Получена: 05 Мая 2023 / Принята: 22 Июня 2023 / Опубликована online: 30 Июня 2023

DOI 10.34689/SH.2023.25.3.010

UDC 579.61

ANALYSIS OF QUALITY INDICATORS IN THE PREANALYTICAL PHASE OF LABORATORY DIAGNOSTICS AT THE CLINICAL DIAGNOSTIC LABORATORY OF THE «NATIONAL RESEARCH ONCOLOGY CENTER», ASTANA, KAZAKHSTAN

Nazym M. Yelemessova[1], https://orcid.org/0009-0008-9804-7793

Gulzhan R. Kerimbekova[1], https://orcid.org/0000-0001-9988-1351

Zaukiya K. Khamitova[1], https://orcid.org/0000-0002-2409-5644

Akmaral K. Mussakhanova[2], https://orcid.org/0000-0002-0399-5045

[1] National Research Oncology Center, the Clinical Diagnostic Laboratory, Astana, the Republic of Kazakhstan;
[2] National Medical University Astana, Department of Public Health and Management, Astana, the Republic of Kazakhstan.

Abstract

Background. The primary focus of the clinical diagnostic laboratory is to ensure the attainment of high-quality results for patient laboratory analyses.

Aim: This study aims to evaluate the effectiveness of employing quality indicators during the preanalytical phase in the "NROC LLP" laboratory through a comparative analysis of the first and second quarters of 2022. By examining this aspect, valuable insights can be gained to enhance the overall efficiency and reliability of laboratory procedures.

Results. The preanalytical phase encompasses a complex set of processes and actions that occur from the moment laboratory tests are prescribed to the initiation of analytical measurements (such as sample loading into analyzers, etc.). This stage involves not only laboratory staff but also the entire medical personnel of the departments. By implementing quality indicators during the preanalytical phase, the functioning of the procedural unit, blood sampling techniques, and proficiency in handling documentation can be assessed. Additionally, this study shed light on the organization of work within the laboratory during this stage. The research methods employed were derived from "Quality Indicators in Laboratory Medicine" proposed by the IFCC Working Group under the guidance of M. Plebani, as well as the current regulations of the Ministry of Health of the Republic of Kazakhstan.

Conclusions. Based on our research, quality indicators tend to improve when regular work is conducted with laboratory staff and the average medical personnel of our Center. Quality performance during this stage enables accurate diagnosis and facilitates appropriate patient treatment.

Keywords: *laboratory diagnostics, preanalytical stage, quality indicator.*

Резюме

АНАЛИЗ ПОКАЗАТЕЛЕЙ КАЧЕСТВА НА ПРЕАНАЛИТИЧЕСКОМ ЭТАПЕ ЛАБОРАТОРНОЙ ДИАГНОСТИКИ В КЛИНИЧЕСКО-ДИАГНОСТИЧЕСКОЙ ЛАБОРАТОРИИ «НАЦИОНАЛЬНОГО НАУЧНОГО ОНКОЛОГИЧЕСКОГО ЦЕНТРА», АСТАНА, КАЗАХСТАН

Назым М. Елемесова[1], https://orcid.org/0009-0008-9804-7793

Гульжан Р. Керимбекова[1], https://orcid.org/0000-0001-9988-1351

Заукия К. Хамитова[1], https://orcid.org/0000-0002-2409-5644

Акмарал К. Мусаханова[2], https://orcid.org/0000-0002-0399-5045

[1] Национальный научный онкологический центр, Клинико-диагностическая лаборатория, г. Астана, Республика Казахстан;
[2] НАО «Медицинский университет Астана», Кафедра общественного здравоохранения и менеджмента, г. Республика Казахстан.

Актуальность. В настоящее время основной задачей клинико-диагностической лаборатории является получение качественных результатов лабораторных анализов больного.

Цель исследования: Оценить эффективность применения индикаторов качества преаналитического этапа в лаборатории «ТОО ННОЦ» путем сравнительного анализа I-II кварталов 2022 года.

Результаты: Преаналитический этап – это комплекс процессов и действий, осуществляемый от момента назначения лабораторных анализов до начала проведения аналитического измерения (загрузки проб в анализаторы

и т. д.). На этом этапе участие принимают не только сотрудники лаборатории, а весь медицинский персонал отделений. Внедряя индикаторы качества преаналитического этапа можно увидеть работу процедурного кабинета, техника забора крови, умение работать с документацией. Также показали, как у нас организована работа в лаборатории на этом этапе. Методы исследования были взяты из «Индикаторы качества лабораторной диагностики» (предложены рабочей группой ИКЛД под руководством М. Плебани, действующих приказов Министерства здравоохранения Республики Казахстан).

Выводы: Индикаторы качества по нашему исследованию имеют тенденцию к улучшению, если на регулярной основе проводить работу с сотрудниками лаборатории и среднего медперсонала нашего Центра. Качественная работа на этом этапе дает возможность для постановки правильного диагноза и в дальнейшем лечении пациента.

Ключевые слова: *лабораторная диагностика, преаналитический этап, индикатор качества*

Түйіндеме

«ҰЛТТЫҚ ҒЫЛЫМИ ОНКОЛОГИЯЛЫҚ ОРТАЛЫҚТЫҢ» КЛИНИКАЛЫҚ-ДИАГНОСТИКАЛЫҚ ЗЕРТХАНАСЫНДА ЗЕРТХАНАЛЫҚ ДИАГНОСТИКАНЫҢ АНАЛИТИКАЛЫҚ КЕЗЕҢІНДЕГІ САПА КӨРСЕТКІШТЕРІН ТАЛДАУ, АСТАНА, ҚАЗАҚСТАН

Назым М. Елемесова[1], https://orcid.org/0009-0008-9804-7793

Гульжан Р. Керимбекова[1], https://orcid.org/0000-0001-9988-1351

Заукия К. Хамитова[1], https://orcid.org/0000-0002-2409-5644

Акмарал К. Мусаханова[2], https://orcid.org/0000-0002-0399-5045

[1] Ұлттық ғылыми онкологиялық орталық, Клиникалық-диагностикалық зертхана, Астана қ., Қазақстан Республикасы;
[2] "Астана медицина университеті" КЕАҚ, Қоғамдық денсаулық сақтау және менеджмент кафедрасы, Астана қ., Қазақстан Республикасы.

Өзектілігі. Қазіргі уақытта клиникалық-диагностикалық зертхананың негізгі міндеті пациенттің зертханалық талдауларының сапалы нәтижелерін алу болып табылады.

Зерттеу мақсаты: 2022 жылдың I-II тоқсандарын салыстырмалы талдау арқылы" ННОЦ ЖШС " зертханасында аналитикалық кезеңге дейінгі сапа индикаторларын қолданудың тиімділігін бағалау.

Нәтижелер: Аналитикаға дейінгі кезең-бұл зертханалық талдаулар тағайындалған сәттен бастап Аналитикалық өлшеу басталғанға дейін (сынамаларды анализаторларға жүктеу және т.б.) жүзеге асырылатын процестер мен әрекеттер жиынтығы. Бұл кезеңге тек зертхана қызметкерлері ғана емес, бөлімшелердің барлық медициналық қызметкерлері қатысады. Аналитикалық кезеңнің сапа индикаторларын енгізе отырып, процедуралық кабинеттің жұмысын, қан алу техникасын, құжаттамамен жұмыс істеу қабілетін көруге болады. Сондай-ақ, осы кезеңде зертханада жұмысты қалай ұйымдастырғанымызды көрсеттік. Зерттеу әдістері "Зертханалық диагностика сапасының индикаторлары" (М.Плебанидің басшылығымен ЗДСИ жұмыс тобы ұсынған, қолданыстағы Бұйрықтар Қазақстан Республикасы Денсаулық сақтау министрлігі).

Қорытындылар: Сапа көрсеткіштері. егер біздің орталықтың зертхана қызметкерлерімен және орта медициналық қызметкерлермен тұрақты негізде жұмыс жүргізілсе, біздің зерттеуіміз жақсарады. Осы кезеңдегі сапалы жұмыс дұрыс диагноз қоюға және пациентті одан әрі емдеуге мүмкіндік береді.

Түйін сөздер: *зертханалық диагностика, аналитикалық кезең, сапа көрсеткіші.*

Bibliographic citation:

Yelemessova N.M., Kerimbekova G.R., Khamitova Z.K., Mussakhanova A.K. Analysis of Quality Indicators in the Preanalytical Phase of Laboratory Diagnostics at the Clinical Diagnostic Laboratory of the “National Research Oncology Center”, Astana, Kazakhstan // *Nauka i Zdravookhranenie* [Science & Healthcare]. 2023, (Vol.25) 3, pp. 80-85. *doi 10.34689/SH.2023.25.3.010*

Елемесова Н.М., Керимбекова Г.Р., Хамитова З.К., Мусаханова А.К. Анализ показателей качества на преаналитическом этапе лабораторной диагностики в клинически-диагностической лаборатории «Национального научного онкологического центра», Астана, Казахстан // Наука и Здравоохранение. 2023. 3(Т.25). С. 80-85. *doi 10.34689/SH.2023.25.3.010*

Елемесова Н. М., Керимбекова Г.Р., Хамитова З.К., Мусаханова А.К. "Ұлттық ғылыми онкологиялық орталықтың" клиникалық-диагностикалық зертханасында зертханалық диагностиканың аналитикалық кезеңіндегі сапа көрсеткіштерін талдау, Астана, Қазақстан // Ғылым және Денсаулық сақтау. 2023. 3 (Т.25). Б.80-85. *doi 10.34689/SH.2023.25.3.010*

Abbreviations:

CARIC - Center for Anesthesiology, Resuscitation, and Intensive Care

OR - Oncohematological Resuscitation

DBMT - Department of Bone Marrow Transplantation

CHS - Center for Hepatopancreatobiliary Surgery, Oncological Hepatology, and Organ Transplantation

CCC - Center for Chemotherapy and Chemoreduction

HEMO - Hematology

CVS - Center for Vascular Surgery

MPD- Multi-profile Paid Department

COO - Center for Orthopedics and Osteooncology

CDC - Consultative Diagnostic Center with Day Hospital

CMS - Center for Multi-profile Surgery

Introduction

Laboratory medicine is currently one of the most extensive branches of clinical medicine in terms of the number of tests conducted. According to WHO data, laboratory investigations account for 75-90% of the total number of various tests performed on patients in healthcare facilities [1].

The preanalytical (Pre-A) phase is responsible for 46-77% of all errors in the overall testing process, with the following breakdown:

- Patient identification errors: 40.8%
- Blood collection errors: 12.2%
- Sample preparation errors: 30%
- Biological material transportation errors: 17%

Every laboratory should have a policy in place for error detection and prevention. The frequency of errors should be systematically determined using standardized methods [2-4].

In this study, our aim was to establish a system in our laboratory for the collection and assessment of Pre-A errors based on Quality Indicators (QIs) developed by the International Federation of Clinical Chemistry and Laboratory Medicine (IFCC) Working Group on Laboratory Errors and Patient Safety (WG-LEPS) [3-5].

Obtaining high-quality results of patient laboratory analyses is a unified process that encompasses various stages, starting from the formulation of test requests, collection of biomaterial, transportation, conducting the investigations, and concluding with the utilization of the results to provide the patient with quality medical care. The quality of this process should be ensured through collaborative efforts between physicians, the average medical personnel, and laboratory specialists [6].

The unified process of laboratory testing is commonly divided into three stages: the preanalytical, analytical, and postanalytical phases.

The preanalytical stage is a complex set of processes and actions that occur from the moment laboratory tests are prescribed to the initiation of analytical measurements (such as sample loading into analyzers, etc.). The preanalytical stage partly takes place outside the laboratory and includes the following steps [7-8]:

• Patient consultation and prescription of necessary laboratory tests by the physician.

• Completion of the test request form.

• Provision of instructions to the patient by the physician or medical nurse regarding the specific requirements for test preparation or collection of biological material.

• Collection of biological samples from the patient in the procedural unit or inpatient department.

• Transportation of the biomaterial to the laboratory.

The following quality indicators for the preanalytical stage have been implemented in the laboratory:

1) Errors in patient identification

2) Incorrect sample type

3) Number of samples unsuitable for testing, including clotted samples

4) Hemolyzed samples

All samples that fall into the above-mentioned categories are recorded in a non-conformity log by a registrar or laboratory technician. At the end of each month, the quality manager analyzes these cases and prepares an analytical report, which is then shared with the staff of clinical departments for review and implementation of corrective measures [9-11].

Methods:

We have identified the most common pre-analytical errors as follows:

1) Errors in patient identification

2) Incorrect sample type

3) Number of samples unsuitable for testing, including clotted samples

4) Hemolyzed samples.

We have standardized the terminology and structured the reporting system in our Hospital Information System (HIS) and Laboratory Information System (LIS). Data were collected monthly over a period of 6 months from 2021 to 2022. The collected data were analyzed; quality indicators (QI) were calculated.

The results were evaluated based on desired levels of effectiveness proposed by the WG-LEPS IFCC and regulatory acts of the Republic of Kazakhstan [3-5].

Quality indicators in laboratory diagnostics are evaluated in accordance with the regulatory documents and standards of the Republic of Kazakhstan:

"Approval of the Standard for the Organization of Laboratory Diagnostics." Order of the Minister of Health of the Republic of Kazakhstan No. KR DSM-257/2020, dated December 11, 2020. Registered with the Ministry of Justice of the Republic of Kazakhstan on December 14, 2020, No. 21768.

"Approval of Reporting Documentation Forms in the Healthcare Sector and Instructions for Their Completion." Order of the Acting Minister of Health of the Republic of Kazakhstan No. KR DSM-175/2020, dated October 30, 2020. Registered with the Ministry of Justice of the Republic of Kazakhstan on November 4, 2020, No. 21579.

"Approval of Reporting Documentation Forms in the Healthcare Sector." Order of the Minister of Health of the Republic of Kazakhstan No. KR DSM-313/2020, dated December 22, 2020. Registered with the Ministry of Justice of the Republic of Kazakhstan on December 23, 2020, No. 21879.

Results:

The quality indicators (QI) for the 1st and 2nd quarters of 2022 in the clinical diagnostic laboratory revealed that "Quantity of samples unsuitable for testing, clotting" and

"Hemolyzed samples" had the highest deviations from the recommended references. Therefore, these errors should be prioritized in quality improvement efforts.

Table 1. reflects the quality indicators for the Center, highlighting the improving trend in the indicators. The values correspond to the reference standards specified in the Standard.

Table 1.

Quality Indicators for the 1st and 2nd Quarter of 2022 in the Clinical Diagnostic Laboratory

№	Indicator	Recommended value	1st quarter	2nd quarter
1	Identification errors	0,1%	0%	0,024%
2	Incorrect sample type	0,03%	0,014%	0,009%
3	Quantity of samples unsuitable for testing, clotting	0,1%	0,06%	0,03%
4	Hemolyzed samples	0.06%	0,03%	0,004 %

Information source: Rejection log and material collection report
Frequency of information: Monthly

Table 2. shows that over a 6-month period in 2021, a total of 151,955 samples were received at the pre-analytical stage from the departments, out of which 173 samples were categorized as unsuitable, accounting for 0.11%. In the same 6-month period in 2022, a total of 151,723 samples were received at the pre-analytical stage from the departments, out of which 119 samples were categorized as unsuitable, accounting for 0.078%. There is a trend of improvement in the coefficient. The number of samples categorized as "hemolyzed" decreased by a factor of seven, and the number of samples categorized as "unsuitable for testing, clotting" decreased by 44 samples. The implementation of "identification errors" was initiated in April 2022 based on the recommendation of the Center's auditor.

Table 2.

Number of samples rejected during the pre-analytical stage.

	2021 (6 months)	2022 (6 months)
Total samples received during the pre-analytical stage	151955	151723
Incorrect sample type	22	14
Hemolyzed samples	50	7
Identification errors	0	37
Quantity of samples unsuitable for testing, clotting	98	54
Others	3	7
Total	173 (0,11%)	119 (0,078%)

During the investigated period, the number of samples categorized as unsuitable decreased by 54 samples. It is worth noting that no identification errors were addressed in 2021, whereas in 2022 there were 37 samples with identification errors. Taking this into account, the overall number of samples categorized as unsuitable for testing, clotting, hemolysis, and incorrect sample type decreased by 44 samples. However, there was an increase of 4 units in the number of samples categorized as hemolyzed.

Table 3.

Comparative analysis of pre-analytical stage errors by departments for the 1st and 2nd quarters.

	Quantity of samples unsuitable for testing, clotting		Hemolyzed samples		Incorrect sample type		Identification errors
Acceptable indicator range	**0,1**	**0,1**	**0,06**	**0,06**	**0,03**	**0,03**	**0,1**
Quarter	**1 кв.**	**2 кв.**	**1 кв.**	**2 кв.**	**1 кв.**	**2 кв.**	**2 кв.**
Center	0,06	0,04	0,03	0,004	0,014	0,009	0,024
CARIC	0	0,01	0	0,015	0,02	0,024	0,02
OR	0,029	0	0	0	0	0	0,012
CMS			0	0,004	0,004	0,012	0,015
HEMO	0,012	0,01	0,01	0,006	0,002	0,024	0,012
DBMT	0,09	0	0	0,003	0,021	0,024	0,024
CVS	0,22	0,23	0	0	0,003	0	0,021
CHS	0,1	0,04	0,13	0,002	0	0	0,050
CCC	0,17	0,28	0,068	0,003	0,011	0,012	0,027
COO	0,12	0,07	0,016	0	0,023	0	0,041
CDC	0,22	0	0	0	0	0,003	0,029
MPD	0,027	0	0,173	0,011	0,07	0,0	0,013

The recommended value for the “Quantity of samples unsuitable for testing, clotting” according to the Standard is 0.1%. However, in the CDL of “NROC” LLP, the values are 0.04% for the 1st quarter and 0.06% for the 2nd quarter. The highest indicators were observed in the CVS department with 0.22% and 0.23%, respectively. In the

CCC department, the values were 0.17% and 0.28%, while in the COO department, they were 0.12% and 0.07%, respectively. These findings demonstrate a notable enhancement in the respective indicator.

Over the course of 6 months, the indicator "Hemolyzed samples" at the Center was 0.01%, 0.03% for the first quarter, and 0.004% for the second quarter, falling within the recommended range according to the Standard of 0.06%. The table shows that the departments with the highest percentage of samples categorized as hemolyzed are MPD with 0.17% and 0.11%, CHS with 0.13% and 0.02%, and HEMO with 0.01% for the first quarter and 0.006% for the second quarter.

Regarding the indicator "Incorrect sample type," the recommended range according to the Standard is 0.03%. At the Center, the values were 0.014% for the first quarter and 0.009% for the second quarter. There were no violations observed for this indicator.

For the indicator "Identification errors," with recommended values of 0.1% according to the Standard, the Center had a value of 0.024%. The departments with the most identification errors were CHS with 0.05%, COO with 0.041%, and CDC with 0.029%.

Discussion:

Our findings demonstrate that quality indicators can be valuable for evaluating the Pre-A process, particularly in identifying frequently occurring errors. However, it is essential for the Hospital Information System (HIS) and Laboratory Information System (LIS) to be structured to collect error data, and the competence of laboratory staff in data management and utilization of quality control tools should be improved.

Summary by departments and recommendations for corrective actions:

Overall, there is an improvement in the indicators across all departments. The number of samples rejected has decreased. In the CVS, MPD, CHS, and HEMO 1, 2 departments, it is recommended to focus on refining blood collection techniques. Additionally, for identification purposes, it is advised that the average healthcare personnel diligently fill out the paper requisitions and cross-verify them with the Comprehensive Medical Information System (CMIS).

Conclusions:

The analysis of quality indicators demonstrates an observable improvement when comparing the first and second quarters. It is noteworthy that efforts should persist in addressing indicators that deviate from the established standards.

The pre-analytical stage plays a pivotal role in the overall process of laboratory testing, consuming a considerable amount of time. Even minor errors encountered during the pre-analytical stage inevitably led to the distortion of the quality of final laboratory test results. Thus, regardless of the laboratory's proficiency in subsequent analyses, the presence of errors during the pre-analytical stage impedes the attainment of reliable results.

All samples that have been rejected undergo thorough analysis, accompanied by collaborative efforts with the procedural unit's staff. At the conclusion of each quarter, departments are duly informed of any pre-analytical stage violations through the dissemination of an analytical report.

In the year 2022, a seminar was conducted involving the participation of the average healthcare personnel from the center after the analysis of the first-quarter performance. To enhance the quality indicators, it is imperative to engage in regular endeavors aimed at capacitating departmental healthcare personnel through ongoing professional development initiatives and refining their techniques for biomaterial collection. The implementation of seminars and workshops targeting the average healthcare personnel has yielded positive outcomes in the improvement of quality indicators. Moreover, it is crucial to emphasize the significance of patient preparation for sample collection, elucidating the pivotal role it plays in ensuring accurate test results.

Consequently, it is evident that the pre-analytical stage encompasses paramount importance in laboratory diagnostics, acting as a primary determinant in mitigating the occurrence of erroneous results and, subsequently, avoiding inappropriate treatment approaches.

Authors' contributions. *Author contribution statement: All authors were equally involved*

Conflict of Interest. *The authors declare that they have no competing interests.*

Funding Source. *The research was funded by the Semey Medical University as part of a doctoral dissertation.*

Acknowledgements. *We gratefully acknowledge assistance and support of the management of the NAO "Semey Medical University", Semey, Kazakhstan. We also want to express our gratitude to all patients who participated in the study.*

Literature:

1. Библиотека Всемирной Организации здравоохранения. Каталог публикуемых данных. Система управления качеством в лаборатории: справочник. ISBN 978 92 4 454827 1 (NLM classification: QY 25) ©, 2013, (http://www.who.int/about/licensing/copyright_form/en/index.html) (Дата обращения: 13.01 2023).

1. *Alcantara T.Y., Rezgui R., Cruz, Ch.P., Alshammary M.H., Almotairi Ya.A., Alcantara Je.C., Alshaghdali Kh.* "Detecting Preanalytical Errors Using Quality Indicators in a Hematology Laboratory" // Quality Management in Health Care. 31(3): p. 176-183, July / September 2022. DOI: 10.1097/QMH.0000000000000343 [accessed Feb 04 2023].

2. "Approval of Reporting Documentation Forms in the Healthcare Sector and Instructions for Their Completion." Order of the Acting Minister of Health of the Republic of Kazakhstan No. KR DSM-175/2020, dated October 30, 2020. Registered with the Ministry of Justice of the Republic of Kazakhstan on November 4, 2020, No. 21579. https://adilet.zan.kz/rus/docs/V2000021579 (accessed Jan 13 2023).

3. "Approval of Reporting Documentation Forms in the Healthcare Sector." Order of the Minister of Health of the Republic of Kazakhstan No. KR DSM-313/2020, dated December 22, 2020. Registered with the Ministry of Justice of the Republic of Kazakhstan on December 23, 2020, No. 21879. https://adilet.zan.kz/rus/docs/V2000021879 (Accessed Jan 16 2023).

4. "Approval of the Standard for the Organization of Laboratory Diagnostics." Order of the Minister of Health of

the Republic of Kazakhstan No. KR DSM-257/2020, dated December 11, 2020. Registered with the Ministry of Justice of the Republic of Kazakhstan on December 14, 2020, No. 21768. https://adilet.zan.kz/rus/docs/V2000021768 (Accessed Jan 11 2023).

5. *Emekli Dİ, Aslan D, Zorbozan N, Yakşi O, Tekten BÖ, Kilit AC, Aydemir E, Yasar MF, Demirci ZŞ, Çelik K, Eyyupkoca F.* Evaluation of the performance of the pre-analytical phase of the testing process in medical laboratory accreditation. // Northwestern Medical Journal. 2022 May 1. https://www.researchgate.net/publication/303696909_Quality_Indicators_in_preanalytical_phase_for_continuous_quality_improvement_in_clinical_laboratories#fullTextFileContent (accessed Feb 04 2023).

6. *Gisslén, Magnus, Veronica Svedhem, Lindborg L., Flamholc L., Norrgren H., Wendahl S., Axelsson M., Sönnerborg A..* "Sweden, the first country to achieve the Joint United Nations Programme on HIV/AIDS (UNAIDS)/World Health Organization (WHO) 90-90-90 continuum of HIV care targets" // HIV medicine 18, no. 4 (2017): 305-307. https://doi.org/10.1111/hiv.12431 Accessed Feb 06 2023.

7. *Kazakov S.P., Suslova L.A.* Development of pre-analytical quality assessment criteria for vacuum blood collection systems impacting clinical patient testing // Medical Immunology, 2020, Vol. 22, No. 3, pp. 585-598. doi: 10.15789/1563-0625-DOP-1920.

8. *Lippi G., Betsou F., Cadamuro J., Cornes M., Fleischhacker M., Fruekilde P., Neumaier M., Nybo M., Padoan A., Plebani M., Sciacovelli L.* Preanalytical challenges–time for solutions // *Clinical Chemistry and Laboratory Medicine.* 2019. *57*(7), pp. 974-981.

9. *Moussaoui M., Firsiwi K., Jbari B., El Morhit M.* Quality analysis of the preanalytical phase of laboratory tests: Case of the civil hospital (Tetouan–Morocco) CHEMAO-ELFIHRI Wafa, Vol. 8(1), pp. 1-7, January 2017 DOI: 10.5897/JMLD2016.0131 [accessed Feb 04 2023].

10. *Sciacovelli L., Lippi G., Sumarac Z., West Ja., del Pino Castro I-G., Furtado K., Ivanov A., Plebani M.* On behalf of the Working Group “Laboratory Errors and Patient Safety” of International Federation of Clinical Chemistry and Laboratory Medicine (IFCC) Quality Indicators in Laboratory Medicine: the status of the progress of IFCC Working Group “Laboratory Errors and Patient Safety” project, DOI 10.1515/cclm-2016-0929, Received October 13, 2016; accepted November 1, 2016; previously published online December 19, 2016.

References: [1]

1. Biblioteka Vsemirnoi Organizatsii zdravookhraneniya. Katalog publikuemykh dannykh. Sistema upravleniya kachestvom v laboratorii: spravochnik [Library of the World Health Organization. Catalog of published data. Laboratory Quality Management System: A Handbook]. ISBN 978 92 4 454827 1 (NLM classification: QY 25) ©, 2013, (http://www.who.int/about/licensing/copyright_form/en/index.html) (Accessed: 13.01.2023). [in Russian]

*** Corresponding author:**
Mussakhanova Akmaral - Associate Professor of the Department of Public Health and Management, National Medical University Astana, Candidate of Medical Sciences, Astana, Kazakhstan,
Mailing address: 010000, Dostyk Avenue 125, Astana, Kazakhstan
e-mail: makmaral1@mail.ru
mobile phone: +77772452200,