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AN EXPERT SYSTEM FOR DIAGNOSIS COW DISEASES

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ABSTRACT

This article describes an automated expert system developed to diagnose cow diseases and assist veterinarians in treatment. We set before a diagnostic method based on the analysis of observed symptoms and experience of veterinarians. The system represents a web interface for maintaining a database of diseases, their symptoms and treatment methods, as well as a smartphone application for the diagnostics in offline mode. The article presents a structural diagram and describes the main parameters of the developed expert system, as well as a general scheme of the interaction of individual components. Diagnostics and ranking of possible diseases is performed by adding and sorting the results of weighting coefficients of observed symptoms and symptom complexes. Weighting values of symptoms and symptom complexes are determined by veterinary experts. Also presented in the article the information on the developed expert system, and the results of tests and testing during its use. We have simulated the real conditions of cow disease, together with students, made a comparative characteristic with and without the use of developed software product in the diagnosis. By constantly monitoring and updating the knowledge base online, the system has potential use in veterinary practice.

Keywords: *Expert System, Diagnosis Of Diseases, Weighting Coefficients, Symptoms, Application Evaluation.*

1. INTRODUCTION

This guide provides details to assist authors in preparing a paper for publication in JATIT so that there is a consistency among papers. These instructions give guidance on layout, style, illustrations and references and serve as a model for authors to emulate. Please follow these specifications closely as papers which do not meet the standards laid down, will not be published.

Development of the livestock industry is currently one of the main tasks of agriculture in the Republic of Kazakhstan today. The state has a high potential in agricultural sector, as it has appropriate natural and climatic conditions and the richest grasslands contributing to the successful development of livestock. Kazakhstan had a population of 9.5 million cattle before the collapse of the Soviet Union, with a population of 16.5 million. The GDP (gross domestic product) of the Soviet Kazakhstan livestock was 58 % of the GDP of the whole agricultural sector of the republic. After the collapse of the Soviet Union, the industry underwent profound changes due to structural changes in the economy, which affected a sharp decline in the number of heads of livestock [1].

Since the early 2000s, the livestock industry has seen a large increase in the number of livestock, including cattle. According to the Statistics Committee of the Ministry of National Economy of the Republic of Kazakhstan (MNE RK), as of July 2019, the number of cattle in the Republic is 4 million heads. As of today, cattle meat production is about 500 thousand tons and milk production is about 6 million tons. The main producers of cattle meat and milk are Kostanay, Almaty, South-Kazakhstan, North-Kazakhstan and Akmola regions. However, the potential of the Republic has not been fully realized, compared to 1990, the current number of cattle in Kazakhstan has decreased by 1.5 times [2].

Livestock breeding is developing very rapidly, but there are few specialists with extensive experience. According to data for 2019, rural areas accounted for 39.2% of services (11.1 billion tenge

+12.2% for the year), of which 10.1% were provided at the expense of the population (1.1 billion tenge -32.3% for the year) [3].

A huge role in the productivity of cattle is played by various diseases [4]. These factors are a significant obstacle to the healthy and sustainable development of livestock breeding. Cattle, in particular cows, have a number of specific features in the diagnostics and establishing diagnosis. Taking into account the world experience in developing intelligent systems, the conclusion on their creation has been made.

The uniqueness of this system is determined by the development methods used and the knowledge base of veterinary experts. The study objective was to develop an automated tool for diagnostics of cattle diseases and, and study its impact on the diagnostics of cattle diseases in Kazakhstan.

2. ANALISYS OF COW DESEASE DIAGNOSTICS PROBLEM

Contrary to humans, animals are unable to describe their feelings, and diagnosis of diseases is based on externally observed symptoms and laboratory tests. For example, if a lacrimation is detected in a cow, it may indicate conjunctivitis. But practice shows that in most cases there are other factors that affect the development of disease. Animals do not exhibit obvious clinical symptoms when they suffer from a disease, the former are usually misdiagnosed as a result of the disease (5).

In spite of the improved diagnostics of cow diseases in recent years, most veterinarians do not have much experience, which leads to serious losses due to delayed disease control, as well as serious problems in accounting diseases on paper. Health of cows is a key factor in dairy herd productivity. Mastitis, ketoses, fattening problems and other diseases significantly reduce dairy production and treatment will be expensive if diagnosed and detected late. Thus, the financial component and disease prevention are interlinked phenomena on any farm. Improving diagnostic accuracy and reducing losses caused by disease are the most serious problems at present (6).

3. INPUT AND OUTPUD DATA OF THE EXPERT SYSTEM FOR VETERINARY MEDICINE PROBLEMS SOLUTION

Input data needed to diagnose cattle diseases should be classified, i.e. we need to know what information a farmer should have in order to make a decision [7]. Several groups of input data can be identified:

1. External characteristics:

- Sex, breed, age (date of birth), live weight of the animal;

- Genealogical tree of the animal (breeding record);

- Animal data: individual number, body type, live weight, age, color, sex, photo of the animal,

- Place of birth, date of birth and location of the animal;

- Method of birth of the animal (natural / artificial breeding);

- Date of slaughter (and disposal actions following the slaughter).

2. Animal productivity:

- Volume of dairy products produced and milking schedule;

- Live weight at present and graphs of live weight changes;

- Date and method of last animal cover (natural or artificial breeding), date of pregnancy test and its result, date of start in the dry;

- Date of last calving and number of calves (live, stillborn);

3. Animal's medical information:

- Full medical history of the animal (dates of diagnosis, treatment);

- Immunization and vaccination of the animal with the dates and type of medication injected;

- Graph of body temperature changes, mobility, recent PH in the stomach.

4. Observed symptoms and organ and body system lesions: skin cover, musculoskeletal system, nervous system, cardiovascular system and others.

By processing the received input and output data, we should obtain a set of expert conclusions (output data) accepted by the system:

1. A diagnosis of the animal's disease obtained by analyzing the input data and comparing it with the symptom data library;

2. Recommendations for further actions on treatment, prevention, use of medications, etc.;

4. GENERAL SYSTEM DESIGN CONCEPT

The expert system architecture was developed according to the method of structured systems development [8]. It consists of a knowledge base, a knowledge subsystem, a decision making subsystem, an administration subsystem and a user interface (Figure 1).

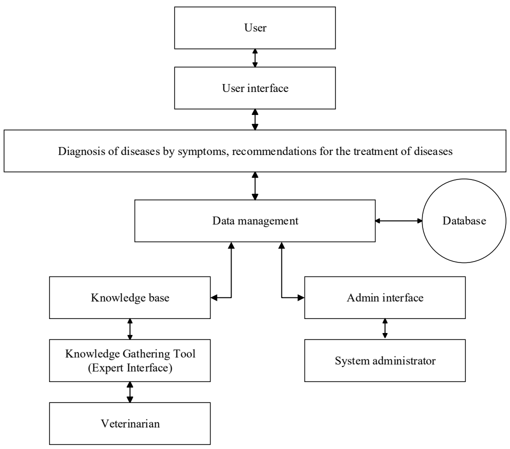

Figure 1: Structure of a cow disease diagnosis system

The system uses N-tier web architecture (Figure 1), the structure has been developed according to the method of development of structured systems, consisting of:

1. Knowledge databases and knowledge generation subsystems (interface for working with veterinary experts);
2. System administration block and the administrator work interface correspondingly;
3. Database and data management block are the core of the system;
4. Work with input and output data as well as decision making and work with the user interface is located in the disease diagnostic subsystem.

Decision making diagram of the system is used for interpretation of user interface functions. Diagram of variants of use of expert system of diagnostics of diseases of the cows consists of six compound blocks shown in Fig. 2.

Figure two shows that a user entity in the system can perform a number of actions, such as viewing the disease registry, performing diagnostics of diseases by symptoms and viewing the medication registry. On this basis, having defined a diagnosis by initial symptoms, the system will offer a description, methods of treatment and prevention of this disease. After selecting a treatment method, it is possible to view the descriptions of the medications used.

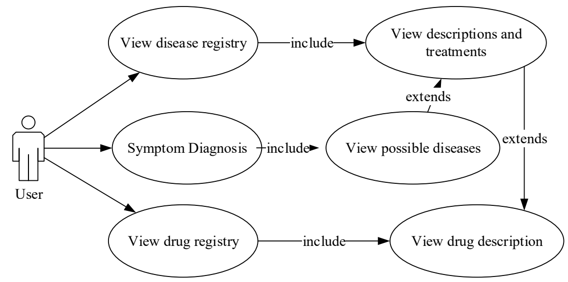

Figure 2: The main scenarios for using the expert system

5. ACQUISITION AND PRESENTATION OF KNOWLEDGE

As expert system, it should contain knowledge obtained from experts in the subject area. Acquisition and presentation of knowledge is the most important stage in building expert systems. The main task is to create a knowledge database to meet the requirements of the expert system for the solution of set tasks. Many methods were developed for obtaining knowledge from experts in the subject area.

In this study, we have analyzed and summarized the aggregate of knowledge by conducting literature reviews and interviewing experts using a questionnaire for disease analysis. It consisted of questions about symptoms, diagnoses and treatments. Based on their experience and requirements to develop an expert system, experts modified the questionnaire and provided information in tabular form [8].

In this study the diagnosis of 16 most dangerous infectious diseases of cattle is considered: Anthrax (D1), FMD (Foot-and-Mouth Disease) (D2), Tuberculosis (D3), Brucellosis (D4), Rabies (D5), Pasteurellosis (D6), Trichophytosis (D7), Leukosis (D8), Infectious Rhinotracheitis (D9), Viral Diarrhea (D10), Lumpy Skin Disease of Cattle (D11), Emphysematous Carbuncle in Cattle (D12), Salmonellosis (D13), Colibacillosis (D14), Rotavirus (D15), Coronavirus (D16).

Symptoms of disease are grouped according to the affected organs and systems, and each symptom is assigned a code for ease of work:

Skin: Skin Lesions (S01), Rumpleness of Hair (S02), Dermatitis (S03), Lumpy Skin, Extuberances

(S04), Papules (S05), Vesicles (S06), Pustules (S07), Sloughs (S08), Scaliness (S09), Scratch (S10), Dark Red Skin Stains (S11).

Musculoskeletal system: Lesion of Limbs (M01), Arthritis (M02), Bursitis (M03), Limp (M04), Bone Deformity (M05), Suppurative Discharge (M06), Edema of Limbs (M07), Edema in Groats, Lungs, Neck, Chest, Lower Jaw (M08), Edema of Joints (M09), Joint Deformity (M10).

Digestive system: Loss of Appetite (F01), Loss of Chewing Cud (F02), Salivation (F03), Stomatitis (F04), Oral Mucosa Hemorrhages (F05), Oral Lesions (F06), Aphta, Oral Ulcers (F07), Vesicles, Tubercules in Mouth (F08), Gastric Timpany (F09), Gastric Atony (F10), Abdomen Wall Disease (F11), Diarrhea (F12), Constipation (F13), Excrements admixed with blood, mucus, gas bubbles (F14).

Respiratory system: Respiratory System Injury (B01), Rapid Pulse (B02), Short Wind (B03), Nasal Cavity Excretion (B04), Injury of Nasal Cavity and Tapetum Lucidum Cellulosum (hemorrhages, wounds, etc.), (B05), Coughing (B06), Lung Rale (B07), Lung Inflammation (B08), Edema in Larynx, Chin, Abdomen (B09).

Central nervous system (CNS): Injury of the CNS (N01), Excitation (N02), Inhibition (N03), Muscular Tremor (N04), Eclampsia (N05), Paresis (N06), Paralysis (N07), Ataxia (N08), Scratch, Pruritus (N09).

Cardiovascular system (CVS): CVS Lesion (H01), Asphyxiation of Mucous Membranes (H02), Mucous Membrane Anemia (H03), Mucous Membrane Hemorrhage (H04), Mucous Membrane Hyperaemia (H05), Tachycardia (H06), Arrhythmia (H07), Myocarditis (H08).

Urogenital system (G-U System): Lesions of G-U System (U01), Nebulous Urine (U02), Urine Erythrocytes (U03), Frequent and Painful Urination (U04), Abortions (U05), Orchids and Epididymitis (U06), Swelling of External Genitals (U07), Hyperemia of External Genitals (U08), Viral Shedding of External Genitals (U09), Retention of Placenta (U10), Endometritis (U11), Lesion of Ovaries and Fallopian Tubes (U12), Vulvovaginitis (U13), Balanopostitis (U14).

Visual organs: Lesions of Visual Organs (E01), Mucous membrane bleeding (E02), Eyeball Retraction (E03), Photophobia (E04), Serous or Suppurative Discharge (E05), Conjunctival Hyperemia (E06), Swelling and Edema of Conjunctival (E07), Corneal Ulceration and Clouding (E08).

Lacteous Gland: Lacteous Gland Lesion (J01), Decreased or Stopped Secretion (J02), Afta, Dug Skin Erosions (J03), Dug Inflammation (J04), Udder Edema (J05), Udder Pain (J06), Mastitis (J07), Enlarged Supramammary Glands (J08), Watery Milk admixed with Blood or Curds (J09).

Lymphoid system: Lesion of Lymphoid System (L01), Inflammation of Submandibular and retropharyngeal Lymphnodes (L02), Inflammation of Prescapular Lymph Glands (L03), Inflammation of Precrural Nodes (L04), Inflammation of Parotid Lymphnodes (L05), Inflammation of Supramural Nodes (L06), Inflammation of Internal Lymphnodes (L07), Tumour Proliferation (L08), Enlarged Spleen (L09) [9].

Based on their own experience, the experts attached a weighting factor (w) to each symptom. The concept of "symptom complex" has also been introduced to reflect a group of symptoms combined into a single value argument, which is also given a weighting value (w). Figure 3 shows some symptom values and weighting values [10].

6. METHOD OF CALCULATION

In order to determine the most probable diseases, the system calculates the sums of the weighting values for the observed symptom complexes and individual symptoms, after which the calculated values and the corresponding diseases are ranked (sorted) in descending order [11].

According to the method of weighting calculation, we can analyze a given case on a concrete example. Viral diarrhea disease, with a certain number of symptoms and symptom complexes. According to the knowledge database and the questionnaire received from veterinary experts, the following symptoms appear in case of viral diarrhea:

C01 (Fever) W(d, s)=1%;

M01 (Lesion of Limbs) W(d, s)=1%;

M04 (Limp) W(d, s)=1%;

F01 (Loss of Appetite) W(d, s)=10%;

F03 (Salivation) W(d, s)=10%;

F04 (Stomatitis) W(d, s)=10%;

F06 (Oral Lesions) W(d, s)=10%;

F07 (Aphta, Oral Ulcers) W(d, s)=8%;

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	Symptom codes	Anthrax	FMD	Tuberculosis	Brucellosis	Rabies	Pasteurellosis	Trichophytosis	Leukosis	Infectious Rhinotracheitis	Viral Diarrhea	Lumpy Skin Disease of Cattle	Emphysematous Carbuncle in Cattle	Salmonellosis	Colibacillosis	Rotavirus	Coronavirus
	Amount:	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Digestive system	F01	1%	1%	-	-	1%	2%	-	-	-	10%	1%	5%	1%	1%	1%	1%
	F02	1%	1%	-	-	1%	2%	-	-	-	-	-	5%	-	-	-	-
	F03	-	8%	-	-	8%	2%	-	-	-	10%	-	-	-	-	8%	10%
	F04	-	8%	-	-	6%	-	-	-	-	10%	-	-	-	-	-	12%
	F05	8%	-	-	-	-	2%	-	-	-	-	-	-	-	5%	-	-
	F06	-	8%	-	-	6%	-	-	-	-	10%	5%	-	-	-	-	-
	F07	-	8%	-	-	-	-	-	-	-	8%	-	-	-	-	-	8%
	F08	-	8%	-	-	-	-	-	-	-	-	5%	-	-	-	-	-
	F09	8%	1%	-	-	-	-	-	1%	-	-	-	-	-	-	-	-
	F10	1%	1%	-	-	1%	1%	-	1%	-	10%	-	-	-	-	-	-
	F11	4%	-	-	-	-	1%	-	-	-	10%	-	-	-	5%	-	-
	F12	4%	-	-	-	-	-	-	1%	-	10%	-	-	8%	6%	12%	12%
	F13	1%	-	-	-	1%	1%	-	1%	-	-	-	-	-	-	-	-
	F14	8%	-	-	-	-	2%	-	-	-	10%	-	-	8%	6%	12%	12%

Figure 3: Table of symptoms and their weighting values

F10 (Gastric Atony) W(d, s)=10%;

F11 (Abdomen Wall Disease) W(d, s)=10%;

F14 (Excrements admixed with blood, mucus, gas bubbles) W(d, s)=10%;

N01 (Injury of the CNS) W(d, s)=6%;

N03 (Inhibition) W(d, s)=1%;

N08 (Ataxia) W(d, s)=1%,

where C01 is the symptom code, W (d, s) is the weight value of symptom s for disease d.

Thus, it is possible to calculate the sum of weighting coefficients of symptoms by disease. A simple sum of weights of symptoms for the disease is calculated using a formula:

$$W(d, S^0) = \sum_{s \in S^0} W(d, s), \quad (1)$$

where d is the disease, So is the observed set of symptoms, W (d, s) is the weighting value of symptom s for disease d.

For the above example with the disease "viral diarrhea" the values of the arguments will be equal to:

With So = 14:

$$W(d, s^0) = W(C01) + W(M01) + W(M04) + W(F01) + W(F03) + W(F04) + W(F06) + W(F07) + W(F010) + W + (F011) + W(F014) + W(N01) + W(N03) + W(N08) = 100\% \quad (2)$$

Due to the fact that several symptom complexes k with different weights w can be defined for disease d, the symptom complex with the highest weighting is taken into account, each symptom of which includes the many symptoms observed:

$$k_{max} \in K(d), \text{ где } S(k) \in S^0, \text{ и } W(d, k), \quad (3)$$

i.e. $W(d, k) \geq W(d, k_i)$ for $\forall k_i \in K(d)$, (4)

where: K (d) - symptom complexes of the disease d, S (k) is the set of symptoms of symptom complex k, W (d, k) - weight coefficient of symptom complex k, for disease d.

Thus, for viral diarrhea, the symptom complex with the highest weighting factor is kmax, which includes symptoms F01, F03, F04, F06, F07, i.e. S(kmax)=5.

In total for the disease "viral diarrhoea" the symptom complex kmax will give W (d, kmax) =65%, according to the knowledge base provided by veterinary experts.

Taking into account the above mentioned number of symptoms not included in the symptom complex will be calculated as Sx=S0-S(kmax) difference, i.e. for viral diarrhea Sx=9. Thus, it is easy to calculate W(d, Sx)=52%.

The total sum of weights R for observed symptoms So and symptom complexes S(kmax) for disease d is calculated by formula [12] :

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$$W_r(d,S) = W(d,k_{max}) + W(d,S^y) \quad (5)$$

For viral diarrhoea, the total sum of R weights for the observed symptom group Sy (F11, F14) and symptom complexes S(kmax) at the same time will be Wr (d,S)=85%.

After calculating the total sums, the obtained data are sorted in descending order.

Thus, we can conclude that the introduction of such a parameter as a symptom complex leads to a more accurate definition of this or that disease. The results obtained as a percentage may show that the observed symptoms belong to a certain diagnosis.

7. DATABASE, THEIR IMPLEMENTATION

For the central database as well as for its local version, relational databases (MS SQL Server 2019 and SQLite) are used on the user device. Figure 4 presents the database structure in terms of knowledge storage about diseases, symptoms and symptom complexes [13].

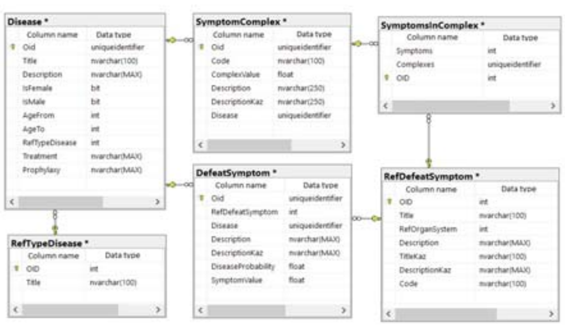

Figure 4: Database structure

Knowledge database contains information about 16 major infectious diseases and 103 symptoms of diseases. The database stores the subject area knowledge needed to solve problems, including age, cow breed, symptoms, photographs, and other relevant information. The database is developed on:

- Operating system: Windows Server 2019 Standard;

- Web server: Internet Information Services;

- DBMS: SQL Server 2017 Standard;

- Platform: NET 4.5.2, language C #;

- Framework: DevExpress XAF 18.2 - a set of libraries to help the developed program with modern high-quality functionality [14].

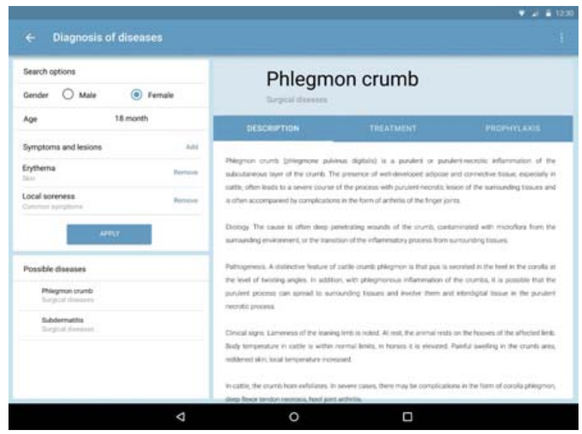

Figure 5: Veterinarian tablet web interface

8. EXPERT SYSTEM EVALUATION – TESTS AND RESULTS

The evaluation process was carried out due to the user-friendliness of the user interface and system utilization efficiency testing. The reliability of the system diagnosis was evaluated with the participation of two groups of senior veterinary students of KATU named after S. Seifullin. Test tasks were prepared for students in advance, as a result of which it was necessary to make the correct diagnosis. The first group of students relied only on their knowledge and personal experience; the second group worked with the “Veterinary Tablet”.

In total, 16 situational tasks were drafted. Two equal groups of 35 people participated in testing. We received some results from the testing. Figure 6 illustrates some of the information obtained, reflecting the diagnosis results of veterinary students without using the “Veterinary Tablet” [15]. In this case, the students relied only on their experience and knowledge without using any technical means. Senior veterinary students have an average level of knowledge comparable to that of a

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№	Anthrax	Foot and mouth disease	Tuberculosis	Brucellosis	Rabies	Пастереллез	Pasteurellosis	Leukemia	Infectious Rhinotracheitis	Viral diarrhea	Nodular dermatitis of cattle	Emphysematous carbuncle of cattle	Salmonellosis	Colibacillosis	Rotaviruses	Coronaviruses	Number of correct answers	% correct answers
1	-	+	-	+	+	-	+	-	+	-	+	+	-	-	-	-	7	43,75
2	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	4	25
3	+	+	-	-	+	-	-	-	-	-	+	-	-	+	-	-	5	31,25
4	-	-	-	+	+	-	+	-	-	-	+	+	-	+	-	-	6	37,5
5	-	+	-	+	+	-	+	-	+	-	-	+	-	+	-	-	7	43,75
6	-	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	5	31,25
7	-	-	-	+	+	+	+	-	-	+	+	-	-	-	-	-	6	37,5
8	-	+	-	+	+	-	+	-	-	-	+	+	-	+	-	-	7	43,75
9	-	+	-	+	+	-	+	-	+	+	+	+	+	-	-	-	9	56,25
10	-	+	-	+	+	+	+	-	-	+	+	-	-	-	-	-	7	43,75
11	-	+	-	+	+	+	-	-	-	-	+	-	-	-	-	-	5	31,25
12	-	+	-	+	+	-	+	-	-	-	-	-	-	-	-	-	4	25
13	+	+	+	+	+	-	-	+	-	-	+	+	-	+	-	-	9	56,25
14	+	+	+	+	+	-	-	+	-	-	-	-	-	-	-	-	6	37,5

Figure 6: Questionnaire of Veterinary Students

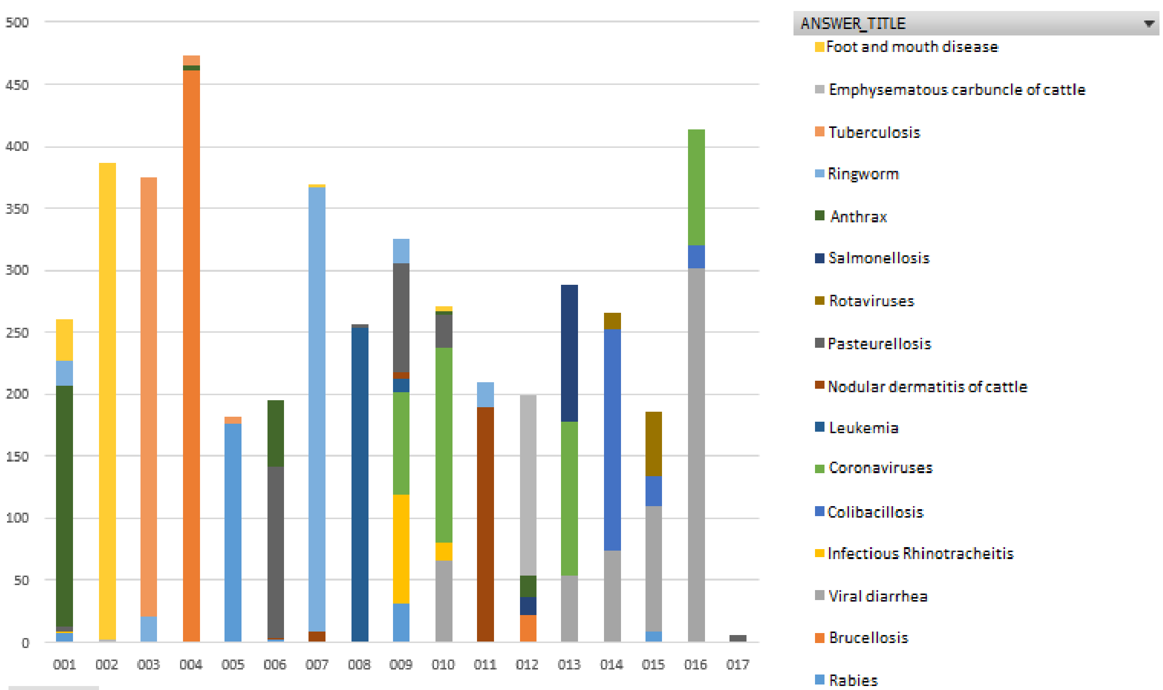

Figure 7: Diagram of Correct Answers Quality Representation

farmer-veterinarian at work. After calculations and analysis of the data obtained, we concluded that the percentage of correct answers without using the “Veterinary Tablet” was 42.28%.

In Figure 6, green indicates that this student has answered the question correctly, and at the end of the table is information on the questions correctly answered and their proportion compared to the total number of tasks.

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The second group of students worked with the "Veterinary Tablet". This group worked on the same test tasks as the first one. Figure 7 provides information on the quantity and quality of correct answers. After calculating and analysis of the data obtained, we concluded that the percentage of correct answers using the "Veterinary Tablet" was 69%.

As the diagram in Figure 7 shows, most students answered the questions correctly. Colors show the ratio of their answers (diagnosis) depending on the task number. The right column of the diagram shows the colors that correspond to a certain diagnosis of the disease, for example, brucellosis is indicated in orange, and etc.

We have analyzed the most common symptoms that students chose when answering questions using the tablet, analyzed the number of selected symptoms and their types [16].

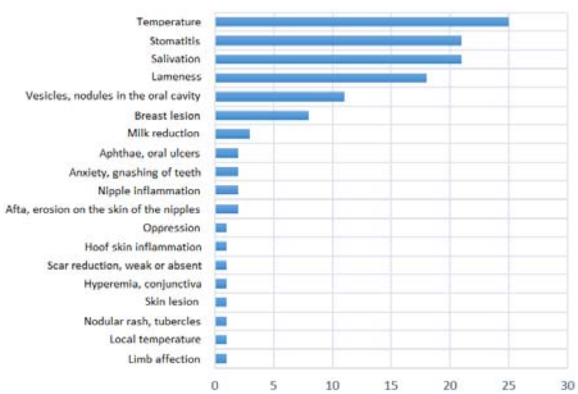

Figure 8: Symptom Distribution Using "Veterinary Tablet"

According to Figure 8, the most frequent symptoms as a result of the test were: fever, stomatitis, salivation, lameness. The rest of the symptoms were less frequent.

After comparing all the data obtained, we came to the conclusion about the probability of making the right diagnosis in cases with and without the application. This information is shown in Table 1.

Table 1 shows the changes characteristic in the disease diagnosis using tablet versus diagnosis without Tablet. The analysis of changes in correct answers taking into account each symptom and set of symptoms is performed.

Table 1: Changes Characteristic in the Disease Diagnosis Using Tablet Versus Diagnosis Without Tablet

Job Number	Name of the disease	Characterization of changes in the diagnosis of the disease when using a tablet, compared with diagnosis without a tablet
001	Anthrax	A significant increase in the probability of diagnosing anthrax – from 20% to 69% (3.43 times)
002	Foot and mouth disease	The increase in the probability of diagnosis of foot and mouth disease - from 70% to 93% (1.33 times).
003	Tuberculosis	A significant increase in the probability of diagnosis of tuberculosis - from 12% to 89% (7.41 times)
004	Brucellosis	A slight decrease in the probability of diagnosis of brucellosis - from 82% to 81%
005	Rabies	A slight decrease in the probability of a correct diagnosis of rabies is from 100% to 92%. Probably by providing subjects with additional options
006	Pasteurellosis	An increase in the probability of correct diagnosis of pasteurellosis - from 44% to 54% (1.23 times)
007	Trichophytos is	A slight increase in the probability of a correct diagnosis from 68% to 74%
008	Leukemia	A significant increase in the probability of a correct diagnosis of leukemia - from 10% to 86% (8.64 times)
009	Infectious Rhinotracheit is	Decrease in probability of correct diagnosis of infectious rhinotracheitis - from 54% to 44%
010	Viral diarrhea	A slight increase in the probability of a correct diagnosis of viral diarrhea - from 20% to 22%
011	Nodular dermatitis of cattle	Increasing the likelihood of a correct diagnosis of nodular cattle dermatitis - from 80% to 90% (1.13 times).
012	Emphysemat ous cattle carbuncle	An increase in the probability of a correct diagnosis of cattle emphysematous carbuncle - from 58% to 67% (1.15 times).
013	Salmonellosi s	Reducing the likelihood of a correct diagnosis of salmonellosis - from 40% to 35%.
014	Colibacillosis	An increase in the probability of correct diagnosis of colibacillosis - from 38% to 58% (1.52 times)

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Job Number	Name of the disease	Characterization of changes in the diagnosis of the disease when using a tablet, compared with diagnosis without a tablet
015	Rotaviruses	A significant increase in the probability of correct diagnosis of rotavirus infections - from 8% to 25% (3.13 times).
016	Coronaviruses	The correct diagnosis when using the tablet was 25%, without using the tablet, no one was tested correctly

The average time to answer each question has also been calculated. This information is reflected in Table 2.

Table 2: Characteristics of Disease Diagnosis Time with the Use of Veterinary Tablet

	Time to make an erroneous diagnosis (seconds)			**Time to make the correct diagnosis (seconds)**		
Row names	**Min.**	**Avg.**	**Max.**	**Min.**	**Avg.**	**Max.**
001	72	255	938	82	213	375
002	-	-	-	62	125	284
003	181	181	181	65	113	201
004	123	301	478	61	165	540
005	-	-	-	64	163	771
006	95	185	700	61	142	294
007	111	201	338	62	148	539
008	89	137	185	64	162	622
009	86	246	937	94	255	584
010	71	207	456	78	160	346
011	83	110	136	60	132	276
012	111	157	205	62	244	1255
013	70	227	900	75	112	198
014	60	93	146	74	142	313
015	63	159	632	64	129	243
016	77	123	319	99	131	185
Total:	**92**	**184**	**468**	**70**	**158**	**439**

According to Table 2, we can conclude that the average time to conduct diagnostics for known symptoms is 2-5 minutes. There are no dependencies between the quality of the diagnosis and the time spent on the test task.

For diseases such as leukaemia, tuberculosis, anthrax, rotavirus infections, a clear improvement in the correct diagnosis with help of the veterinary tablet was found (a total of 12 out of 16 test questions showed an improvement in the quality of diseases diagnosis). Separately considering rotavirus infections, the developed software allowed the correct diagnosis of diseases in a quarter of cases, given that without the veterinary tablet no test subjects in this case answered the questions correctly.

Summing up, we can conclude that the software implemented has improved, on average, the results of correct diagnosis from 42% to 69%.

9. CONCLUSION

Upon analyzing the problem of cow diseases diagnostics, we came to the conclusion that it is necessary to develop an expert system of cattle diseases diagnostics. When setting the main tasks to build an expert system, the main one was to determine the input and output data of this system. By using the induction method, we have identified separate groups of input and output data, which will be used to build this system. The next stage was the creation of a generalized web architecture, with the indication of individual functional blocks and equally developed the basic scenario of the use of the intellectual system. When diagnosing a disease, the way the knowledge base is presented plays an important role, which in turn depends on the experience of team of veterinarians. Information on main symptoms and diseases has been collected through questionnaires and this information is structured and presented for better understanding. Thus, a model of knowledge representation has been developed, which leads to an accurate diagnosis. Together with a team of veterinarians, each symptom and symptom complex was given the weight coefficients required for a more accurate diagnosis of the disease.

Thus, we can conclude that the developed expert system for addressing veterinary medicine challenges is effective. By comparing the percentage ratios of the results of the questionnaire of two groups, it becomes obvious that its use is expedient. A detailed analysis of the test subjects' answers has been made and all regularities in both cases of testing have been taken into account. Conclusions were made that the process of diagnosing diseases is simplified in terms of speed of decision-making and their reliability, a direct correlation between the number of detected initial symptoms of the disease and the correct formulation of the diagnosis was revealed. Also, with the participation of veterinary students, an evaluation of the user interface was conducted,

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which included checking system design and correct compilation of the knowledge base to meet user requirements.

In summary, the developed software has shown its need for use. In future, the database of expert system on diseases and symptoms will be expanded, all deficiencies related to the convenience of the user interface and the operation of the program in general will be taken into account and eliminated.

An expert system under development provides information on 16 major infectious diseases and 103 symptoms, which is currently being developed and populated in the database. The development works are carried out in the S. Seifullin Kazakh Agro Technical University, at the faculties of computer systems and veterinary medicine.

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REFRENCES:

[1] Ermekov Aidar. Meat March, 2013, [Online]. Available at: http://mk-kz.kz/article/2013/02/11/810619-myasnoy-marsh.html/ (in Russian).

[2] Committee on Statistics of the Ministry of National Economy of the Republic of Kazakhstan: [Online]. Available at: http://www.kazagro.kz/analiticeskij-obzor-po-zivotnovodstvu/ (in Russian).

[3] The Committee on Statistics of the Ministry of National Economy of the Republic of Kazakhstan: [Online]. Available at: https://www.zakon.kz/4951625-obem-veterinarnyh-uslug-v-kazahstane.html/ (in Russian).

[4] L. I. Zubkova, "The effect of diseases of the udder on the milk productivity of cows," *Dairy and beef cattle breeding*, vol. 4, 2005, pp. 35-37. (in Russian).

[5] H. Qin, J. Xiao, X. Gao, H. Wang, "Horse-Expert: An aided expert system for diagnosing horse diseases," *Veterinary Sciences*, vol. 4, 2016, pp. 907-9015.

[6] M. Dorosh, Diseases of cattle, Veche, Moscow, 2007, 7 p. (in Russian).

[7] Yu. N. Kozlov, N. M. Kostomakhin, Genetics and selection of farm animals, Kolos, Moscow, 2013, 100 p. (in Russian).

[8] O. V. Zavyazkin, Breeding and keeping cattle, BAO, Kiev, 2012, 100p. (in Russian).

[9] Fu Zetian, Xu Feng, Zhou Yun, Zhang Xiao Shuan, "Pig-vet: a web-based expert system for pig disease diagnosis," *Expert Systems with Applications*, vol. 29, pp. 93-103, 2005.

[10] Daoliang Li, Zetian Fu, Yanqing Duan, "Fish-Expert: a web-based expert system for fish disease diagnosis," *Expert Systems with Applications*, vol. 23, pp. 311-320, 2002.

[11] Paolo Liberati, Paolo Zappavigza, "Improving the automated monitoring of dairy cows by integrating various data acquisition systems," *Computers and electronics in agriculture*, vol. 68, pp. 62-67, 2009.

[12] D. Rice, Common dog diseases and health problems 4-H Companion Animal Health, 2014, [Online]. Available at: https://www.extension.purdue.edu/extmedia/4H/4-H-852-W.pdf/

[13] E. B. Hunt, Artificial Intelligence, New York, San Francisco, London, Academic Press, 558 p, 1975.

[14] M. I. Makarov, V. M. Lokhin, Intelligent Automatic Control System, Moscow: Fizmatlit, 2001, 576 p. (in Russian).

[15] T. A. Gavrilova, V. F. Khoroshevsky, Knowledge Base of Intelligent Systems, St. Petersburg: Piter, 2000, 384 p. (in Russian).

[16] D. Zeldis and S. Prescott, "Fish disease diagnosis program – Problems and some solutions" Aquacultural Engineering, vol. 23, no. 1–3, 2000, pp. 3-11.