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THE EFFECTIVENESS OF THE MEDICAL DECISION-MAKING SUPPORT SYSTEM "ELECTRONIC CLINICAL PHARMACOLOGIST" IN THE MANAGEMENT OF PATIENTS THERAPEUTIC PROFILE

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ABSTRACT

Objective: There is a huge amount of new information about drugs in the scientific world every day that cannot be tracked in time and the practitioner cannot be remembered. There is a large flow of patient data, in the clinical practice, where medical information systems are used, which, unfortunately, is not fully processed in real time. The objective of the present study was to decide about the problem by using ECF. Methods: As the semantic core in the ECF was used by the UMKB, which accumulates knowledge from all areas of practical medicine and basic science, starting with the clinical experience of doctors and ending with general pharmacology. Within the framework of UMKB, a separate area is developed, where knowledge in the field of pharmacology is presented in the form of a semantic network. Results: The patient was successfully treated with the support of the ECF system. Pain syndrome in the patient was stopped almost immediately after 2 days, sleep was restored, and the patient stopped waking up in the middle of the night due to pain. Conclusion: Based on the results of the tests the ECF system was introduced into practice in several Russian clinics.

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Introduction

Ensuring the safe use of medicines is one of the global priorities of modern health care. According to the world health organization, adverse reactions (side effects) of drugs are among the top ten leading causes of death in many countries. The effectiveness of the detection of drug safety problems largely depends on the attention to pharmacovigilance of doctors and

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pharmacists, their willingness to inform regulatory authorities, and pharmaceutical manufacturers of the identified adverse reactions. Today, health professionals do not report all the complications of the use of drugs that they face in their work. This is largely due to the lack of time, fears of administrative sanctions for the development of adverse reactions, underestimation of the importance of the information sent and lack of knowledge about pharmacovigilance [1, 2]. The problem of ensuring the completeness and quality of reports of adverse reactions reported to Roszdravnadzor remains important [3-6].

Additional risks of insufficient awareness of the properties of the drugs used are related to the fact that the majority of clinical trials have been initiated and funded by pharmaceutical companies [7-9]. The results of studies that did not meet the expectations of the sponsor and did not show the expected effectiveness or safety of the studied product, is not always published. Thus, the use of exclusively published data is not enough to conduct a full analysis and build an accurate prediction of the drug behavior in a wide clinical practice [10-12].

The solution of the above problems is the development and implementation of an automated intelligent system in the clinical practice for monitoring the effectiveness and safety of prescribed therapy, which allows protecting the health of citizens when using medicines [11].

Materials and Methods

Electronic clinical pharmacologist (ECF) is a physician decision support system (DSS) for doctors. The system is based on the Unified Medical Knowledge Base (UMKB), which is updated with the release of new drugs and the release of specialized publications in peer-reviewed biomedical scientific journals. When used in clinical practice, ECF reduces the risks of medical mistakes and errors at the stages of pharmacotherapy, reduces the number of complications and side effects from the use of drugs, reduces the time-spending of the doctor, and improves the quality of medical care. When the patient is discharged, the system generates an electronic prescription by which the patient can apply to any pharmacy and receive the prescribed medicines [4,5].

Within the framework of UMKB, a separate area is developed, where knowledge in the field of pharmacology is presented in the form of a semantic network. It has over a million concepts used in the industry and millions of connections between them, as well as intersystem connections with other sections of UMKB, in particular, with pathological signs and factors that determine the personal characteristics of the organism. Such a volume of formalized knowledge in this field was accumulated with the help of crowdsourcing technology (an expert group of clinical pharmacologists, pharmacists, and doctors of different specialties) in combination with the technology of machine analysis of medical texts. As a result, more than 20 thousand instructions of medicines and more than 8 thousand publications in peer-reviewed biomedical scientific journals were analyzed.

The ECF system is integrated into the MIS ("Jupiter") of the Stavropol diagnostic center, where it allows to check drug prescriptions in the background and issue recommendations at the doctor's electronic workplace. UMKB is located in the "cloud", i.e. the system which transmits depersonalized and encoded data and receives a response from the "cloud" server. The system is updated in real time.

The study was conducted in the ANMO "Stavropol regional clinical consultative and diagnostic center" and LLC "Dental clinic of Professor Dolgalev".

The ECF system was installed on the computers of doctors of clinics and was used as a tool for checking the drug prescriptions.

Results and Discussion

From 2017 to 2018, 500 patients with disorders of the musculoskeletal, urinary, and cardiovascular systems were examined at the Stavropol diagnostic center. In accordance with the inclusion and non-inclusion criteria, 301 patients were selected, which in turn were randomized into two groups (table.1). The first group included 151 patients aged 56±12 years, whose drug prescriptions were carried out using the ECF system at all stages of the patient's stay in the hospital. The second group with 150 patients aged 55±10 years was considered as the control group, where drug therapy was administered without the support of the ECF system.

Table 1: General clinical characteristics of patients and their distribution in groups.

Index	Group 1 (with ECF support)	Group 2 (without ECF support)	Amount
Number of patients	151	150	301
Age, years (m±D)	56±12	55±10	55,5±11
Sex m / f	76/75	80/70	156/145
Psoriatic arthritis, abs.number of patients (%)	57 (38%)	45 (30%)	102 (34%)
Coronary heart disease, abs.number of patients (%)	51 (34%)	48 (32%)	99 (33%)
Pyelonephritis, abs.number of patients (%)	42 (28%)	56 (37,3%)	98 (32,6%)

Hypertension, abs.number of patients (%)	54 (39%)	51 (36%)	101 (37%)
Diabetes mellitus, abs.number of patients (%)	1 (0%)	0 (0%)	0 (0%)
Combined pathology, abs.number of patients (%)	48 (33%)	42 (27%)	90 (29%)

Basically, drugs were prescribed as part of the following pharmacological groups: cytostatic drugs from the group of antimetabolites, antiplatelet agents, proton pump inhibitors, synthetic glucocorticosteroids (GCS), immunosuppressants, diuretics.

Comparative performance indicators of the ECF system in two groups are given in table 2.

Table 2: General characteristics of the purposes and effectiveness of the ECF system in two groups.

Performance indicator	Group 1 (with ECF support)	Group 2 (without ECF support)	Amount
the total number of detected drug-drug interactions	78	102	180
- critical	90	96	186
the total number of identified limitations for using, related to diagnosis and age	18	24	42
the total number of identified duplicate combinations	93	87	180
the total number of warnings that allowed the doctor to have a correct therapy in a timely manner	289	0	289
the total number of errors in the appointment/development of side effects or complications of therapy	37	343	380
- assignment errors identified by the ECF system	0	309	309

As can be seen from the first row of the table, the two groups were comparable in the number of irrational assignments. However, the total number of therapy errors and complications was 46 times more than in the second group.

In the second group without the use of ECF, in 48% of cases, there were side effects; complications of therapy; irrational combinations; polypragmasia; as well as drug interactions including bleeding in the gastrointestinal tract, increased shortness of breath, nausea, vomiting, stool retention, and high blood pressure.

In the second group of patients the following problems were recorded (appointments were checked through the ECF system retrospectively):

- inter-drug interactions, both in the form of pharmaceutical incompatibility and pharmacological interactions.
- prescribing of medicines in the presence of contraindications and restrictions to use, taking into account the main and concomitant diseases;
- prescription of drugs without regard to age restrictions;
- unwarranted co-administration of excessive quantities of medicines for the treatment of the same disease (polypharmacy);
- anticipated side effects that could have been avoided if the ECF SYSTEM was used in a timely manner;
- exceeding the maximum permitted daily dose, taking into account the method of the drug application and body weight.

Among other things, the control group was recorded with repeated complaints of patients on a long queue to the administration when receiving a prescription.

Thus, in 88.6-90.1% of cases, the ECF system was able to prevent the irrational appointment of a doctor and improve the safety of therapy by improving the prognosis of clinical outcome and the quality of patient management.

As an example, the clinical case of a patient with psoriatic arthritis - a systemic inflammatory disease that requires the appointment of combined pharmacotherapy was considered in more details.

The 67-year-old patient turned to a therapist at the Stavropol diagnostic center. The following data were entered into the web-interface and MIS ECF: age, height, body weight, nosological forms, and about which a drug appointment was made. In this particular example, the doctor revealed the main disease – psoriatic arthritis and concomitant diseases: coronary heart disease and hypertension stage 1.

Based on clinical, x-ray, and biochemical data, the doctor prescribed the therapy as follows: methotrexate (repeated courses), clopidogrel (4 tablets in the morning), omeprazole (20 mg once a day), dexamethasone (I/m, 1 ml once a day), Ketonal (capsules of 50 mg, 2 times a day), bisoprolol (tablets of 5 mg, 1 time a day) (Fig. 1).

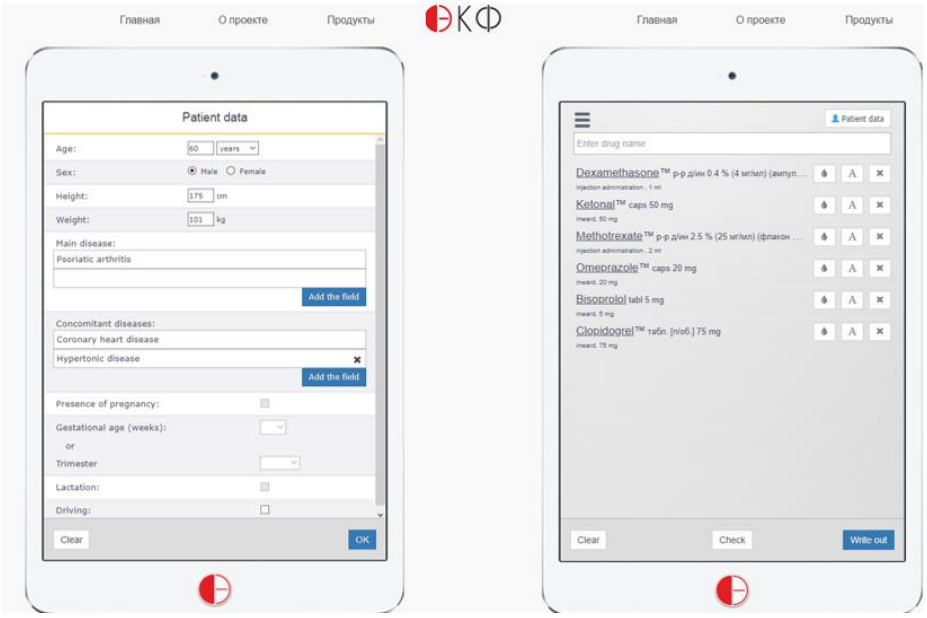

Figure 1: The original patient data and the destination worksheet.

When checking the entered data, the system issued 3 warnings aimed at helping the doctor to optimize the selection of drug therapy:

1. Drug-drug interactions.
2. Contraindications and limitations.
3. Age limit.

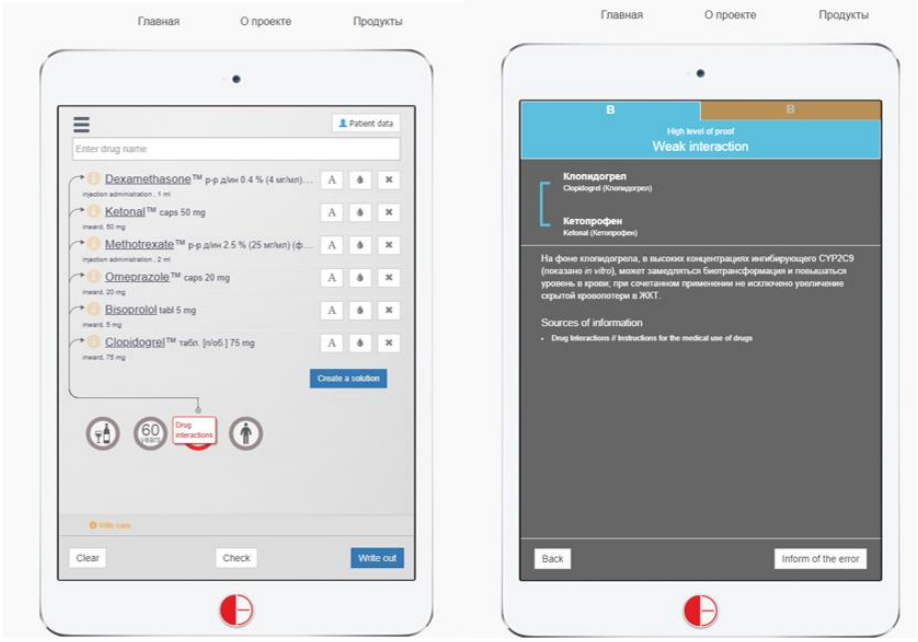

Figure 2: Identification of the Interactions between drugs.

In this case, there were 4 drugs that could enter into the patient's body in inter-drug interactions.

Figure 3 shows the interaction between Ketonal and clopidogrel, which in this case was generally insignificant (which is indicated in blue). Despite the antiplatelet effect of both drugs, their combination is rational and the risk of gastrointestinal bleeding is low.

The system focused on the combination of methotrexate and omeprazole. Thus, their combined use is expected to increase the concentration of methotrexate in the blood plasma, which is a factor in enhancing its pharmacodynamic effects.

Warning "use with caution" system issued in relation to the combination of dexamethasone and Ketonal, since their combined use in this patient was likely to increase the risk of erosive and ulcerative bleeding in the gastrointestinal tract (GI). In this connection, it was recommended to conduct fibrogastroduodenoscopy (FGDs) before using this combination.

Age restrictions in our example were relevant for the use of methotrexate in the treatment regimen (elderly, 67 years).

The potential incompatibility of dexamethasone and bisoprolol with alcohol and alcohol-containing products was also noted by the ECF system. Bisoprolol in combination with ethanol can cause orthostatic hypotension in the human body. Therefore, it is necessary to exclude the use of alcoholic beverages when taking this drug on the recommendation of the system.
The patient was successfully treated with the support of the ECF system. Pain syndrome in the patient was stopped almost immediately after 2 days, sleeping was restored, and the patient stopped waking up in the middle of the night because of pain.

Conclusion

The ECF system was integrated into the IIA "Jupiter" of Stavropol diagnostic center. The system showed easy IP functionality for integration.
The use of ECF has improved the efficiency of error detection in the appointment of drugs in the following pathologies: CHD, pyelonephritis, and psoriatic arthritis up to 90%: when handling psoriatic arthritis – 90%, when handling pyelonephritis - 87,09%, and when dealing with complaints of CHD – 90% compared with the control group.
Based on the results of the tests, the ECF system was introduced into practice in the following medical institutions: Voronezh diagnostic center, Stavropol diagnostic center, Dolgalev Clinic.
Today, the Electronic clinical pharmacologist system is undergoing a pilot clinical testing in several regions of the Russian Federation (Stavropol territory, Irkutsk region, Moscow, Moscow region, Rostov region). The project team developed recommendations for the use and implementation of the latest cybernetic medical systems, their modernization, and development of similar systems.

Author's Contribution

G. A. Bledzhyants, A. E. Mishvelov and K.V. Nuzhnaya developed the program source. O. I. Anfinogenova managed the project, J. A. Isakova evaluated the pharmacological statistics, R. S. Melkonyan supervised the medical research, G. Y. Hite carried out a practical investigation. V. E. Suprunchuk, A. V. Makova, and A. N. Popov tested the system and prepared the manuscript. V. S. Ovechkin reviewed and edited the manuscript. M.P. Marinicheva supported all technical aspects of the experiment

Conflict of Interest

The authors declare no conflicts of interest

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