

# Software Development for Research Support in Epilepsy

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**Abstract** – In the paper are described the objectives and designing status of an intelligent software for support of: a) remission's research of patients with resistant forms of epilepsy; b) diagnosis and treatment of epilepsy patients and c) *e-Learning*. The research is multidisciplinary and requires knowledge of medicine, mathematics, artificial intelligence, *e-learning*, etc. The study is based on experience gained during 22 years treatment of epilepsy of over 2000 patients by one of the authors, Alexander Popov - Head of Epilepsy Department at Psychiatric Hospital of the Republic of Moldova. This experience has achieved the remission of over 100 patients with resistant forms of epilepsy. Authors began collaborating in 2005. Meanwhile, on the one hand were collected and systematized information on experience treating patients with epilepsy, and on the other hand, it was started the development of intelligent software elements for research assistance, treatment of epilepsy patients and *e-learning* of epilepsy issue. It was developed an expert system for diagnosing epilepsy groups *F00 - F09* according to classification "*The ICD-10 Classification of Mental and Behavioural Disorders*". It is developed a version of Support System for doctors' assistance for establishing the treatment programs for epilepsy patients. Have been developed *e-learning* components within epilepsy issue. It was significantly improved the concept of "*relational therapy*", which now integrates the experience of treating patients with resistant epilepsy with up to 7 pharmacological preparations in the same time with psychotherapy. At the moment it is being finished a treatment methodology of epilepsy based on concepts of "*remission*", "*rational therapy*".

**Key words** – relational therapy, remission in epilepsy, expert systems, decision support systems, *e-learning*.

## I. INTRODUCTION

The epilepsy is a multidisciplinary problem. The success in epilepsy treatment requires collaboration of high qualification experts from different areas as: neurologists, psychiatrists, geneticists, paediatrician, mathematicians, immunologists, neurophysiologists, neuro-pharmacologists, artificial intelligence specialists.

The research presented in the paper apply to following objectives: a) accumulation of information on the remission (rehabilitation) phenomenon of patients with epilepsy, b) processing information on the treatment dynamics of over 2000 patients with epilepsy in order to develop within this context a *model of rational therapy of epilepsy*; c) application of artificial intelligence methods in information processing of over 100 remission cases of resistant forms of epilepsy in order to *discover new knowledge about the phenomenon of remission* – the knowledge will be applied in the future to develop a *new model of epilepsy remissions*; d) development of an *expert system* specialized in the diagnosis of epilepsy; e) developing a *decision support system* for doctors' assistance for establishing the treatment programs for epilepsy treatment programs f) development of *e-learning* elements within epilepsy issues.

Epilepsy is a mental illness from the category of endogenous psychoses. It is a multi-etiological chronic brain disease, which depending on the location of brain

pathological centre becomes evident through repeated *paroxysms* (*convulsive* and *non-convulsive*) and / or through *paroxysmal psychopathological manifestations* as result of excessive neuronal discharge with the gradual development of mental and emotional disorders.

Воронкова К.В. in the context treatment of epilepsy related the following: "At the moment, epilepsy is a disease that can be treated. If is established a successful treatment program, then about 70% of patients can be brought to remission status or at least decreased by over 50% of epilepsy accesses frequency "[1].

## II. EPIDEMIOLOGICAL INFORMATION

The worldwide prevalence of epilepsy is approximately 1.0% of the population. Men and women have a rate of 0.6/0.4, the rate of developing epilepsy is prevalent in male. Symptomatic epilepsies predominate in men. The disease usually starts in young ages (in 60% cases up to the age of 21 years in 50% cases manifested clinically develop until the age of 10. The second peak of frequent expression of epilepsy is found after the age of 60 years. The disease progression in most cases has a slow character progressing with seizures or without seizures of low frequency (when given appropriate treatment) and minimal non-psychotic mental disorders (in 30-40% cases). In other 30-40% of cases (some forms of this disease are properly assisted by the doctors ), evolves progressing with paroxysms of low frequency and more obvious non-

psychotic mental disorders being accompanied by psychiatric – psychotic disorders transitional temporal. The epilepsy exhibits malignant evolution in up to 20% of cases. These are the cases with frequent *polymorphic attacks* (despite appropriate treatment) and intensive *psychiatric disorders* (psychotic and/or non-psychotic).

The epilepsy incidence in Moldova in 2009 was 11 cases per 10000 populations. The prevalence of epilepsy in Moldova in 2009 was 11,224 cases (about 31,3 to 10000 persons).

### III. DEFINITIONS

**The Epilepsy** (from Greek – “*epilamvano*”- means “to grab, to gather”) can be defined as a mental illness category of endogenous psychoses. It is a chronic, pluri-etiological brain disease, which depending on the location of brain pathological centre becomes evident through repeated paroxysms (convulsive and non-convulsive) and / or through paroxysmal psychopathological manifestations as result of excessive neuronal discharge with the gradual development of mental and emotional disorders.

**Antiepileptic Rational Pharmacotherapy** [1] in view of our experience has the following meaning:

- a) to achieve the main objective in the treatment of epilepsy, which under present-day conditions has modified classical known of clinical expression and stopped the repeating epileptic accesses, the doctor epileptologist endowed with extensive multidisciplinary knowledge in fields of: neurology, neurophysiology, immunology, psychiatry, pharmacology, knowing brain mapping and performing with available modern technologies, knowing the epileptogenesis processes at the cellular and neurohormonal levels, apply all mentioned for: 1) avoiding potentially adverse effects of eventually possible medication; 2) examines the interaction between two and even three antiepileptic preparations with exact knowledge of their potential effect to achieve the desired objective, 3) and then comes the prescription from the beginning with two or more antiepileptic drugs, the doctor mandatory monitors the control concentration of the preparations in the blood and evaluates the patient's clinical picture of disease under strict supervision of the laboratory analyses. This hard work can be named as rational antiepileptic pharmacotherapy.
- b) The treatment is required and mandatory is brought to the knowledge of the patient and his relatives, with the approval and signing the informed consent forms.
- c) These measures have demonstrated the efficiency of treatment, establishing friendly and voluntary relationships between doctor and patient.

**The remission at patients with epilepsy** is a complex, broad and dynamic process, which is based on mechanisms of adaptation, rehabilitation and compensation, and the laboratory and clinical examination results mutually, proves beneficial processes that occur in the human brain.

**Remissions forecast**, improving the patient's mental and general status, which often depend on the formed nature of “*epileptic system*”, that has a dynamic and evolutionary character and depends a lot on the absence of epileptic attack and of “*paraepileptics phenomena*”.

Assessment of remission is based not only on lack of epileptic attacks “*Para epileptics phenomena*”, but depends on the psycho-psychological, social, family status and life quality of patients with remission.

### IV. NATIONAL CLINICAL PROTOCOL "PSYCHIATRIC DISORDERS IN EPILEPSY"

It is finished the development of the National Clinical Protocol “*Psychiatric Disorders in Epilepsy*”. The Protocol includes content regarding: classification of epilepsy, prevention, risk factors; patient behaviour with epilepsy, history, clinical expression, laboratory investigations, differential diagnosis, treatment conditions, epilepsy treatment (jugular therapy, ending and evaluation treatment therapy, negative symptomatic correction, prophylaxis (support) therapy, socio-professional rehabilitation, psychotherapy, surveillance of patients with epilepsy, complications, etc.). The Protocol includes also *the algorithm scheme* of patient with epilepsy recovery within early post-acute phase, *the description of patient recovery methods, techniques and procedures* within early post-acute phase.

The National Clinical Protocol is developed in accordance with current international guidelines on psychiatric disorders in epilepsy and will serve as a basis for developing institutional protocols, according to the real possibilities of each institution this year. Protocol is based on experience gained in the treatment of epilepsy, including completed remission.

Protocol development followed the following purposes: a) facilitating the process of diagnosing epilepsy, b) improving the quality of management, treatment and quality of life of the patients with epilepsy, c) early detection of patients with insidious onset of epilepsy; e) avoid non-validation and stigmatization based on the effect of “*hospitalization*” to chronic patients.

Within this context rehabilitation of patients with epilepsy we will divide into: a) *remedial therapy*, b) *re-adaptation* and c) *rehabilitation session*.

**Remedial therapy.** The first recovery stage is responsible of services which offers inaugural treatments (sometimes by epileptologist form family doctors' offices) and who will tend to prevent the establishment from very begging of a *psychic defect* and *handicapping* at examined patients. This is the task of prophylaxis actions carried out at the first stage of rehabilitation treatment of patients with epilepsy. Also at this stage will tend to cancel or at least minimize hospitalization phenomena, strengthening mechanisms for clearing and balancing functions of the disturbed patient with epilepsy and their social relationships. This phase will be specified by the combined application of pure biological methods (pharmacological) with different psychosocial therapies (treatment by environment, implication in various activities, psychotherapy, different physiotherapy methods and exercises of medical gymnastics). As a result of such services at this stage we will obtain: *reducing* and *extinction of seizures*.

**Re-adaptation phase.** The main task of this phase of epilepsy treatment we propose the adjustment to the social environment and reconstruction of adaptive potential:

- *Stimulating social engagement of patients* in various ways (ergotherapy to train or to develop at patients new professions skills, and specific educational activities with psychotherapeutically aspect, covering not only the patient with epilepsy but also his family).
- *Participation*, including cultural activities, curative gymnastics.

**Rehabilitation** phase includes a more plenary restoration of rights, individual and social values recovery, restoration of pre-existing relationships with reality of patients assisted in this rehabilitation complex formula.

## V. PROJECT LIFE CICLE

Based on a complex analysis on research material, methods of treatment for resistant types of epilepsy, development and implementation of intelligent support system for diagnosis and treatment of epilepsy will be attempt to develop for the first time in our republic an intelligent support system for treatment and diagnosis of epilepsy.

We propose a new project composed by a few stages.

*At the first stage were selected* the information from clinical history of more than 2000 epilepsy cured patients, with the aim to develop a model of *relational therapy of epilepsy*.

*The second stage* of the project is to develop an *expert system* for diagnosis of epilepsy patients (groups of epilepsy *F00* to *F09* according to classification [2]). The system is planned to assist doctors from Moldova and abroad clinics. The system will provide a higher level of medical diagnosis from provinces and respectively, a smaller quantity of errors in diagnosis. The expert system is projected to be used in the training process in Medical Universities. It also could be used to support remote diagnosis process of patients with symptoms of epilepsy and to be used for population information on epilepsy and prophylaxis of this disease.

*The third stage* of the project consists in data selection and systematization based on patients with remission of epilepsy, database development regarding medical histories of epilepsy patients with remission. In present there are found 100 former epilepsy patients and brought with contribution of a *new treatment (non-conventional) methodology into remission of the disease*. Data regarding on medical reports of these group of patients will be prepared according to requirements of *Data Mining* technology for preparing data based of patients' peculiarities (age, social group, diagnosis, etc.).

*The fourth stage* of the project will consist of database knowledge retrieval. Knowledge will be collated into groups of patients according to diagnosis and degree of remission. Our experience of treating patients with epilepsy and bringing on remission status allows us to distinguish following *classes of patients with remission*:

- *patients with therapeutic remission* – patient is maintained in this condition on a background of daily therapeutic treatment;

- *patients with therapeutic remission with stable compensation* – to patient are not prescribed any drugs;
  - *patients with spontaneous remission* – after a short period of anti-epileptic drugs prescription (3-6 months);
  - *after anti-epileptic drugs prescription* (6-12 months);
  - *patients judged by differential diagnosis with other diseases* (early metabolic disorders, deficiency of Mg ions, Ca etc.);
  - *cured patients, with diverse long term remission and intermission*;
  - *patients, who eventually are diagnosed and then cured*.
- At this stage will be developed a model of *rational therapy of epilepsy*.

*The fourth stage* is represented by implementation of artificial intelligence methods for processing of the information regarding remissions with the aim to *discover new rules (knowledge)* regarding phenomenon of *remission* and development of a *new remission model*.

*The fifth stage* is to develop an *intelligent support system* able to attend the following observations on patients with epilepsy – the scope is to improve the models developed in previous stages.

*The sixth stage* is planed for development of a support system for doctor's assistance within the process of development of patient epilepsy treatment. The system will be developed following specialty classifiers.

*The seventh stage* is to develop a distance learning system on epilepsy and an information system of population regarding epilepsy and prophylaxis of this illness. As result of performed investigations we intend to promote and implement a series of original and differentiated programs of family and social rehabilitation, epilepsies prophylaxis through information and education, provisions and suggestions for epilepsy prophylaxis and treatment.

## VI. THE EXPERT SYSTEM

With the aim of developing an expert system in psychiatry [3] it was taken into account a particular group of diagnosed diseases of mental disorders. Thus, the diagnosis of diseases of the group mentioned above has some peculiarities; they are based on clinical investigations. Using expert system can be established nine groups of diagnoses mental graded from *F00* to *F09* in ICD-10 classification of mental and behavioural disorders. In the computer this base is stored in *two forms*: a) a version in *Prolog* - to diagnose epilepsy, and b) a version in *HTML* - to develop treatment programs for epilepsy patients with psychiatric disorders. Expert system can be used both as support to diagnosis of epilepsy patients with psychiatric disorders and in teaching.

Developed expert system establishes mental disorders according to symptoms that patients have. It asks questions concerning 132 *symptoms*. The software result can be one of 24 *different diagnoses*. *Knowledge base* for diagnosis keeps information regarding treatment rules of mental illness. The conclusion, obtained by inferential Engine of Expert System serves as a prerequisite for the next phase - development of treatment programs for epilepsy patients.

Due to this the expert system is equipped with two

knowledge bases: first - to support the diagnosis, the second - to support development of treatment programs.

VII. ELECTRONIC TEXTBOOK IN EPILEPSY

Electronic textbook on epilepsy is a database for support of programs' development for treatment of patients with epilepsy. The electronic manual contains tables with information about the group diseases F00 to F09 (Fig. 1).



Fig. 1. Electronic Textbook

VIII. THE DECISION SUPPORT SYSTEM

The problem of treatment programs is a weak-structured problem and it may have several solutions. Therefore, for solving problem of issuing advices regarding treatment peculiarities was developed a decision support system (Fig. 2). The tables contain information on diseases of the group F00 to F09 [4], including data about: a) laboratory investigations; b) advices provided by specialty doctors; c) treatment schemas; d) daily dosage; e) costs etc.

Cămin clasificării internaționale	Grupurile medicale	Durata medie a tratamentului	Investigații și consultații	Cost	Tratament	Doza zilnică	Cantitatea
F01	Demența vasculară F01.0 Debut acut F01.1 Demență subacută F01.2 Demență F01.3 Alți demenși vasculari F01.8 Alți demenși vasculari F01.9 Demenși vasculari nespecificați	60 zile	Investigații de laborator Anamneză generală Anamneză 11.8 EKG 14.4 Hemoglobină K3 Teste serologice 11.6 Colesterol 5.6 Proteine 9.7 EKG 4.4 RMP la sfârșit 22.4 Fecale la 22.4 Alte teste laborator Investigații de diagnostic Instrumentale EKG 3.7 Revenire alografică 12.4 EKG 8.3 Examinare clinică și psihopatologică (COP) Investigat 9.45 Neurolog 8.45 Comun psihologic 2.5 Psihiatru 8.45	Cost Comp. Antipsihic 2.5 mg Sal. Acetaminofen 100 mg sau 11.8 Comp. Cholinergici 25 mg Sal. Clonazepam 25 mg x 2 ml sau 14.4 Comp. Prozac 30 mg sau 11.6 Nero-antipsic 5.6 Sal. Chaperomina 2.5% x 2 ml Comp. Haloperidol 5 mg Sal. Haloperidol 0.5% x 1 ml sau 9.7 Comp. Clonazepam 25 mg sau 4.4 Comp. Tioridină 25 mg sau 22.4 Căpșule Solușid 50 mg Sal. Solușid 5% x 2 ml sau 12.4 Sal. Difenhidramin 50 mg Comp. Difenhidramin 5 mg sau 3.7 Căpșule Solușid 50 mg Sal. Solușid 5% x 2 ml sau 8.3 Sal. Difenhidramin 50 mg Comp. Difenhidramin 5 mg sau 9.45 Ridolol 8.45 Sal. Tracietam 20% 2 ml sau 2.5 comp. Amoxicilin 25 mg sau 4.5 mg x 15 mg comp. Cinnarizina 25 mg sau 12.0 mg Sal. Tracietam 20% 2 ml sau 8.0 mg sau 12.0 mg x 40 mg x 6.0 mg Sal. Cerebrohidrat 0.5 ml sau 2 ml sal. Fenilalanin 2.5% x 2 ml sal. Glucoză 40% x 20 ml sau	Antipsihic Comp. Antipsihic 2.5 mg Sal. Acetaminofen 100 mg sau 11.8 Comp. Cholinergici 25 mg Sal. Clonazepam 25 mg x 2 ml sau 14.4 Comp. Prozac 30 mg sau 11.6 Nero-antipsic 5.6 Sal. Chaperomina 2.5% x 2 ml Comp. Haloperidol 5 mg Sal. Haloperidol 0.5% x 1 ml sau 9.7 Comp. Clonazepam 25 mg sau 4.4 Comp. Tioridină 25 mg sau 22.4 Căpșule Solușid 50 mg Sal. Solușid 5% x 2 ml sau 12.4 Sal. Difenhidramin 50 mg Comp. Difenhidramin 5 mg sau 3.7 Căpșule Solușid 50 mg Sal. Solușid 5% x 2 ml sau 8.3 Sal. Difenhidramin 50 mg Comp. Difenhidramin 5 mg sau 9.45 Ridolol 8.45 Sal. Tracietam 20% 2 ml sau 2.5 comp. Amoxicilin 25 mg sau 4.5 mg x 15 mg comp. Cinnarizina 25 mg sau 12.0 mg Sal. Tracietam 20% 2 ml sau 8.0 mg sau 12.0 mg x 40 mg x 6.0 mg Sal. Cerebrohidrat 0.5 ml sau 2 ml sal. Fenilalanin 2.5% x 2 ml sal. Glucoză 40% x 20 ml sau	250 mg 150 mg 150 mg x 30 ml x 3.0 g 150 mg x 30 ml x 3.0 g 150 mg x 30 ml x 0.75 g 30 mg 30 mg x 20 ml x 0.6 g 150 mg 150 mg x 10 ml x 1.5 g 20 mg 20 mg x 0.1 ml x 1 g 50 mg 50 mg x 30 ml x 1.5 g 75 mg 75 mg x 30 ml x 0.25 g 100 mg 50 mg x 10 ml x 1.0 g 50 mg x 5 ml x 0.25 g 150 mg x 5 ml x 0.5 g 30 mg 30 mg x 10 ml x 0.5 g 30 mg x 35 ml x 0.75 g 1200 mg 1200 mg x 40 ml x 6.0 g 1200 mg x 10 ml x 12.0 g 50 mg 50 mg x 60 ml x 3.0 g 45 mg 45 mg x 60 ml x 2.7 g 75 mg 75 mg x 40 ml x 3.0 g 120 mg 120 mg x 30 ml x 3.0 g 10 ml 10 ml x 10 ml x 20 ml 2 ml 2 ml x 10 ml x 20 ml 20 ml 20 ml x 10 ml x 200 ml sau	

Fig. 2. A fragment of the Database „Treatment”

The table *Treatment* can be accessed from the Contents page of the electronic manual. The system can be used as well in medical practice, as for training of healthcare professionals. The strategies implemented within system are based on the knowledge of expert specialists in the area.

IX. CONCLUSION

In the paper was described a project of development of an intelligent support system within research and treatment area of epilepsy.

The tasks of the research are:

- to prove based on material of over 100 patients with remissions that epilepsy is curable;
- to group these people by remissions groups;
- to develop and implement an intelligent support system for epilepsy research, diagnosis and treatment assistance;
- to develop and implement the principles of psychological, psychiatric and to remedy the critical situations with which face epileptics, including support services under the socio-psychological and psycho-neurological clinics.

Currently are developed: an expert system for diagnosis of epilepsy patients with psychiatric disorders, an electronic textbook in the area of epilepsy, a support system for developing treatment programs for patients with epilepsy and other components in the context of research [3, 4].

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