology and traditions of classical geography and cartography with the capabilities and availability of the apparatus of applied mathematics, computer science, and computer technology [14]. The tasks and resources of the management and veterinary services can be improved using GIS. It becomes possible to describe the geographical dynamics of diseases over time, risk factors due to spatial relationships, as well as mapping risks and damage. [21]. One of the most important sources of information about the presence of foci of echinococcosis is information from the laboratories of the VSE of food markets, meat processing plants, and slaughterhouses. The presence of affected organs in offal from a certain area indicates the presence of a source of infection—a sick dog that invades the environment, other animals, and possibly people. To eliminate the focus of the disease in this locality, a complex of diagnostic and therapeutic measures should be carried out in animals (coproscopy in dogs and their deworming) and in people at risk (ultrasound and computed tomography of internal organs). At the same time, all data on cases of echinococcosis should be entered into a specialized GIS database with reference to the locality. Monitoring and evaluation of veterinary and environmental factors in space and time are carried out using standard procedures that ensure their comparison with a variety of natural and climatic indicators of the area, the state of the environment, and public health. Epizootological diagnostics and analysis, the development of complexes of antiepizootic and preventive measures, and the assessment of their effectiveness in modern conditions are impossible without a system for collecting and accounting for reliable information entered into a database and its multifactorial analysis. [6] The use of geoinformation systems as a method for monitoring zooanthroponous cestodoses makes it possible to create a model of a multi-level platform that allows solving a wide range of tasks in the field of combating these diseases. GIS as a method of epizootology for monitoring zooanthroponous cestodoses is a model of a multilevel geoinformation system for solving a wide range of tasks in the field of combating these diseases.

CONCLUSION

1. Helminthoinvasia, including echinococcosis, is usually interconnected with specific territories where populations of farm animals are concentrated. Monitoring of zooanthroponous cestodoses using geoinformation technologies (GIS technologies) is a real way to increase the economic indicators of animal husbandry and a comprehensive fight against invasive diseases.

2. The analysis of the epizootic situation allows us to form a forecast of the

development of invasion, which does not exclude the possibility of an outbreak of echinococcosis in farms.

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