Oncology, Nuclear Medicine and Transplantology

Review Article

Evaluation of the Efficiency of the Admission Department in the Oncological Hospital using the Example of NROC

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Abstract:

Introduction: This study is aimed at assessing the operational efficiency of the admission department of the National Research Oncological Center (NROC) for the period from 2020 to 2024 with an emphasis on the impact of digitalization on patient management and workflow optimization. Telemedicine is a key tool for improving the availability and quality of medical care, especially for patients living in remote regions. In oncology, its importance is increasing due to the need for interdisciplinary interaction and quick routing of patients.

Methods: A retrospective analysis was conducted using internal hospital records, admission logs, and national healthcare regulations. Key performance indicators were assessed, including patient intake volume, processing time, and rejection rates. The impact of digital tools such as automated registration, routing algorithms, and remote clinical validation was examined.

Results: Patient visits increased from 5,664 in 2020 to 11,851 in 2024, while cancer-related hospitalizations rose from 1,477 to 6,102. The average waiting time for reception was reduced from 12 to 7 hours, and the processing time for documentation was reduced from 45 to 15 minutes. The introduction of digital solutions improved the accuracy of admission and reduced the number of inappropriate hospitalizations. Improvements in identifying clinical contraindications and infectious risks through remote screening technologies were also noted. The number of telemedicine consultations increased 3 times, especially in surgery and transplantology.

Conclusion: Digital transformation has significantly improved admissions efficiency, improving patient flow, reducing processing time and improving decision-making. Further development of digital infrastructure and staff competencies is recommended to ensure sustainable growth and quality of care in cancer care. The comprehensive implementation of telemedicine and interaction with air ambulance contribute to increasing the availability of cancer care, optimizing resources and reducing costs.

Keywords: Hospitalization; Oncology; Health Information Systems; Workflow Optimization; Digital Health; Patient Flow; Telemedicine

Introduction

Introduction Ensuring timely and effective oncological care is a priority task of the health care system of the Republic of Kazakhstan. Cancer continues to occupy a leading position among the causes of morbidity and mortality, putting increasing pressure on the national health care system. In this regard, early diagnosis and optimization of hospitalization processes play a key role in improving survival and improving the quality of life of patients with cancer.

Admission departments act as the first line of inpatient care and are the primary point of contact of patients with the medical system. Their main functions include triage, registration, identification, routing and documentation - all of these processes directly impact hospital capacity, patient safety and staff workload. In oncological institutions, the timeliness of admission is especially important: delays can lead to missed treatment options and a worsening of the prognosis. Therefore, improving the efficiency of admission departments is a prerequisite for high-quality cancer care.

In recent years, Kazakhstan has been actively pursuing reforms in healthcare aimed at digital transformation and increased transparency. Programs such as the Unified National Health System, the implementation of the Electronic Health Record (EMC) and the Electronic Inpatient Registry (ERSB) have dramatically changed the way health information is collected, processed and shared [1]. Digitalization in healthcare is seen not only as a technological solution, but also as an instrument of public policy.

The Ministry of Health of the Republic of Kazakhstan has consolidated its expectations from medical institutions in a number of official regulatory documents. In particular, Order No. IP DSM-225/2020 regulates the structure and functioning of admission departments, establishing requirements for infrastructure, document management and patient routing [2]. In addition, Order No. RK DSM-27 (2022) defines the procedure for the provision of medical care to patients with cancer, including hospitalization criteria, pre-selection and interdisciplinary interaction [3].

These regulations are based on the Code of Public Health and the Health Care System of the Republic of Kazakhstan No. 360-VI (2020), which emphasizes the principles of a patient-oriented approach, digital integration and continuous quality improvement [4].

Limited Liability Partnership "National Research Oncological Center" (NROC), located in Astana, is one of the leading oncological institutions in Kazakhstan. In addition to clinical activities, it serves as a research and innovation center. Over the past five years, the NROC has implemented a number of projects to digitalize patient admission processes, including electronic triage, remote verification of diagnoses and integration with national digital platforms.

In the context of digitalization of all spheres of life, healthcare is actively introducing innovative approaches to the provision of medical care. One of these areas is telemedicine - a system for the provision and receipt of medical services using remote technologies. According to the definition of the World Health Organization (WHO), telemedicine contributes to improving the availability of medical care, reducing the burden on hospitals and improving the quality of treatment through prompt communication between medical specialists. According to WHO, telemedicine technologies began to be introduced in Kazakhstan since 2004 [5].

NROC began using telemedicine in 2015. Today, along with traditional face-to-face care, the center actively uses digital tools in diagnosis, monitoring and treatment, especially in the areas of transplantation and oncology. Modern technologies allow doctors to consult patients after liver and kidney transplants, providing control over their condition, regardless of the region of residence.

Particular attention is also paid to emergency situations. If the telemedicine consultation indicates the need for face-to-face intervention, and the patient is not transportable, the specialists of NROC leave with the help of air ambulance and provide assistance on the spot. Thus, telemedicine becomes a link between highly specialized medicine and the needs of the regions.

In terms of legal regulation, telemedicine practice in Kazakhstan is based on the provisions of the Law of the Republic of Kazakhstan "On People's Health and the Health Care System" (as amended in 2020), as well as a number of by-laws. The country has approved standards for the provision of remote medical services and established procedures for maintaining electronic medical records, which together form a regulatory framework for the integration of digital technologies into the healthcare system [6].

Given the growing workload, the complexity of cancer care and the course towards digital transformation of healthcare, an analysis of the effectiveness of the NROC admission department is especially relevant. This study is aimed at studying the evolution of admission processes, assessing the results achieved and compliance with the requirements of the Ministry of Health of the Republic of Kazakhstan, as well as identifying factors contributing to sustainable development.

Materials and Methods

The study used a retrospective mixed method covering the period from January 2020 to December 2024. Within the framework of the methodology, a quantitative analysis of the performance indicators of the NROC admission department was carried out, as well as a qualitative assessment of its compliance with the current regulatory documents in the field of health.

Data sources

Data were collected from internal NROC information systems, including:

- Electronic patient logs,
- Hospitalization registers,
- Annual reports on the activities of the subdivision,
- Patient routing systems,
- Integrations with the Electronic Inpatient Registry (ERSB) and the National Health Platform.

Patients were classified by year of presentation, nosological form, source of referral (outpatient clinic, emergency, screening), and reason for hospitalization. Personal data were depersonalized in accordance with the Law of the Republic of Kazakhstan "On Personal Data and Their Protection" [6].

Key Performance Indicators (KPIs)

The assessment included the following indicators:

- Total number of requests,
- Hospitalizations for oncological diagnoses,
- Average reception time (from arrival to accommodation),
- Medical record time,
- Proportion of failures in hospitalization,
- The level of digitalization was assessed using a 0–5 scoring system, where each core component (electronic triage, remote pre-registration, automated verification modules, integration with national health platforms, interoperability with external diagnostics) contributed 1 point. A total score of 0 indicated no digitalization, while 5 indicated full implementation of all modules.

These indicators comply with international recommendations (for example, WHO) and the requirements of the Ministry of Health of the Republic of Kazakhstan, fixed in orders No. IP-DSM-225/2020 and No. IP-DSM-27/2022 [2,3,5].

Regulatory Review

NROC practice was compared with the current legislation on the basis of the following documents:

- Order No. IP-DSM-225/2020 - defines the standards for the operation of reception offices [2],
- Order No. IP-DSM-27/2022 - On approval of the Standard for the organization of medical care in inpatient conditions in the Republic of Kazakhstan [3],
- Order No. IP-DSM-27/2022 - On approval of the Standard for the Organization of Emergency Medical Care in the Admission Departments of Medical Organizations Providing Medical Care in Inpatient Conditions in the Republic of Kazakhstan [7].
- Code of the Republic of Kazakhstan No. 360-VI - general legislation in the field of health care [4].

An expert assessment of the compliance of all stages of patient admission with the current standards was carried out.

An important direction in the development of telemedicine at NROC was its combination with the work of air ambulance. In cases where remote interaction with the patient is not enough, specialists fly out to conduct face-to-face consultations, perform surgical interventions on the spot, or transport severe patients to the NROC.

Within the framework of the article, a descriptive statistical analysis was conducted on telemedicine consultations carried out by NROC during the period from 2020 to 2024. A total of 1,120 consultations were recorded over this time. The information was systematized by year, specialist profiles, and regions from which the requests originated. The data are presented in summary tables and analyzed to identify trends and priority areas.

Digitalization assessment

The study analyzed the degree of implementation of digital solutions:

- Software (SmartHosp, EPB),
- Module implementation dates,
- Use of digital verification and pre-registration,
- Interviews with medical and IT specialists of the NROC.

Performance indicators (time, errors, staff satisfaction) and the degree of integration with public health systems were highlighted.

The effective deployment of telemedicine depends on a robust and integrated technological infrastructure encompassing both hardware and software components. At the National Research Oncology Center, as well as in other medical organizations across Kazakhstan, a range of advanced technical solutions has been implemented to ensure reliable and secure remote care delivery.

Key components include:

Telemedicine complexes – mobile diagnostic and consultation stations capable of transmitting high-quality video and medical data in real time, enabling timely specialist input regardless of patient location.

Video conferencing systems – platforms such as Zoom for Healthcare, Cisco Webex, and domestic

analogues, integrated with secure communication channels to ensure confidentiality and compliance with national data protection standards.

Medical diagnostic equipment with remote data transfer – including portable ultrasound devices, electrocardiographs (ECG), and endoscopic systems, enabling immediate sharing of results with consulting physicians.

Specialized software solutions – integration with the Unified Medical Information and Analytical System (UMIAS RK), Hospital Information System (HIS), and Picture Archiving and Communication Systems (PACS) to streamline patient data access, imaging management, and multidisciplinary collaboration.

Looking ahead, promising directions for technological advancement include the integration of artificial intelligence (AI) tools for automated interpretation of medical images, predictive analytics, and the generation of personalized clinical recommendations. Additionally, the use of wearable medical devices—such as smart bracelets and continuous monitoring sensors—offers opportunities for ongoing remote health surveillance, enabling early detection of changes in patient condition and reducing the need for in-person visits.

Results

In the period from 2020 to 2024, the admission department of the NROC demonstrated a significant increase in the volume of work and an improvement in efficiency indicators. This section presents the quantitative and qualitative results of the study.

Table-1. Increase in complaints and hospitalizations

Year	Total Patient Visits	Oncology-specific Hospitalizations	Hospitalization Refusals	Avg. Admission Time (hrs)	Avg. Document Processing Time (min)
2020	5,664	1,477	119 (2.1%)	12	45
2021	7,402	2,835	102 (1.4%)	10	35
2022	9,018	4,200	83 (1.1%)	9	25
2023	10,987	5,301	71 (0.9%)	8	20
2024	11,851	6,102	55 (0.5%)	7	15

The total number of requests has more than doubled. The number of hospitalizations of cancer patients has quadrupled, which indicates both an increase in cancer incidence and the effectiveness of referrals. Hospital refusals decreased by more than 75%, indicating improved triage and accuracy of patient pre-assessment.

Reduced time for reception and documentation

An important area of the center's work was the introduction of digital pre-registration, identification of patients through barcodes and electronic certificates, integration with external diagnostic institutions, SmartHosp and ESD modules, which made it possible to significantly optimize the hospitalization processes. The use of patient routing algorithms and automated data recording helped to reduce the average waiting time for hospitalization from 12 to 7 hours, and the duration of medical documentation decreased by 66.7% - from 15 to 45 minutes. These changes have improved the efficiency of the admission department, as well as reducing the burden on patients and medical personnel.

As part of improving the organization of work and digitalization of processes in a medical institution, a phased modernization plan was implemented. In 2020-2021, electronic forms of patient sorting and a system of electronic registration and sorting units (ERSB) were introduced, which made it possible to speed up data processing and increase the accuracy of flow distribution.

In 2022, full integration with the National Health Platform was completed, ensuring uninterrupted exchange of health information between institutions and government systems.

According to internal surveys conducted after the introduction of digital solutions, significant positive changes were achieved. The administrative burden on staff was reduced by 30%, which allowed employees to devote more time to direct medical care. The level of employee satisfaction has increased significantly due to the simplification of work processes and a decrease in routine operations. In addition, the number of errors in the preparation of documentation decreased from 4% to less than 1%, which had a positive effect on the quality

and accuracy of medical records.Regulatory Compliance Assessment

The activities of the admission department were compared with the requirements:

- Order No. IP-DSM-225/2020 (structure, flows, premises, documentation); [2]
- Order No. IP-DSM-27/2022 (procedure for providing oncological care, hospitalization criteria). [7]

Legal regulation and ethical aspects of telemedicine

In Kazakhstan, the legal basis for the provision of medical care using telemedicine is enshrined in Order of the Ministry of Health of the Republic of Kazakhstan dated February 1, 2021 No. IP DSM-12/2021, which determines the procedure for remote consultations, a list of permissible services and requirements for technical equipment [8].

Since 2023, amendments have been made to strengthen the requirements for:

- protection of personal data of patients (according to the Law of the Republic of Kazakhstan "On Personal Data and Their Protection");
- use of secure communication channels;
- mandatory informed consent to remote consultation;
- storage of medical records in electronic form during the period established by law.

The key ethical aspect remains ensuring the confidentiality and security of data, preventing unauthorized access, as well as respecting the rights of patients to refuse telemedicine in favor of face-to-face admission.

In international practice, the regulation of telemedicine is based on standards such as the General Data Protection Regulation (GDPR) in the European Union and the Health Insurance Portability and Accountability Act (HIPAA) in the United States. These regulatory frameworks can serve as a reference point for the further development of telemedicine legislation in the Republic of Kazakhstan [9].

Table- 2. Dynamics of telemedicine consultations by years

Year	Number of consultations
2020	35
2021	109
2022	309
2023	303
2024	364

In 2020, despite the outbreak of the COVID-19 pandemic, the number of telemedicine consultations remained minimal (35), likely due to logistical constraints, a heavy burden on the healthcare system, and the urgent need to restructure processes [10]. Since 2021, there has been a steady increase in the number of online consultations, which may indicate NROC's adaptation to new conditions and the gradual implementation of telemedicine solutions.

Expert Advice Analysis

The largest number of consultations was recorded in the following areas:

- Nephrologist - 389 consultations (high activity is explained by the need for long-term follow-up of patients after kidney transplantation).
- Hematologist - 198 consultations (including oncohematology).
- Hepatologist - 176 consultations (related to liver transplantation and chronic hepatitis).
- Vascular surgeon - 111 consultations.
- Surgeons (abdominal and thoracic) - 87 consultations.

Table- 3. Dynamics of telemedicine consultations

Field	2020	2021	2022	2023	2024
Surgeon	7	23	29	6	22
Vascular Surgeon	2	1	46	27	35
Urologist		2	3	1	3
Transplantologist		3	4	6	7
Oncologist		1	5	5	6
Traumatologist		1	3		6
Chemotherapist			2	2	12
Nephrologist		31	120	140	98
Hepatologist	11	29	30	44	62

Hematologist	6	14	34	60	84
Otorhinolaryngologist		1	2		
Resuscitator	4	7	17	8	15
Cardiologist		2	5		
Reconstructive Surgeon				1	
Neurologist				1	
Gynecologist				1	
Radiation Therapist					4
Oncology Surgeon Of The Head And Neck Sector					4
Others		2	9	1	6

Consultation analysis by region

The greatest activity was noted from the following regions:

- Mangystau region - 103 consultations
- West Kazakhstan region - 95
- Kostanay region - 67
- Zhambyl region - 63
- Shymkent - 70
- Aktobe region - 59
- Atyrau region - 58

This picture indicates a high level of need for oncological and transplantation care in these regions. It is noteworthy that Almaty and Astana, despite the presence of a developed medical and technical base, also actively interact with NROC through telemedicine channels, which indicates the demand for expert support even in large cities.

Table- 4. Dynamics of telemedicine consultations by region

	2020	2021	2022	2023	2024
Akmola region		9	30	26	17
Mangystau region		13	29	22	39
Atyrau region		15	23	21	19
Kyzylorda region		4	15	23	12
Turkestan region			3	18	21
Karaganda region		4	6	7	16
North Kazakhstan region		4	17	10	5
East Kazakhstan region		4	7	9	10
Pavlodar region		5	8	12	9
Aktobe region		8	18	18	15
Kostanay region		12	5	14	36
Abay region			6	12	5
Zhambyl region		4	8	18	33
Shymkent		12	18	10	30
West Kazakhstan region		10	11	38	36
Astana			4	12	15
Zhetysu region			10	5	15
Ulytau region		5	10	4	7
Almaty				24	18

Telemedicine consultations and air ambulance

In the period 2020-2024 28 such flights were performed, the structure of which is shown in Table 5. Structure and Dynamics of Air Ambulance Missions (2020–2024).

Table- 5. Structure and Dynamics of Air Ambulance Missions (2020–2024)

Year	Number Of Departures	On-Site Operations	Personal Consultations	Patient Transport
2020	6	5	–	1
2021	5	2	–	1
2022	3	3	–	–
2023	5	4	2	–
2024	9	9	–	–

The dynamics show an increase in activity in 2024, when the number of air ambulance departures increased 1.8 times compared to the previous year, while all departures were accompanied by surgical interventions on the spot. This indicates an increase in the level of equipment of field teams and the effectiveness of integrating telemedicine technologies with emergency medical care.

As a result of an audit of the Ministry of Health conducted at the end of 2023, the department demonstrated more than 95% compliance with the standards.

Discussion

This retrospective, single-center study conducted at the National Research Oncology Center (NROC) between 2020 and 2024 provides valuable insights into the evolving role of digital technologies and telemedicine in optimizing hospital admission processes and expanding access to specialized care. While the descriptive nature of the data limits the ability to draw causal conclusions, the observed trends suggest meaningful improvements in operational efficiency, clinical coordination, and regulatory alignment.

Growth in Patient Volume and Efficiency Indicators

Over the five-year period, the admission department experienced a substantial increase in workload, with the total number of patient visits more than doubling. Oncology-specific hospitalizations rose from 1,477 in 2020 to 6,102 in 2024, indicating both a growing demand for oncological services and potentially improved referral mechanisms. The reduction in hospitalization refusals—from 2.1% to 0.5%—may reflect enhanced triage protocols, better pre-admission assessments, and more accurate patient routing.

These quantitative shifts were accompanied by notable improvements in time-related metrics. The average admission time decreased from 12 to 7 hours, while documentation processing time dropped by 66.7%, from 45 to 15 minutes. These changes coincided with the implementation of digital pre-registration systems, barcode-based patient identification, and integration with external diagnostic platforms such as SmartHosp and ESD modules. The introduction of patient routing algorithms and automated data entry tools likely contributed to these gains by reducing administrative redundancy and streamlining workflows.

Internal surveys conducted post-implementation revealed a 30% reduction in administrative burden on staff, allowing clinicians to allocate more time to direct patient care. Additionally, the error rate in medical documentation preparation decreased from 4% to less than 1%, suggesting improved data accuracy and record quality. Staff satisfaction also increased, attributed to the simplification of routine tasks and the overall modernization of work processes.

Expansion and Impact of Telemedicine

Telemedicine emerged as a critical component of NROC's digital transformation strategy. The number of remote consultations grew from just 35 in 2020 to 364 in 2024, reflecting a tenfold increase. This upward trend began in 2021, likely driven by the need to adapt to pandemic-related constraints and the broader push toward digital healthcare solutions. The data suggest that telemedicine became an increasingly accepted and integrated modality for delivering care, particularly in specialties requiring long-term follow-up and interdisciplinary collaboration.

Nephrology accounted for the highest number of consultations (389), followed by hematology (198) and hepatology (176). These specialties are closely linked to transplant medicine and chronic disease management, where continuous monitoring and timely expert input are essential. Other areas such as vascular surgery, abdominal and thoracic surgery, and resuscitation also demonstrated consistent engagement, albeit at lower volumes.

While some fields—such as oncosurgery of the head and neck, chemotherapy, and otorhinolaryngology—showed limited telemedicine

activity, their inclusion underscores the model's relevance even in complex clinical scenarios. In many cases, telemedicine served as a preliminary step, followed by in-person visits, mobile team deployment, or hospitalization. This hybrid approach highlights the flexibility and adaptability of remote care models in supporting decision-making and ensuring continuity of care.

Regional Distribution and Equity of Access

Analysis of consultation data by region revealed significant engagement from areas such as Mangystau, West Kazakhstan, and Kostanay, suggesting a high demand for specialized services in regions with limited local capacity. Interestingly, major urban centers like Almaty and Astana also actively utilized telemedicine channels, indicating that expert support remains valuable even in well-equipped settings. This pattern points to telemedicine's potential to bridge geographic disparities and enhance equity in healthcare access across Kazakhstan [12].

Integration with Air Ambulance Services

A notable innovation was the integration of telemedicine with air ambulance operations. Between 2020 and 2024, NROC conducted 28 field missions, with a marked increase in 2024. That year, all nine departures included on-site surgical interventions, reflecting improved equipment, team readiness, and coordination. This synergy between remote consultations and emergency response capabilities enabled timely care delivery in remote areas and reduced delays in critical interventions.

Regulatory Alignment and Ethical Considerations

The transformation of the admission department was guided by national regulatory frameworks, including Order No. IP-DSM-225/2020 and Order No. IP-DSM-27/2022 [2,3]. These directives provided clear guidelines for structuring workflows, defining patient routes, and standardizing documentation. A Ministry of Health audit conducted in late 2023 confirmed over 95% compliance with these standards, underscoring the department's commitment to regulatory adherence.

Telemedicine practices were governed by Order No. IP DSM-12/2021, which outlined the scope of permissible services, technical requirements, and consultation procedures [8]. Amendments introduced in 2023 strengthened provisions related to data protection, secure communication, informed consent, and electronic record storage. Ethical considerations—particularly around confidentiality, patient autonomy, and the right to opt for in-person care—remain central to telemedicine implementation.

Internationally, frameworks such as the General Data Protection Regulation (GDPR) in the European Union and the Health Insurance Portability and Accountability Act (HIPAA) in the United States offer valuable models for further refinement of Kazakhstan's telemedicine legislation. These standards emphasize patient rights, data security, and accountability, which are essential for building trust and ensuring sustainable adoption [11].

Limitations

It is important to acknowledge the limitations of this study. As a retrospective, single-center analysis, the findings are inherently descriptive and cannot establish causality or be generalized to the broader healthcare system. The data reflect the specific context of NROC and may not capture variations in implementation, infrastructure, or patient demographics across other institutions. Future research should include multi-center, prospective studies with control groups to validate these observations and assess long-term clinical and economic outcomes.

Challenges

Despite these advances, the implementation process revealed several operational and organizational challenges. Staff resistance, especially during the initial phases of IT system implementation, highlighted the pivotal role of human factors in the success of digital transformation. This resistance was primarily driven by limited familiarity with new technologies, apprehension about potential changes in workload, and the challenges associated with adjusting to updated operational procedures. Additionally, occasional digital infrastructure failures highlighted the importance of robust technical readiness and system redundancy to prevent disruptions in patient care.

A further obstacle was the shortage of specialists proficient in managing and maintaining digital medical systems, which slowed the pace of adoption and placed added strain on existing IT teams. These challenges underline the necessity of comprehensive pre-implementation planning, ongoing technical support, and a phased, iterative approach to introducing innovations—allowing gradual adaptation and minimizing operational risks.

Recommendations and Lessons Learned

Drawing on this experience, the NROC's journey offers a set of actionable recommendations for other healthcare institutions in Kazakhstan and the wider Central Asian region:

1. Conduct a regulatory audit before launching digital initiatives to identify

alignment gaps, ensure compliance, and streamline approval processes.
2. Integrate KPI monitoring systems into routine workflows to enable data-driven decision-making and maintain accountability at all operational levels.
3. Establish continuous collaboration with government agencies to ensure adherence to evolving legislation, secure stable funding, and coordinate large-scale implementation efforts.

Ultimately, the integration of digitalization with a well-structured regulatory framework produces benefits that extend beyond technical modernization. It fosters strategic improvements in service delivery, enhances institutional resilience, and supports the long-term sustainability of the healthcare system. The NROC's case demonstrates that when innovation is anchored in clear, adaptable regulations, it can yield transformative outcomes—serving as a model for other specialized institutions in Kazakhstan and beyond.

Conclusion

This study provides a comprehensive evaluation of the admission department's performance at the National Research Oncology Center from 2020 to 2024, highlighting the transformative role of digitalization and regulatory alignment in oncology care. Strategic integration of pre-registration, digital triage, and interoperability with national systems (EPSS, EMC, SmartHosp), in compliance with Ministry of Health standards, has led to measurable improvements, including more than a twofold increase in patient flow, a fourfold rise in oncological hospitalizations, and a >75% reduction in hospitalization refusals.

The data suggest that telemedicine in Kazakhstan already serves as an effective tool in highly specialized fields such as oncology and transplantology, contributing to improved access to specialized care, optimized patient routing, reduced inpatient burden, and enhanced cost-effectiveness. Sustained progress will require continued legal framework development, workforce training, technical infrastructure enhancement, and integration with AI-driven analytics.

NROC's experience demonstrates that the combination of advanced information technologies and supportive regulatory policy enables the creation of an effective, safe, and sustainable model for oncology care delivery. This model has the potential to be adapted in other specialized institutions across Kazakhstan and Central Asia; however, its replicability and applicability at the systemic level require validation through comparative or multicenter studies.

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