**Introduction**

Modern imaging techniques such as computed tomography (CT) and magnetic resonance imaging (MRI) play a key role in the diagnosis and monitoring of various diseases. These technologies provide highly accurate information about the condition of organs and tissues, which helps to improve the effectiveness of treatment. However, there are a number of challenges to their use, including high cost, the need for radiation risk assessment (in the case of CT), and limited availability in some regions.

An important aspect of the rational use of imaging modalities is the interdisciplinary collaboration between general practitioners (GPs) and radiologists. GPs are often the first decision-makers in deciding whether to prescribe CT or MRI, while radiologists provide expert judgment and interpretation of the appropriateness of these modalities. Unwarranted prescriptions may result in unnecessary burden on patients and health care systems, and underutilization may delay diagnosis.

**The aim** of this work is to analyze the awareness of GPs about the indications for CT and MRI and the problems they face in prescribing high-tech tests, as well as to assess the reasons for unjustified prescription of tests through the eyes of a radiologist, based on the results of their questionnaires. Analysis of interaction and perception of these specialists will allow to identify key barriers and suggestions for optimization of diagnostic processes.

**Materials and Methods:**

A questionnaire survey was conducted among 108 radiologists of large medical organizations, cities of republican significance (Almaty, Astana) using Google form (online questionnaire). The questionnaire consisted of 12 questions, 11 with answer options and 1 open-ended question, 3 of them with multiple-choice answers.

By type of medical organization: 61 radiologists from city hospitals (56.5%), 18 employees of Research Institutes (16.7%), 21 physicians from private clinics (19.4%) and 8 radiologists from other types of medical enterprises (7.4%)

The data of the survey of 163 GPs on the topic “Assignment of CT and MRI examinations within the framework of mandatory social health insurance” were also analyzed by means of questionnaire survey in Almaty city and Almaty region. The data of questionnaire survey of 163 GPs were analyzed, 86 of which responded in paper form, 77 were surveyed online. The questionnaire consisted of 15 questions, with 11 single and 4 multiple-choice answers.

**Results**

Out of 108 radiologists, 35 of them had up to 5 years of experience in radiology, which is 32.4%; 36 doctors with 5 to 10 years of experience - 33.3%; 29 doctors with 11 to 20 years of experience - 26.9% and 8 doctors with more than 20 years of experience - 7.4%.

The frequency of unjustified investigations per month according to radiologists is: more than 5 cases per month - 61 (56,5%), from 1 to 5 cases - 30,6% (33vp) and less than 1 case - 13% (14vp), presented in Diagram 1.

 Diagram #1. Frequency of unjustified studies per month.

The most frequently unreasonably prescribed investigations are the following: CT - 87 (80.6%), MRI - 29 (26.9%), contrast-enhanced studies - 40 (37%), other (ultrasound, X-ray, mammography, etc.) - 11 (10%). More detailed data are shown in Diagram No. 2.

The categories of patients with the most frequent unjustified appointments for investigations are presented below: Patients with complaints that can be evaluated by other methods (e.g. ultrasound or radiography) - 77 (71.3%); Patients with no clear indications for investigation - 65 (60.2%); Patients insisting on investigation - 69 (63.9%), others - 2 (1.8%).

Radiologists consider the main reasons for unjustified appointments to be: Lack of knowledge of doctors about CT/MRI indications - 72 (66,7%), Pressure from patients - 73 (67,6%), Pressure from administration about plan fulfillment - 37 (34,3%), Unnecessary reinsurance of doctor - 63 (58,3%), Lack of clear recommendations or protocols in mandatory social health insurance - 52 (48,1%).

Regarding the assessment of compliance of the mandatory social health insurance tarifficator list with the real costs of radiologic examinations, the following results were obtained: 5 (4.6%) believe that they fully comply, 27 (25%) partially comply, 76 (70.3%) do not comply, the real cost is higher than believed.

Diagram #2. Distribution of unjustified appointments by type of trials

Do doctors receive additional payments for trials within the framework of MHI, the following comments were given: yes, regularly - 12 (11.1%); yes, but rarely - 16 (14.8%); no, I do not receive - 64 (59.3%); found it difficult to answer - 16 (14.8%).

As for the suggestions to reduce unjustified appointments for investigations, the following options were received: Raising awareness of GP physicians about protocols and indications - 82 (75.9%); Introduction of mandatory coordination with radiologists before appointing investigations - 59 (54.6%); Development of clear clinical guidelines for GP physicians - 75 (69.4%); Restriction of CT/MRI appointments within the framework of MHI for some cases - 36 (33.3%).

According to the results of the questionnaire survey of GPs, the number of doctors working in the city polyclinic was 114 (69.9%), working in private organizations was 11 (6.75%), combining/other was 38 (23.31%) out of 163.

The mean age of the physicians was 30-40 years and mean work experience was 5-10 years.

The frequency of appointments for investigations by GPs within the framework of MHI was: 70(42.9%) physicians answered “1-5 times a month”, 67(41.1%)- less than once a month and 26(16.0%)- more than 5 times a month.

Physicians consider the following as the main difficulties in prescribing CT and MRI scans: Limited MHI quotas - 72(29,3%); Long waiting time before the study - 49(19,9%); The list of studies conducted under MHI is limited - 36(14,6%); No clear indications for the study - 32(13,0%); Long waiting time for the conclusion - 24(9,8%);

To the question “How often do you face unjustified referrals for CT or MRI?”: 68(41.7%) physicians answered “Rarely”, 44(27.0%)-“Sometimes”, 30(18.4%)-“Often”, 18(11.0%)-“Never”, and 3(1.8%)-“Always”.

Diagram #3. Main difficulties in prescribing CT and MRI scans

Gaps and shortcomings in radiology diagnostics according to primary care physicians are as follows: 60(34.9%) doctors noted - Lack of standards and protocols for prescribing and performing examinations, which can lead to redundant or unnecessary examinations; Insufficient integration between different levels of medical care, which leads to inconsistencies in referrals for examinations - 30(17.4%); Lack of qualified specialists, which makes it difficult to perform high-tech examinations - 24(14%); There are no problems, because radial diagnostics is not within our competence - 23(13.4%); Don't know - noted by 35(20.4%).

To the question “What risk factors in your opinion cause the increase in the number of CT and MRI examinations?”: 61(30%) physicians noted - It is necessary to introduce mandatory informing patients about radiation exposure and possible alternatives; 43(21.1%) - Lack of informational activities for patients about explaining the risks and benefits of CT and MRI, 41(20.1%) - Low level of patients' awareness about the risks and necessity of the studies; 32(15.7%) - Training of physicians to better explain the necessity of the studies; 27(13.2%) - Lack of explanatory work on the part of physicians (lack of time at appointments), which may lead to excessive prescriptions.

In the question about the development of approaches to determine the need for high-tech methods of radiation diagnostics, doctors consider the following necessary: Development of methodological recommendations for doctors of polyclinics to determine the indications for referrals to CT and MRI can improve integration between doctors of different specialties - 60(32,3%); Conducting regular surveys and studies substantiate the needs of the population in high-tech research - 38(20,4%); Lack of data in wide access about the real needs of the population in diagnostic services - 37(19,9%); Lack of a systematic approach to assessing the need for high-tech research in medical organizations necessitates development - 37(19.9%); Assessment and revision of needs for diagnostic services is possible on the basis of up-to-date data through the creation of interdisciplinary working groups - 14(7.5%).

Diagram #4. The need to develop approaches to determining the need for high-tech methods of radiology diagnostics

**Discussion**

The results of the study demonstrate important aspects of the current situation in the utilization of high-tech radiotherapy diagnostic techniques, including CT and MRI, and indicate key gaps and challenges faced by physicians.

The distribution of radiologists by years of experience shows that the most significant part of the sample consists of specialists with up to 10 years of experience (65.7%). This may indicate that the majority of practicing radiologists are in the active phase of their professional activity. The small percentage of specialists with more than 20 years of experience (7.4%) indicates the need to attract experienced personnel to the field to improve mentoring and knowledge transfer.

The data on the frequency of unjustified prescriptions is alarming, with more than half of radiologists (56.5%) reporting more than 5 such cases per month. This indicates a systemic problem that may be related to lack of physician knowledge, lack of strict protocols, or the influence of external factors such as patient and administrative pressure.

The most frequently unnecessarily prescribed diagnostic method is CT (80.6%), which emphasizes the need for attention to the rational use of this resource-intensive method associated with radiation exposure. MRI (26.9%) and contrast-enhanced studies (37%) also account for a significant share. This indicates the need for additional training of general practitioners (GPs) and the introduction of restrictions on such prescriptions in cases where they are inappropriate.

Analysis of the categories of patients with unjustified appointments highlights the main problems: a significant proportion of tests are performed in the absence of clear indications (60.2%) or in cases where the diagnosis can be established using less costly methods (71.3%). Also, patient insistence (63.9%) is an important factor emphasizing the need to work with patient expectations and inform them about diagnostic options.

Radiologists cited lack of knowledge of GP physicians (66.7%) and patient pressure (67.6%) as the main reasons for unjustified prescriptions. These data point to the need for systematic educational activities and the introduction of protocols that would allow GP physicians to act confidently, excluding redundant investigations. Pressure from the administration (34.3%) is also a significant factor emphasizing the need to revise management approaches.

The overwhelming majority of radiologists (70.3%) believe that the current tarifficator for mandatory medical social insurance does not correspond to the real costs of conducting trials. This indicates the need to revise the financial model of mandatory medical social insurance to ensure adequate compensation of costs for high-tech trials.

The majority of radiologists (59.3%) do not receive additional payments for trials under the MHI, which may reduce their motivation to participate in the development of the system. Fair remuneration for performing complex trials could be an incentive to improve the quality of services.

The results of the survey of primary care physicians show that the main group of respondents are doctors working in urban polyclinics (69.9%), which logically reflects the structure of primary health care in urban settings. About a quarter of respondents combine work in other organizations, which may indicate a high workload of primary care physicians. The average age of physicians (30-40 years) and length of service (5-10 years) indicate an active professional period, which makes their opinions particularly valuable for analyzing current problems.

The frequency of prescribing trials within the MHI varies, with 42.9% of physicians prescribing trials 1-5 times per month and 41.1% prescribing trials less than once. Only 16% of physicians prescribe trials more than 5 times a month, which may be due to quota restrictions, lack of physician awareness, or lack of clear protocols. This figure emphasizes the need to analyze the factors influencing the use of high-tech diagnostic methods.

The frequency of unjustified referrals is of concern. Although 41.7% of physicians noted that they encounter such cases rarely, 18.4% reported that it happens frequently. The main reason for unjustified referrals may be the lack of standards and protocols (34.9%), which is confirmed by the high proportion of physicians' responses to this item. Insufficient integration between levels of medical care (17.4%) also affects the compliance of referrals with clinical requirements.

Physicians noted the lack of standards and protocols (34.9%) as the main problem that leads to unnecessary tests. Insufficient integration between levels of medical care (17.4%) and lack of qualified specialists (14%) also create barriers to effective use of diagnostic methods. It is noteworthy that 20.4% of respondents found it difficult to answer this question, which may indicate that physicians are not sufficiently informed about the organizational aspects of radial diagnostics.

Among GP physicians the key difficulties are limited MHI quotas (29.3%) and long waiting times for trials (19.9%). For radiologists, the lack of clear protocols (48.1%) and pressure from the administration (34.3%) remain the main problems. Both aspects indicate the need to optimize organizational processes and funding.

Both radiologists and GP physicians emphasize the low awareness of patients about the risks and necessity of investigations. There is also a lack of information activities for patients (21.1%) and lack of explanatory work on the part of doctors (13.2%). The introduction of mandatory informing of patients about radiation exposure and possible alternatives (30%) could significantly reduce unjustified prescriptions.

A common proposal for both groups is the development of methodological recommendations for GP physicians (75.9% among radiologists and 32.3% among GPs). The introduction of mandatory coordination with radiologists (54.6%) is also seen as an important step to improve the quality of the diagnostic process. Eliminating gaps in protocols and systematizing approaches to assessing the need for diagnostic services (19.9%) would improve interdisciplinary collaboration.

**Conclusion**

The results of questionnaires of radiologists and PTOs demonstrate the need for systemic changes in the organization of radial diagnostics. The main directions of work include:

* Development of educational programs for PTO physicians about indications for CT and MRI.
* Informing patients about risks and alternative methods of diagnostics.
* Optimization of the quota system and organizational processes of providing high-tech methods of radiation diagnostics.
* Development of clinical recommendations at the republican level for doctors of all specialties.

These measures will not only reduce the number of unjustified prescriptions, but also improve the availability and quality of high-tech diagnostic methods for patients.

References:

1. **Brenner, D. J., & Hall, E. J. (2007).** Computed tomography—an increasing source of radiation exposure. *New England Journal of Medicine*, 357(22), 2277-2284.

2. **Kressel, H. Y., & Van Tongerloo, A. (2019).** Optimizing imaging utilization: Challenges and solutions. *Radiology*, 291(3), 499-508.

3. **World Health Organization (2016).** WHO guidelines on radiation protection in diagnostic and interventional radiology.

4. **European Society of Radiology (ESR) (2017).** ESR concept paper on value-based radiology. *Insights into Imaging*, 8(6), 447-454.

5. **Mills, P., & Palmer, B. (2020).** The role of interdisciplinary collaboration in reducing unnecessary diagnostic imaging. *Journal of Clinical Radiology and Imaging*, 4(2), 75-82.

6. **Griffey, R. T., & Pines, J. M. (2011).** Reducing the overuse of diagnostic imaging in the emergency department: An evidence-based approach. *Academic Emergency Medicine*, 18(11), 1315-1322.

7. **Bohannon, L. S., & Malley, D. (2018).** Educational strategies for improving referral appropriateness for advanced imaging. *Journal of Continuing Education in the Health Professions*, 38(4), 223-230.

8. **Mendiratta-Lala, M., et al. (2020).** Value of evidence-based guidelines for imaging appropriateness: The ACR Appropriateness Criteria. *Journal of the American College of Radiology*, 17(7), 904-912.

9. **Fletcher, R. H., & Fletcher, S. W. (2020).** Clinical epidemiology: The essentials. *Lippincott Williams & Wilkins*.

11. **Schnyder, P., et al. (2015).** Communication between referring physicians and radiologists: Systematic review of barriers and solutions. *Insights into Imaging*, 6(5), 573-583.

12. **Rosenkrantz, A. B., et al. (2015).** Strategies to improve appropriateness in advanced diagnostic imaging. *American Journal of Roentgenology*, 204(6), 1196-1202.

13. **Pandharipande, P. V., et al. (2016).** Impact of medical imaging on patient care. *Radiology*, 279(3), 678-689.

14. **Cohen, M. D., et al. (2013).** Unnecessary imaging: Definitions, causes, and solutions. *Journal of the American College of Radiology*, 10(9), 607-614.

15. **Meyer, J. R., & Luetmer, P. H. (2017).** Role of clinical decision support tools in optimizing imaging utilization. *Neuroimaging Clinics of North America*, 27(4), 515-526.

16. **Berland, L. L., et al. (2018).** Appropriateness criteria in radiology: Development and application. *Radiology*, 288(3), 658-664.

17. **Harolds, J. A., et al. (2016).** Clinical decision-making in radiology: Barriers and facilitators. *Radiology Leadership Institute Reports*, 8(1), 12-19.

18. **Hendee, W. R., et al. (2010).** Addressing overutilization in diagnostic imaging. *Radiology*, 257(1), 240-245.

19. **Brady, A. P., et al. (2017).** Radiology education for non-radiologists: Building bridges. *Insights into Imaging*, 8(2), 137-144.

20. **Jha, S., & Topol, E. J. (2016).** Enhancing patient care through digital radiology. *Journal of Digital Imaging*, 29(5), 564-571.

21. **Boone, J. M., et al. (2014).** Radiation dose management in CT: International trends and future directions. *Journal of Radiology Protection*, 34(3), R25-R37.