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INTERPRETATION OF LABORATORY RESULTS THROUGH COMPREHENSIVE AUTOMATION OF MEDICAL LABORATORY USING OPENAI

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In modern medicine, laboratory tests play an important role in the diagnosis, treatment and monitoring of patients. However, the volume and complexity of the data obtained can create challenges for interpreting the results. In this paper, we present a study on the application of integrated automation of a medical laboratory using OpenAI for a more accurate and effective interpretation of laboratory results.

Interpreting laboratory results through integrated automation using artificial intelligence (AI) and other digital technologies automatically analyzes and interprets laboratory results. This approach aims to streamline the process of interpreting laboratory results and provide more accurate, consistent and timely results to healthcare providers. Comprehensive automation of the interpretation of laboratory results can improve the efficiency and accuracy of laboratory results, leading to improved patient outcomes and better clinical decision-making. However, it is essential to note that AI models are imperfect and can still make mistakes. Therefore, healthcare professionals should always review automated interpretation results before diagnosing or treating. The work presented results in applying OpenAI to interpret laboratory results in the laboratory information system smartLAB Kazakhstan, which provides a complete cycle of automation of all medical laboratory processes.

In the course of the study, an automated information system of a medical research complex using artificial intelligence was developed and implemented

Keywords: information system, OpenAI, interpretation, laboratory analyzers, equipment

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1. Introduction

The field of medical laboratory testing plays a crucial role in diagnosing and monitoring diseases, guiding treatment decisions, and evaluating overall patient health. However, the interpretation of laboratory results can be a complex and time-consuming task for healthcare professionals. In recent years, there has been a significant advancement in the application of artificial intelligence (AI) technologies, particularly through the use of OpenAI, to automate and streamline various processes in the healthcare industry.

One area where OpenAI has shown remarkable potential is the comprehensive automation of medical laboratories. By leveraging AI algorithms and machine learning techniques, OpenAI can process vast amounts of laboratory data and provide real-time, accurate interpretations. This automation not only reduces the burden on laboratory staff but also enhances the overall efficiency and accuracy of the diagnostic process.

The interpretation of laboratory results involves analyzing numerous parameters, such as blood counts, biochemical markers, microbiological cultures, and genetic tests. Each parameter requires careful analysis, taking into account the patient's medical history, symptoms, and other relevant factors. OpenAI's advanced algorithms can learn from vast databases of medical knowledge and integrate this information to generate meaningful interpretations, taking into account various contextual factors that might affect the results.

Moreover, OpenAI can assist in the identification of patterns and trends in laboratory data that may not be immediately apparent to human observers. By recognizing subtle correlations and associations between different parameters, OpenAI can provide valuable insights that may help in the early detection of diseases or the optimization of treatment plans. This proactive approach to data analysis can significantly contribute to improved patient outcomes and the prevention of potentially serious health conditions.

Another significant advantage of using OpenAI for laboratory result interpretation is its ability to handle large-scale data processing. Medical laboratories generate vast amounts of data on a daily basis, which can be overwhelming for healthcare professionals to analyze manually. OpenAI's automation capabilities enable the rapid processing of extensive datasets, ensuring that no valuable information is overlooked and reducing the risk of human error.

The integration of OpenAI into medical laboratories also allows for seamless collaboration and knowledge sharing among healthcare professionals. With the capability to access a centralized AI system, healthcare providers can exchange insights and interpretations, promoting standardized practices and facilitating decision-making processes. This collaborative environment fosters a multidisciplinary approach to patient care and encourages the sharing of best practices across different healthcare institutions.

Furthermore, OpenAI's automation of laboratory interpretation can lead to significant cost savings. By reducing the time and effort required for manual analysis, healthcare institutions can optimize their resource allocation and improve overall operational efficiency. This can translate into lower healthcare costs for patients and healthcare systems, making quality diagnostics more accessible to a broader population.

Despite the numerous benefits, it is essential to note that OpenAI should be considered as a supportive tool rather than a replacement for healthcare professionals. The human expertise and clinical judgment of medical professionals remain critical in the interpretation of laboratory results. OpenAI's role is to augment their capabilities by providing accurate and timely information, assisting in decision-making processes, and freeing up valuable time for more personalized patient care.

Modern medical diagnostics and research place increasingly high demands on the accuracy, speed and efficiency of interpretation of laboratory results. With the development of new technologies and the increasing volume of medical data, medical laboratories face a number of complex problems that can affect the quality and accuracy of analysis.

One of the key factors determining the success of medical diagnostics is the automation of information systems. Traditional approaches to data processing and interpretation of results can be inefficient and time-consuming. Despite some advances in automation, there is a need to develop more advanced and intelligent solutions.

One of the potential solutions to the problems facing medical laboratories is the use of artificial intelligence (AI). In particular, OpenAI is an advanced artificial intelligence system with the ability to analyze, process and interpret large amounts of data with high accuracy and speed.

However, before implementing integrated automation using OpenAI in medical laboratories, it is necessary to conduct scientific research to assess the effectiveness, advantages and possible limitations of this approach. Such studies will help to determine the optimal parameters of model training, assess the degree of automation and explore the possibilities of using AI in various fields of medical diagnostics.

In conclusion, the comprehensive automation of medical laboratories using OpenAI has the potential to revolutionize the interpretation of laboratory results. By leveraging AI algorithms and machine learning techniques, OpenAI can process vast amounts of data, identify patterns, and provide real-time, accurate interpretations. This technology enhances efficiency, reduces errors, promotes collaboration, and contributes to better patient outcomes. As the field of AI continues to evolve, the integration of OpenAI into medical laboratories holds tremendous promise for the future of diagnostics and healthcare delivery.

2. Literature review and problem statement

The paper [1] is devoted to the creation of automated workplaces of complex medical information systems. It discusses the main aspects, features and requirements for the structure and software of specialized workplaces (ARMov), which allow you to automate the organization and optimize medical and diagnostic processes in clinical settings and management of a medical institution. As an example, an emergency medicine hospital is considered. Part of the problem that has remained unexplored in this paper is related to the consideration of aspects of the efficiency and effectiveness of the implementation of the created automated workplaces. Probably, the paper did not provide detailed information on how the implementation of specialized ARMov leads to concrete improvements in medical practice, optimization of processes and improvement of the quality of healthcare. This could include analysis of research results, statistical data on improving the effectiveness of diagnosis and treatment, reducing waiting times, improving patient management and resources.

The paper [2] examines the latest achievements in the field of artificial intelligence (AI) and its application in biomedical applications. The main attention is paid to the problems associated with the development of medical AI systems, as well as the economic, legal and social consequences of the use of AI in the field of healthcare. The development of data availability and overcoming computational limitations have led to the use of AI in medicine to solve complex problems. In this review, we present the current landscape of AI applications in medicine and review the latest advances in the diagnosis, treatment and management of patient health using AI technologies. They also analyze in detail the challenges faced by the developers of medical AI systems, as well as discuss the social, legal and economic aspects of the use of AI in the medical field. The work does not sufficiently cover the ethical and social aspects of the use of artificial intelligence in medicine. Problems related to patient data confidentiality, algorithm transparency, responsibility for AI errors, as well as issues of trust on the part of patients and medical professionals in automated systems are also important aspects of the development of AI in healthcare.

In the paper [3], an introduction to artificial intelligence (AI) and its subsection – machine learning is considered. The following sections describe machine learning systems that are currently used in clinical laboratory practice or are proposed for such use in recent studies. Machine learning systems using laboratory data outside the clinical laboratory are also considered, as well as problems associated with the introduction of machine learning and future possibilities of its application in laboratory medicine.

Artificial intelligence and machine learning have a significant impact on the practice and scope of laboratory medicine. This has become possible thanks to advances in computing and the universal digitalization of medical information. Despite the fact that these technologies are rapidly developing and being described, their implementation has so far been limited. To encourage the adoption of reliable and sophisticated machine learning technologies, it is necessary to continue to develop best practices and improve the information system and communication infrastructure. The participation of clinical laboratories is important to ensure the availability of laboratory data and their integration into reliable, safe and clinically effective diagnostics with machine learning support. The paper does not consider in detail the problems of integration and adaptation of artificial intelligence and machine learning technologies into real working processes of laboratory medicine. This may include difficulties associated with the transition from the theoretical concept of artificial intelligence to its practical use, integration with existing systems, training of medical professionals to use these technologies, etc.

The paper [4] considers the issues of information security in medical information systems. It presents the basic concepts, requirements and classification of measures necessary to ensure the security of information, data and programs. The authors describe organizational and software-technical means of ensuring information security in clinical practice using the medical information system ExterNET. The development of a security system takes into account the peculiarities of medical information. The paper also describes the principles of the security policy in clinical information systems, including the principle of continuous improvement and development of the information security system, as well as the principle of the integrated use of protective equipment in all elements of the medical institution and at all stages of information processing. The scheme of interaction of the components of the information security subsystem, as well as the algorithms of their functioning are presented. In his work, he does not pay enough attention to the technical aspects of ensuring information security in medical information systems. This may include a more detailed description of technical measures and mechanisms, such as data encryption, multi-level authentication systems, protection against malicious software and other technical tools that ensure data security.

In the paper [5], the field of laboratory medicine is considered, where minimizing errors and establishing standardization are possible only through predetermined processes. The purpose of this study was to create an experimental model of the decision-making algorithm, which was open to improvements and allowed to efficiently and quickly evaluate the results of biochemical tests with critical values by simultaneously taking into account several factors. The paper does not conduct a comparative analysis of the developed model with other existing methods of evaluation and decision-making, such as traditional approaches or other machine learning algorithms.

The paper [6] discusses the importance of clinical diagnostic laboratories that produce information as their main product. For this information to be valuable, it must be clinically relevant, accurate, and provided in a timely manner. Despite the fact that diagnostic information can significantly improve patient treatment outcomes and reduce healthcare costs, technological problems and methods of organizing laboratory work processes have an impact on the timeliness and clinical value of diagnostics. This paper will examine how setting priorities in laboratory practice, with a patient focus, can be used to optimize technological advances in order to improve patient care. The authors of the paper were limited to a certain volume and could not consider in detail all aspects of the problem, including obstacles to the introduction of advanced technologies.

The paper [7] presents the results of the use of laboratory information systems in a clinical laboratory. The main purpose of the laboratory service is to provide clinical departments of medical institutions with qualitative and quantitatively sufficient laboratory analysis data in accordance with standards. The main advantages and results of using laboratory information systems in clinical practice are shown. This paper presents examples of the use of artificial intelligence (AI) in medicine for processing large amounts of data and searching for new biomarkers, as well as describes some of the developments and tools used in this field. The problem that has remained unexplored or insufficiently discussed in this context is related to the limited discussion of ethical, legal and privacy issues related to the use of AI in medicine.

In the paper [8], the authors present a brief introduction to machine learning for medical professionals and give a comprehensive review of the literature describing the current state of the use of machine learning in routine laboratory medicine. Although machine learning is in its early stages, it is already being used to automate laboratory tasks, optimize resource usage, and provide personalized reference ranges and test interpretation. The published literature indicates that machine learning will become increasingly important for laboratory technicians. The authors suggest that in the future laboratories will actively use these methods to significantly improve the efficiency and accuracy of diagnostics. The paper emphasizes that the use of machine learning in laboratory medicine has the potential to significantly improve the processes of diagnosis, optimization and interpretation of test results. This can play an important role in improving the quality of medical practice and improving treatment outcomes.

Artificial intelligence and machine learning in laboratory medicine: The problems of integration and adaptation of artificial intelligence and machine learning technologies into real laboratory medicine workflows are not being solved enough. The paper does not address practical issues such as the transition from theory to practice, integration with existing systems and training of medical professionals in the use of these technologies.

3. The aim and objectives of the study

The aim of this study is determination of the possibility of using the smartLAB laboratory information system (hereinafter referred to as LIS) and OpenAI for interpreting the results of laboratory studies.

To achieve the aim mentioned, the following objectives are accomplished:

– to determine requirements for data interpretation systems for medical laboratories;

– to develop and implement automated interpretation systems for laboratory results.

4. Materials and methods of research

The object of the research is the integration of the smartLAB Laboratory Information System (LIS) with OpenAI for the purpose of interpreting the results of laboratory studies. The study investigates the feasibility and effectiveness of using these technologies to enhance the interpretation process within medical laboratories.

The main hypothesis of the study is that by combining the smartLAB LIS with OpenAI, it is possible to create an automated interpretation system that can accurately analyze and interpret the results of various laboratory studies. This integration aims to improve the efficiency, accuracy, and consistency of result interpretation while reducing the reliance on manual interpretation by laboratory professionals.

Several assumptions are made in this work to guide the research and development process. These assumptions include:

1. The smartLAB LIS is capable of integrating with OpenAI and can effectively manage the data flow between laboratory equipment and the AI interpretation system.
2. OpenAI, when properly trained and fine-tuned, has the potential to understand and interpret laboratory data across a range of test types and parameters.
3. Adequate and reliable training data are available to train the AI model effectively for accurate interpretation.

To manage the complexity of the study, certain simplifications have been adopted:

1. The study assumes that the smartLAB LIS and OpenAI integration does not face significant technical compatibility issues during the implementation process.
2. The focus is primarily on the interpretive aspect of laboratory results and does not delve into broader aspects of laboratory management or workflow optimization.
3. The study simplifies the clinical variability and nuances that may arise in interpreting complex cases, concentrating on general interpretation scenarios.

These assumptions and simplifications are important for guiding the scope and direction of the research. However, it's crucial to recognize that real-world implementation and outcomes might be influenced by factors not fully accounted for in the study's assumptions and simplifications [16].

The structuring and synthesis of almost any automated system are based on the choice of a decomposition scheme for a system-wide task that allows for the coordination of local modules, their coordination according to goals, criteria, constraints and management methods. Function decomposition method. This makes it possible, taking into account the main goal, to build a "tree of goals" facing the system under study, and then a "tree of functions" through which the goals are realized (Fig. 1).

Taking into account the fact that several different objects can coexist within the system S, for example, $i_1, i_2, ..., i_n$, the functions of the first level include the functions of a set of certain i–x objects. Various operations can be performed on each object from the set $\{i\}$, for example, $j_1, j_2, ..., j_n$. In accordance with this, the functions of the second level include the functions of a set of operations characteristic of a given object, for example, i_1. The functions of the third level are functions of some object, for example, i_1, when performing a certain operation on it, for example, j_1, consisting of a set of so-called transitions, for example, $k_1, k_2, ..., k_n$ and so on.

As a result, the decomposition of the system functions in general can be expressed as follows:

$$Q^F = \sum_{i=1}^{n} \sum_{j=1}^{m} \sum_{k=1}^{l} q_{i,j,k},$$

where Q^F is the total number of elementary functions, through the implementation of which the main goal X is achieved; n is the number of i–x objects (i=1, n); m is the number of j–x operations performed on the i-th object (j=1, m); l is the number of k–x transitions into which the j-th operation can be divided (k=1, l); $q_{i,j,k}$;... is the number of the control function of the i–m object when it passes the k-th transition of the j-th operation.

Web services technology. Web services that produce knowledge base training through OpenAI have been published. The Lab API is published at https://ai.smartlab.kz, with the following methods:

– getToken – token for authorization;
– checkToken – token validity check;
– GetExplanation – getting interpretation.

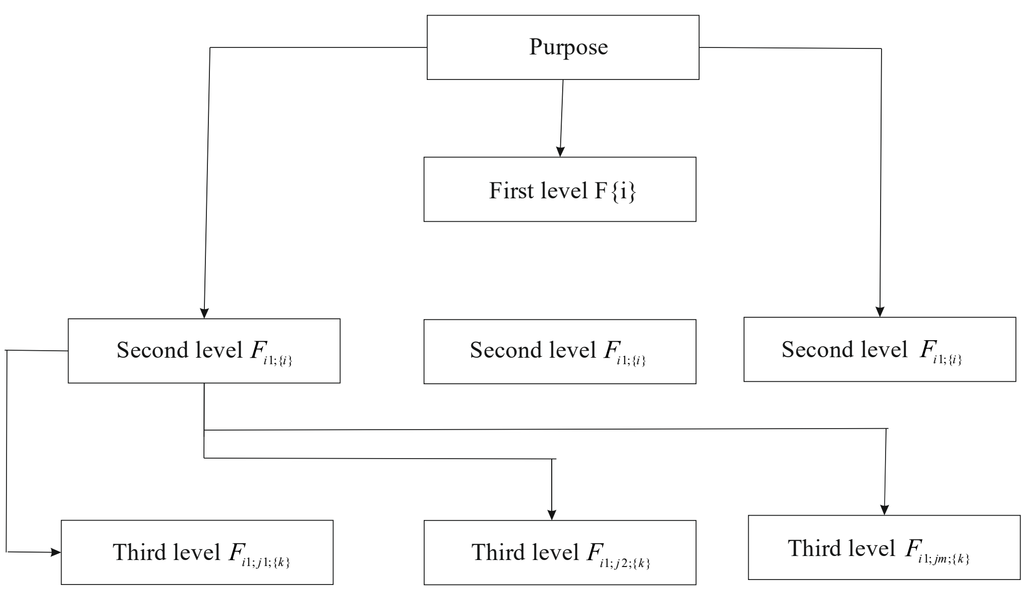

Fig. 1. Function decomposition method

Hypothesis about the reduction of the human factor: Automation of the interpretation of laboratory data can reduce the human factor and the probability of errors, which will increase the reliability and continuity of the analysis.

5. Results of the study of interpretation of the results of calculation of automation of the information system of the medical research complex

5. 1. Determination of requirements for data interpretation systems for medical laboratories

The medical laboratory plays an important role in the diagnosis, monitoring and treatment of patients. However, manually performing analyses and interpreting the results can be a time-consuming and error-prone process. In recent years, there has been a rapid development of artificial intelligence and machine learning, which opens up new opportunities for automation and optimization of medical laboratories [15]. In this paper, we will explore methods of complex automation of a medical laboratory using OpenAI's open solutions and evaluate their potential to improve the quality and speed of data analysis.

Requirements for Data Interpretation Systems for Medical Laboratories:

– accuracy and reliability: the system should ensure high accuracy of interpretation of the results, taking into account the variability of data and potential errors;

– adaptability and versatility: the system should facilitate the interpretation of a wide range of laboratory studies, adapting to different types of analyses;

– efficiency and speed: the system should provide prompt interpretation of the results, providing quick and informative conclusions;

– flexibility and customizability: the system should allow adjustment of interpretation parameters taking into account the specifics of a particular laboratory and analyses;

– integration and compatibility: the system should be easily integrated with the existing laboratory information system (LIS) and other relevant infrastructures;

– intuitive interface: the system interface should be intuitive for medical personnel, simplifying the interpretation process;

– security and privacy: the system should provide a high level of security and data protection, taking into account patient confidentiality;

– training and updating: the system should support the possibility of learning taking into account new data and methodologies, as well as updating interpretation algorithms;

– technical support: system developers must provide reliable technical support and training of medical personnel;

– ethical and legal aspects: the system must comply with ethical standards and legal standards, especially regarding the use of patient data.

Compliance with these requirements will help to ensure an effective and safe system of data interpretation in medical laboratories, contributing to the improvement of diagnostics and patient care.

5. 2. Development and implementation of automated interpretation of laboratory results

Automation of all processes from the registration of patient data, the issuance of results, the interpretation of data, as well as the use of the OpenAI library was carried out by using the smartLAB intelligent laboratory information system [9].

Interpretation was carried out in real time, through full integration with laboratory equipment, using the knowledge base of interpretation of deviations from the standard values of the analyzed tests, and final interpretation using AI.

The solution consists of the main 4 stages:

1. Interaction with laboratory equipment occurs through the use of international protocols for the exchange of medical data, such as HL7 (in English health level 7 – "Seventh level") [10] and ASTM ((English American Society for Testing and Materials – "American Society for Testing Materials" [11]. But a number of modern laboratory equipment have their own local standards, and do not follow international standards. In these cases, the system is trained to recognize third-party forms and standards for interaction with the equipment. Technical interaction takes place via TCP/IP protocols (English Transmission Control Protocol/Internet-Protocol – transmission Control Protocol/Internet Protocol) and RS232 (English Recommended Standard 232 – recommended standard 232) [17].

As a result, the model of interaction with the laboratory analyzer has the following logical model (Fig. 2):

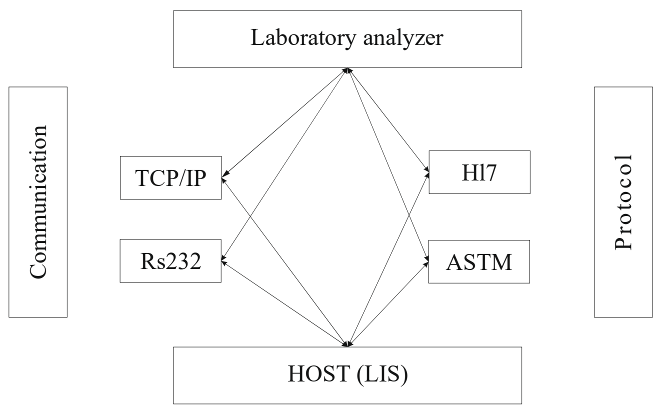

Fig. 2. The interaction model with the laboratory analyzer

Fig. 1 shows that the analysis of the analyzer with the laboratory information system uses complex communication and data exchange protocol links.

2. The use of a knowledge base of integration with laboratory equipment, where the recognition of received results from analyzers and LIS is done by training the system tests with the unique test codes of the laboratory equipment. This is done by matching the test codes with the analyzer tests (Fig. 3).

According to Fig. 3, the laboratory information system is trained on the tests available in each laboratory equipment, which allows automatic recognition of the results of laboratory tests after exporting them to the LIS.

3. Interpretation of test deviations from standard values by using the knowledge base. Each type of test has its own interpretation data, and there are also differences in the types of studies. Interpretation of qualitative types of studies is carried out by comparing the result obtained with a set of preliminary data sets, among which by default there should be a negative indicator, in other words, an indicator that denies pathology. Interpretation of qualitative research is carried out according to the following logical model (Fig. 4).

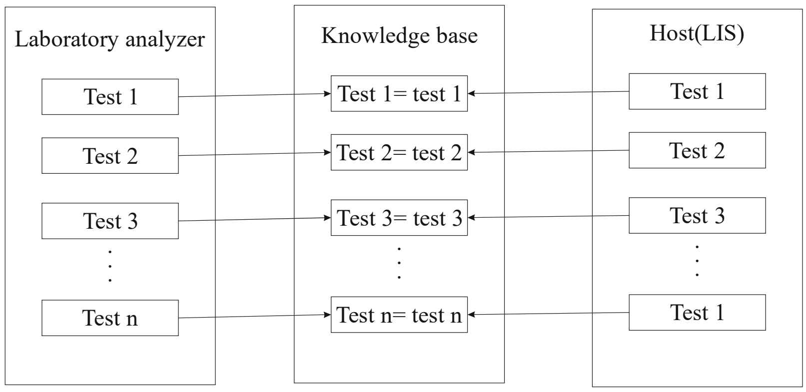

Fig. 3. Knowledge base of relationships between the analyzer and the laboratory information system

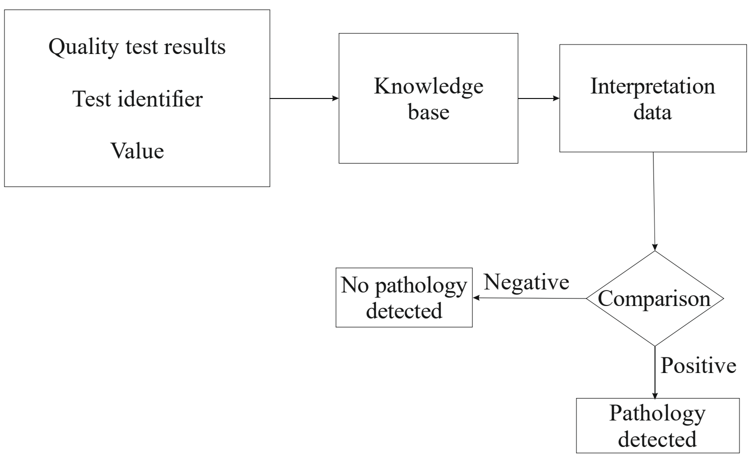

Fig. 4. A quality test interpretation model

According to the logical model in Fig. 4, the test identifier and its result are checked in the knowledge base, after receiving regulatory data, a comparison is made and information about deviations is provided.

Interpretation of quantitative and computational tests is performed by analyzing normative values, such as upper and lower threshold values. Information about reference values is extracted by accessing the knowledge base through the unique identifier of the test and its quantitative result, as well as the age and gender of the patient affects the receipt of correct normative values [14]. The process of determining deviations for quantitative tests is described and reflected in the following logical model (Fig. 5).

According to the presented model (Fig. 5), the value of the laboratory test result is checked in the data interval, that is, between the values of the lower and upper threshold. If the result is rejected, namely, if the value is greater than the upper or lower threshold, then this will be a deviation from normal values. The process of interpreting deviations from the normal values of laboratory results is carried out in real time, that is, using the technology of connecting laboratory equipment to the information system. Which allows automatic interpretation of deviations without the participation of specialists. The interpretation process is performed using complex SQL (structured query language) code, which interacts with the knowledge base in a complex way and instantly gives the necessary result.

4. Final interpretation using OpenAI, by using the text-davinci-003 model conversation algorithms [12].

```
{“model”: “text-davinci-003”,
“prompt”: “Explain why the bilirubin value is higher than the normal value and the hemoglobin value is lower than the normal value”,
“temperature”: 0.9,
“max_tokens”: 2000,
“top_p”: 1,
“frequency_penalty”: 0.0,
“presence_penalty”: 0.6,
“stop”: [“ Human:”, “ AI:”]}.
```

The basis for the interpretation of the results is the results of all the previous 3 stages, where the deviation is detected. After the deviations are detected, artificial intelligence is used, which will interpret the deviations associated with the tests. Integration with OpenAI was carried out by using public API methods [13], which allow using the knowledge base of artificial intelligence. The AI was contacted by using questions about the deviations received. The request is generated in JSON format:

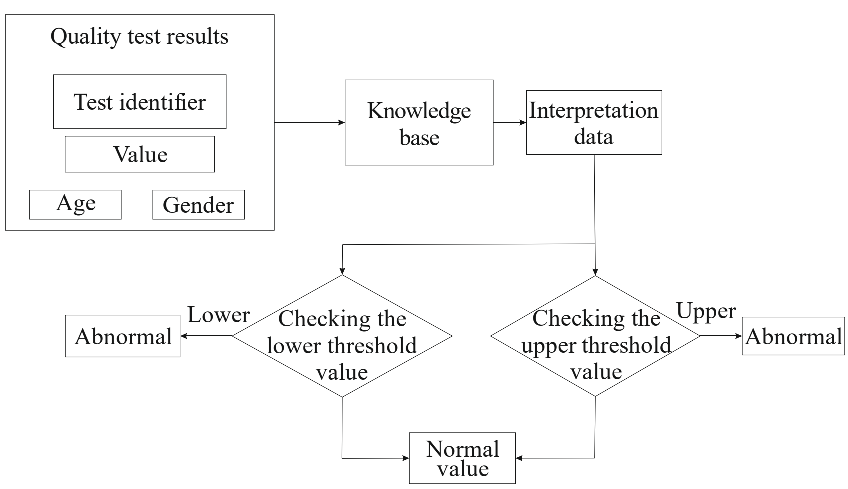

Fig. 5. Model for interpreting quantitative tests

{
"id": "cmpl-6kCzTTq5kX3lzDgUD2LarlDl3dMaE",
"object": "text_completion",
"created": 1676471043,
"model": "text-davinci-003",
"choices":[
{
"text": "High bilirubin levels and low hemoglobin levels can be an indication of liver disease or other medical conditions. Bilirubin is a waste product that is produced in the body when red blood cells are broken down. When the liver is not functioning efficiently, it is unable to properly process bilirubin, leading to its accumulation in the blood. Low hemoglobin levels indicate that the body has fewer healthy red blood cells which can be caused by many different medical conditions, including liver damage, chronic illnesses, and nutritional deficiencies.",
"index": 0,
"logprobs": null,
"finish_reason": "stop"
}],
"usage":{
"prompt_tokens": 28,
"completion_tokens": 111,
"total_tokens": 139}}.

When sending a request with such a body, OpenAI returns an interpretation on the requested text: the received JSON response contains all the necessary response parameters, as well as a text field for interpreting the result to our request (field choices→text). The "finish_reason: stop" field means that the AI has fully formed the response and there is no need to repeat the request. Upon repeated access, OpenAI will return a similar text, only with slight differences from the previous response.

All the stages necessary for an integrated approach to the interpretation of laboratory results can be briefly described by the following logical model (Fig. 6):

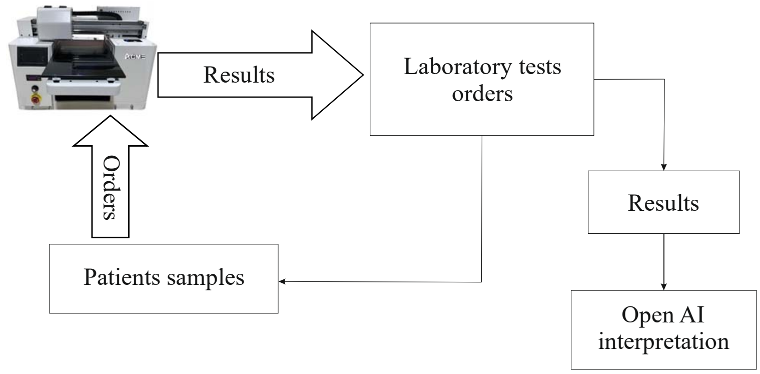

Fig. 6. Short logical model of laboratory test results interpretation

As a result, this mechanism was introduced into the Smart Lab laboratory information system and is used as an interpreter of research results (Fig. 6, 7).

The results obtained are an interpretation of the results of tests that had deviations, and are ultimately validated by doctors. The interpretation is presented in the form of a description of a possible pathology, indicating the diagnosis according to ICD 10.

A special feature is that the solution is a software module of the smartLAB laboratory information system, which automates all processes in the laboratory, and interprets the results in real time using the OpenAI knowledge base, which subsequently also forms its own knowledge base for subsequent use without referring to OpenAI.

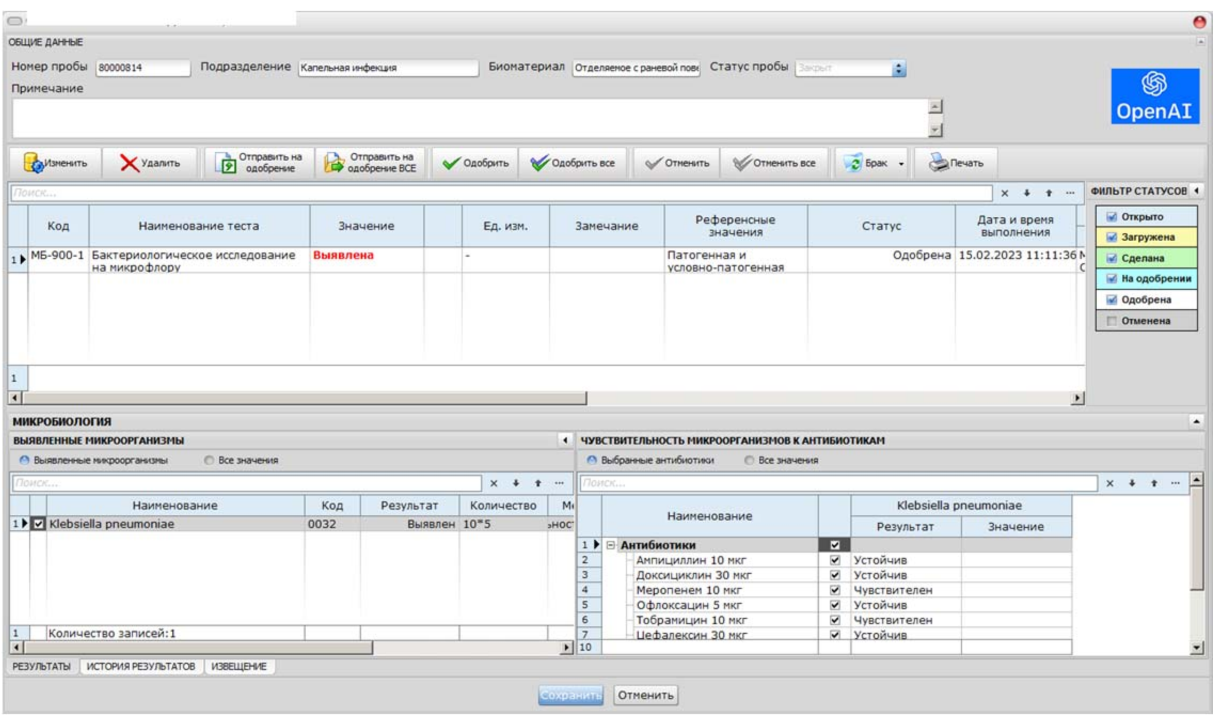

Fig. 7. Laboratory test result form

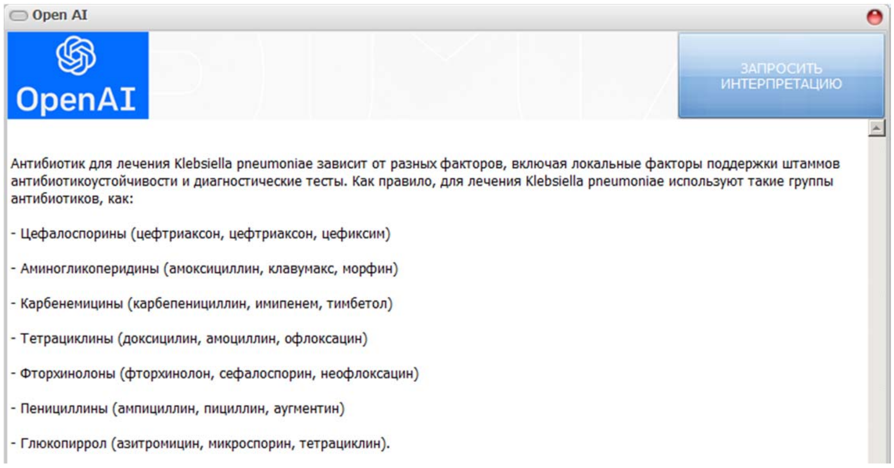

Fig. 8. OpenAI interpretation form

6. Discussion of the results of the study of interpretation of the results of calculating the automation of the information system of the medical research complex

Fig. 8 illustrates the result of the work of artificial intelligence, where the results of laboratory studies are interpreted depending on the deviations identified in Fig. 7. Fig. 7 shows a deviation from the reference values. When conducting biochemical, hemotalogical and other tests, deviations are detected automatically when results are obtained from analyzers, in the case of manual methods, deviations are identified after entering the detected result. Then, as any deviation was revealed, the user can turn to AI by clicking the "OpenAI" button in Fig. 7. After clicking the button, a window opens in Fig. 8. By clicking the "request interpretation" button, the system accesses https://ai.smartlab.kz for interpretation (API methods: getToken – token for authorization; checkToken – token validity check; GetExplanation – getting interpretation). If the interpretation is in its own knowledge base, the system will give out information without referring to OpenAI. If there is no response, the system turns to OpenAI with a request for information. The request body has been illustrated in the current paper.

In conclusion, we can say that Fig. 8 is the final software module that is used by laboratory doctors to obtain an interpretation through the use of artificial intelligence, which can be presented in two stages:

– stage 1 – identification of deviations (Fig. 7);
– stage 2 – getting an interpretation (Fig. 8).

The results obtained are an interpretation of the results of tests that had deviations, and are ultimately validated by doctors. The interpretation is presented in the form of a description of a possible pathology, indicating the diagnosis according to ICD (international classification of diseases) 10.

A special feature is that the solution is a software module of the Smart Lab laboratory information system, which automates all processes in the laboratory, and interprets the results in real time using the OpenAI knowledge base, which subsequently also forms its own knowledge base for subsequent use without referring to OpenAI.

The only limitation is the response time of OpenAI services, which has already been tested in practice. This module has already been implemented in practical application, and its own knowledge base is being trained.

7. Conclusions

1. Key aspects have been identified that should be taken into account when developing such systems. Specific requirements for accuracy, adaptability, efficiency, flexibility and safety were identified taking into account the unique features of medical data and the needs of clinical practices. The results obtained make it possible to determine the directions of development of future data interpretation systems, ensuring their compliance with the requirements of the medical community and improving the quality of diagnostics.

2. Systems have been developed and integrated that combine the smartLAB laboratory information system and OpenAI artificial intelligence. The obtained results showed that this integration contributes to a more accurate, prompt and reliable interpretation of a variety of laboratory studies. This original scientific result opens up prospects for optimizing diagnostic processes, reducing interpretation time and improving the overall quality of medical care. This approach represents an innovation in the field of medical technologies and can become the basis for further development and practical implementation in clinical practice.

Conflict of interest

The authors declare that they have no conflict of interest regarding this research, whether financial, personal, authorship or otherwise that could affect the research and its results presented in this paper.

Financing

The study was conducted without financial support.

Data availability

The manuscript has no associated data.

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