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FEATURES OF THE TNM-9 CLASSIFICATION FOR LUNG CANCER AND INTEGRATION OF TNM-8 LIMITATIONS

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ABSTRACT

Relevance: *Lung cancer ranks among the leading causes of morbidity and mortality in oncological diseases both in Kazakhstan and worldwide. Accurate tumor staging is crucial for choosing patient management strategies, considering the continuously advancing diagnostic and treatment methods. The 8th edition of the Tumor-Node-Metastasis (TNM) classification, introduced in 2017, brought significant changes to the staging approach, thereby improving its precision. However, accumulated data have demonstrated the need for further refinement, particularly in assessing mediastinal lymph nodes and systemic metastasis. Therefore, the 9th edition of TNM came into force on January 1, 2025. It includes important updates that require adaptation in radiological practice.*

The study aimed to *compare the 8th and 9th editions of the TNM classification in lung cancer and identify key changes to improve staging accuracy and facilitate multidisciplinary treatment planning.*

Methods: *This study conducted a structured review of the changes introduced in TNM-9 compared to TNM-8, with a focus on interpreting the N and M categories. The analysis utilized clinical guidelines from the International Association for the Study of Lung Cancer (IASLC) and recent publications reflecting current approaches to tumor staging.*

Results: *In the TNM-9 classification, the N and M categories were refined by introducing new subcategories, N2a/N2b and M1c1/M1c2. The staging of several combinations of T and N categories was also revised. Particular emphasis was placed on the need for more detailed anatomical characterization of lymph nodes and the systemic nature of metastases.*

Conclusion: *Understanding the new provisions of TNM-9 is essential for accurate stage assessment, improving communication during multidisciplinary tumor boards, and optimizing therapeutic decision-making.*

Keywords: *lung cancer, staging, TNM, TNM-9.*

Introduction: Lung cancer ranks first in morbidity and mortality among all oncological diseases. According to the Kazakh Research Institute of Oncology and Radiology (KazRIOR), in 2023, 3,872 new cases of lung cancer were registered in the Republic of Kazakhstan, which is 9.3% of the total number of oncological diseases. Despite the decrease in incidence, lung cancer remains the leading cause of cancer mortality in the country: in 2023, 2,034 persons died from it, that is 15.7% of all cancer deaths [1].

In recent years, the diagnostics and treatment of lung cancer have advanced significantly. If earlier surgery was the primary method of treatment only in the early stages, and chemotherapy and radiotherapy were used for more advanced forms, today, a multidisciplinary approach is implemented. Local methods are increasingly used in advanced processes, while systemic treatment is employed at early stages. It requires a more accurate assessment of the anatomical spread of the tumor, especially in high categories N and M [2].

The TNM (Tumor-Node-Metastasis) system, developed by the American Joint Committee on Cancer (AJCC) and the Union for International Cancer Control (UICC) [3], remains a key staging tool in international clinical practice and serves as the standard for describing the extent of a malignant process worldwide. The use of the TNM system provides a standardized anatomical staging system for malignant neoplasms. The TNM system is based on an assessment of three key components. The first component, T (Tumor), reflects the size of the primary tumor and the degree of its invasion into the surrounding structures. The second component, N (Nodes), characterizes the presence and degree of involvement of regional lymph nodes. The third component, M (Metastasis), indicates the presence or absence of distant metastases in other organs and systems [3, 4]. Each of these categories is further subdivided into subcategories (e.g., T1, T2; T1a, T1b), and their combinations form a certain stage of the disease, as recommended by the International Association for the Study of Lung Cancer (IASLC) [4].

Since January 1, 2017, the use of TNM-8 has been recommended worldwide for staging non-small cell and small cell lung cancer. This publication is based on the results of a large-scale IASLC study, which analyzed data from over 77,000 patients from various regions worldwide. Despite the significant contributions of the 8th edition to standardizing disease staging and improving predictive stratification, subsequent clinical experience and analysis have revealed several limitations. In particular, there was a need for a more accurate gradation of mediastinal lymph nodes, as well as for

a detailed characterization of the metastatic lesion. Taking into account the accumulated data and the needs of clinical practice, the UICC and AJCC, with the participation of IASLC, approved TNM-9, the official use of which will begin on January 1, 2025 [5-7]. Radiologists need to familiarize themselves with the new provisions to accurately reflect the stages of the disease in their reports and participate in decision-making at multidisciplinary boards.

The study aimed to compare the 8th and 9th editions of the TNM classification in lung cancer and identify key changes to improve staging accuracy and facilitate multidisciplinary treatment planning.

Materials and methods: This review is an analytical study based on a comparative analysis of the changes reported in TNM-9 compared to TNM-8, specifically concerning lung cancer staging. The basis for the analysis was the official publications of the IASLC, AJCC, and UICC, published from 2017 to 2024 [3-7].

Results:

Major updates in TNM-9. There were no changes in category T in the TNM-9 classification. As before, the key criterion for staging remains the maximum tumor diameter measured by thin-slice CT (≤1.5 mm) in the pulmonary windows. In this case, only a solid component of mass is taken into account; the ground-glass component or the lepidic component, if any, shall not be included in the measurement. In the presence of multiple solid foci, classification is performed according to the largest of them. If it is difficult to assess the dimensions, multiplane reconstructions can be used. Category T is subdivided as follows: T1 includes tumors up to 3 cm and is divided into T1a (≤1 cm), T1b (>1-2 cm), and T1c (>2-3 cm); T2 encompasses tumors 3 to 5 cm in size and is divided into T2a (>3-4 cm) and T2b (>4-5 cm), or invasion of the visceral pleura, adjacent lobe, involvement of the main bronchus, or the presence of atelectasis/obstructive pneumonia; T3 corresponds to sizes from 5 to 7 cm, as well as when the chest wall, parietal pleura, phrenic nerve, pariental pericardial membrane or the presence of individual tumor nodes within the same lobe as the primary tumor; T4 - tumors of 7 cm or more or with invasion of the vertebral body, large vessels (including subclavians), adipose tissue of the mediastinum or other mediastinal structures, trachea, esophagus, visceral pericardium, diaphragm, thymus or brachial plexus, as well as the presence of individual tumor nodes in another part of the lung on the same side, but in a different lobe. Individual neoplasms with distinct histological structures are considered independent primary tumors and are classified separately according to the TNM system.

The Tis (preinvasive tumor in situ) and T1mi (minimally invasive adenocarcinoma) categories also remain, as they reflect the growth features of the lepidic component. The Tis category includes in situ adenocarcinomas and squamous cell carcinomas. For adenocarcinomas, it means a ≤3 cm ground-glass lesion on CT scan with no invasive component. A lesion >3 cm with signs of lepidic growth without invasion is classified as T1a. T1mi is a partially solid node measuring ≤3 cm, where the invasive (dense) component is ≤0.5 cm. If the dense part is >0.5 cm, then this lesion is classified as T1. These criteria remain important for the accurate assessment of stage and prognosis in lung adenocarcinomas with lepidic growth.

Consolidation and the "pneumonic" form of cancer. In the case of diffuse consolidation without bronchial obstruction (referred to as invasive mucinous adenocarcinoma), staging is determined by the number of lobes: one lobe is classified as T3. In contrast, different lobes of the same lung are classified as T4 (Figure 1), and involvement of both lungs is classified as M1a (Figure 2).

Division of category N2 into subcategories N2a and N2b. In TNM-8, category N was determined solely by the anatomical location of the affected lymph nodes, regardless of their number or extent. The classification was based on the location of the lesion and did not take into account either the number of lymph nodes or the number of anatomical stations affected.

However, it has been observed in clinical practice that patients with lesions confined to a single mediastinal station (e.g., the subcarinal station) have a significantly better prognosis compared to those with lesions involving two or more stations (e.g., parallel lesions of the paratracheal and subcarinal nodes). This difference was not reflected in the eighth edition and may have influenced therapeutic decision-making, particularly in potentially resectable cases.

In this regard, the ninth edition of TNM clarified the N2 category by dividing it into two subcategories: N2a – metastases in one anatomical station of ipsilateral mediastinal and/or subcarinal lymph nodes; N2b – metastases in two or more anatomical stations in the same regions (Figure 3). It is emphasized at the same time that the assessment should be based on the number of affected stations, rather than individual lymph nodes. The basis for this change was the data from the IASLC database, which demonstrated significant differences in survival between the N2a and N2b groups, regardless of age, gender, histological type of the tumor, and other factors [8, 9].

The ninth edition retains its reliance on the IASLC International Lymph Node Map, where groups are numbered from 1 to 14 and are indicated by side (e.g., 4R, 4L, 7). The ninth edition also clarifies that lymph nodes not included in the IASLC map (e.g., diaphragmatic, cervical, intercostal, axillary) are not classified as regional, but are treated as distant metastases (category M1). This is crucial for accurate staging.

Thus, the ninth edition of TNM emphasizes the need for accurate anatomical localization of affected stations in radiological reports. This means that the radiologist must indicate the numbers and sides of suspicious stations (e.g., 4R) and note whether one or more stations are affected, allowing for the differentiation between N2a and N2b. Such a description is important for multidisciplinary tumor boards and can influence the choice of therapy. For example, surgery may be considered for N2a, but becomes less likely for N2b, especially if there is more severe or multiple lymph node involvement.

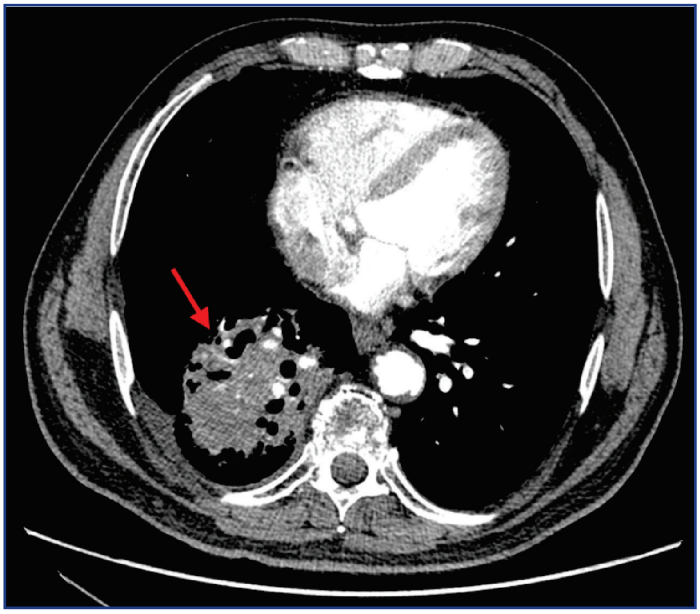

Figure 1 - Pneumonia-like form of cancer in segments S6, S9, S10 of the right lung with marked enlargement of segmental and subsegmental bronchi in a 60-year-old woman; the tumor process spreads to different lobes of one lung, which corresponds to category T4 according to TNM-9 [Source: author's collection]

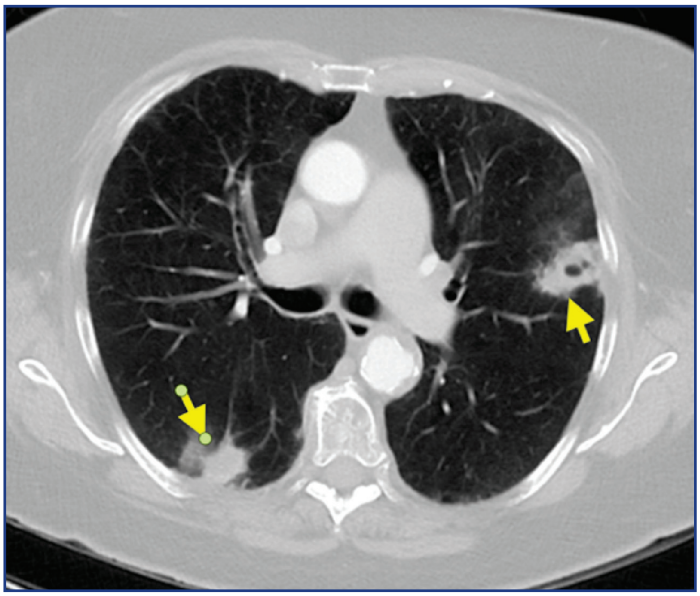

Figure 2 - Two masses up to 3 cm in diameter in the lungs of a 71-year-old woman. The lesion in the right lung is treated as a metastatic lesion, which corresponds to category M1a according to TNM-9 [Source: author's collection]

Division of category M1c into subcategories M1c1 and M1c2. The M category was divided into three levels in the eighth edition of the TNM classification: M1a, M1b, and M1c. The M1a subcategory included signs of intrathoracic metastasis, such as tumor nodes in the contralateral lung, malignant pleural or pericardial effusion, and pleural or pericardial tumor nodes. M1b corresponded to the presence of a single extrathoracic metastatic focus in one organ. The M1c subcategory included multiple extrathoracic metastases regardless of the number of organs affected. This division enabled the refinement of prognoses for patients with varying metastatic loads, particularly in stage IV.

The ninth edition of TNM clarifies the M1c category by dividing it into two levels: M1c1 and M1c2. The M1c1 subcategory corresponds to multiple metastases within a single organ system. M1c2 refers to the involvement of two or more organ systems (Figure 4). In this case, both single organs (for example, the liver or brain) and paired organs (such as the adrenal glands or kidneys) or diffuse

anatomical structures (such as the skeletal system) are considered part of an organ system. Thus, multiple bone metastases, regardless of the number of foci, are classified as M1c1. If metastases are found, for example, simultaneously in the bones and liver, this situation is interpreted as M1c2.

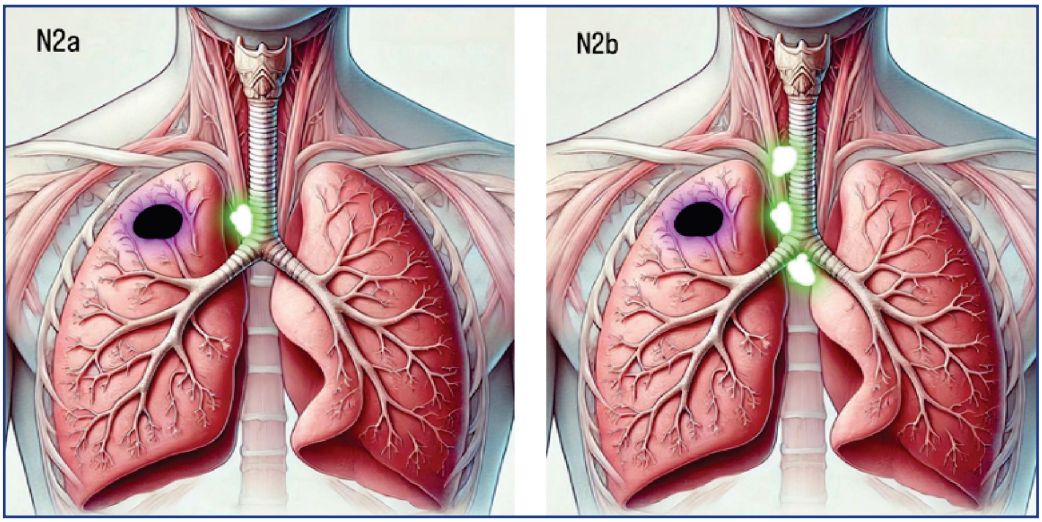

Figure 3 - Division of N2 (ipsilateral lymph nodes) into single (N2a) and multiple ipsilateral stations (N2b) according to TNM-9 [Source: author's collection]

The additional division of M1c into M1c1 and M1c2 reflects the desire for a more accurate stratification of patients based on their prognosis and the extent of systemic tumor spread. Quantitative criteria (for example, the number of foci within one organ) are not defined in the new classification; the emphasis is on the number of organ systems involved [7-9]. It is essential for the radiologist not only to record the presence of multiple metastases but also to specify exactly which organ systems are involved, for accurate staging and informed therapeutic decision-making (Table 1).

Table 1 – Staging of lung cancer according to TNM-9 (from 2025) [5, 6, 14]

Component	Subcategory	Short description
T – Tumor	T1a,b,c	≤3 cm (in 1 cm increments: a – up to 1 cm, b – from 1 to 2 cm, c – from 2 to 3 cm)
	T2a,b	>3–5 cm, T2a – 3 to 4 cm, T2b 4 to 5 cm, also invasion of the visceral pleura, adjacent lobe, involvement of the main bronchus, or the presence of atelectasis/obstructive pneumonia
	T3	>5 to 7 cm, involvement of the chest wall, parietal pleura, phrenic nerve, parietal pericardial membrane, or the presence of individual tumor nodes within the same lobe as the primary tumor
	T4	>7 cm, with invasion to the vertebral body, large vessels (including subclavians), adipose tissue of the mediastinum or other mediastinal structures, trachea, esophagus, visceral pericardium, diaphragm, thymus or brachial plexus, as well as the presence of separate tumor nodes in another part of the lung on the same side, but in a different lobe
N – Lymph nodes	N0	No metastases in regional lymph nodes
	N1	Ipsilateral peribronchial and/or hilar lymph nodes
	N2a	New subcategory: one ipsilateral mediastinal/subcarinal station
	N2b	New subcategory: two or more ipsilateral mediastinal lymphatic stations
	N3	Contralateral or supraclavicular lymph nodes
M – Metastases	M0	Absence of distant metastases
	M1a	Contralateral foci, pleural or pericardial effusion/node
	M1b	One extrathoracic metastasis
	M1c1	A new subcategory: multiple metastatic foci localized within a single anatomical system (e.g., liver, brain, skeletal system, paired organs such as kidneys and adrenal glands).
	M1c2	New subcategory: metastases in two or more organ systems (for example, in the liver and in the skeletal system at the same time)

Redistribution of stages according to changes in N and M categories. Comparative analysis shows that:

T1N1 now belongs to stage IIA, instead of IIB in the eighth edition;

T1N2a – to stage IIB, instead of IIIA in the eighth edition (Figure 5);

T1N2b and T2N2a remain in stage IIIA (unchanged);

T2N2b – stage IIIB (eighth edition – IIIA);

T3N2a – stage IIIA;

T3N2b – stage IIIB;

T4N2a and T4N2b – both combinations remain in stage IIIB, as before (Figure 6) [11, 12].

These changes enable potential downstaging, thereby expanding the indications for surgical treatment (Table 2) [2, 8, 9].

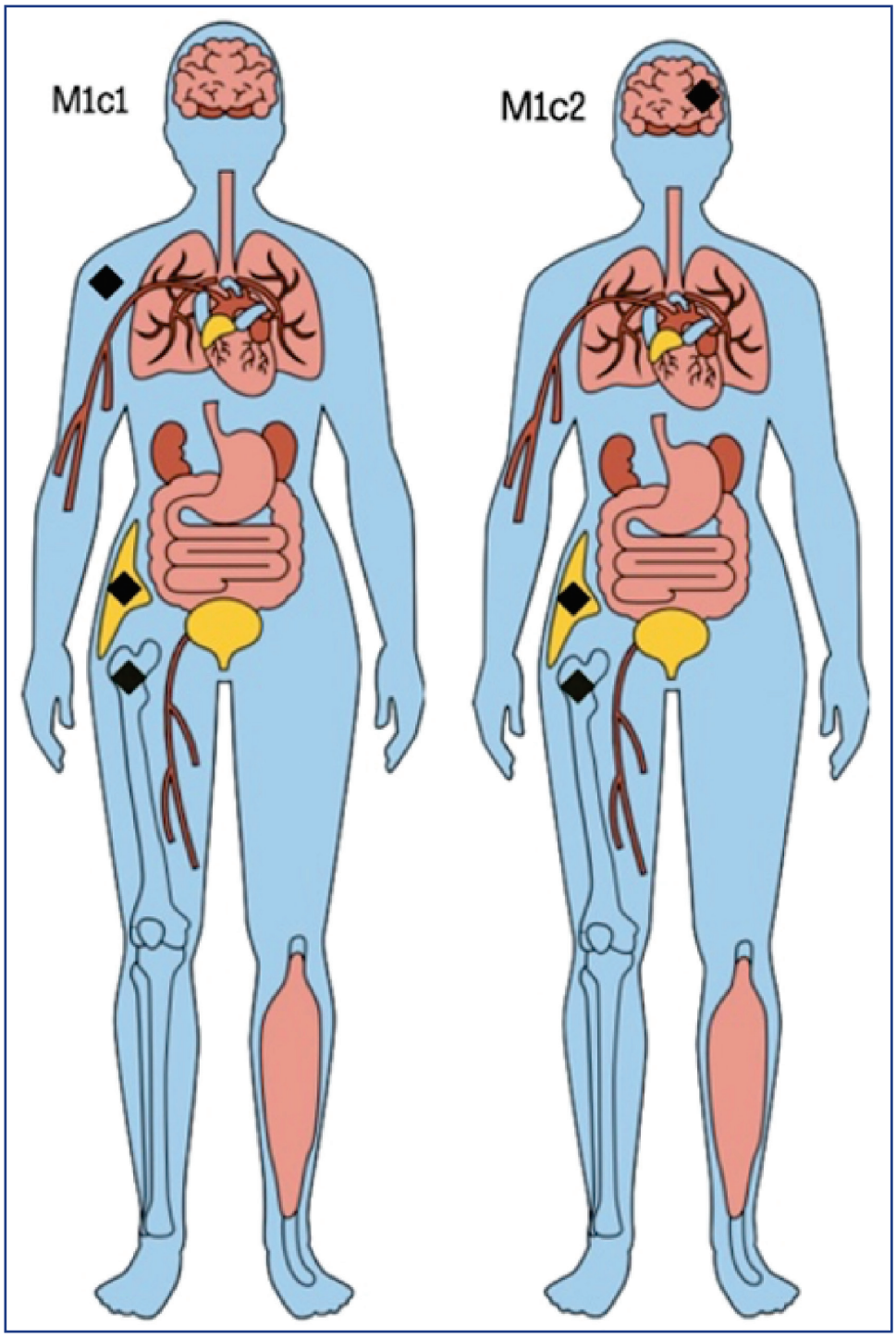

Figure 4 – Division of the subcategory M1c (multiple extrathorocal metastases) into metastases in one organ/system and metastases in several organ systems according to TNM-9. Picture A demonstrates multiple metastases to bone structures, corresponding to the category M1c1. Figure B demonstrates metastases to bone structures and the brain. They reflect lesions of two organ systems and are categorized as M1c2 [Source: author's collection].

TNM-9 in the structure of the radiological report.

The T category is determined based on the maximum diameter of a solid tumor component as imaged on a high-resolution CT scan with a slice thickness of no more than 1 mm, excluding the ground-glass and lepidic components. The T1 category encompasses tumors measuring up to 3 cm in size and is further divided into T1a (tumors measuring up to 1 cm), T1b (tumors measuring 1 to 2 cm), and T1c (tumors measuring 2 to 3 cm). The T2 category includes tumors 3 to 5 cm in size, as well as cases involving the visceral pleura, proximal bronchus, or accompanied by atelectasis/obstructive pneumonitis. T3 corresponds to tumors measuring 5 to 7 cm or invasions of the chest wall, diaphragm, pericardium, and other structures. T4 includes tumors larger than 7 cm or cases of invasion of large vessels, spine, trachea, and other critical anatomical formations. Multiple tumor foci are classified based on localization and histological identity as T3, T4, or M1a.

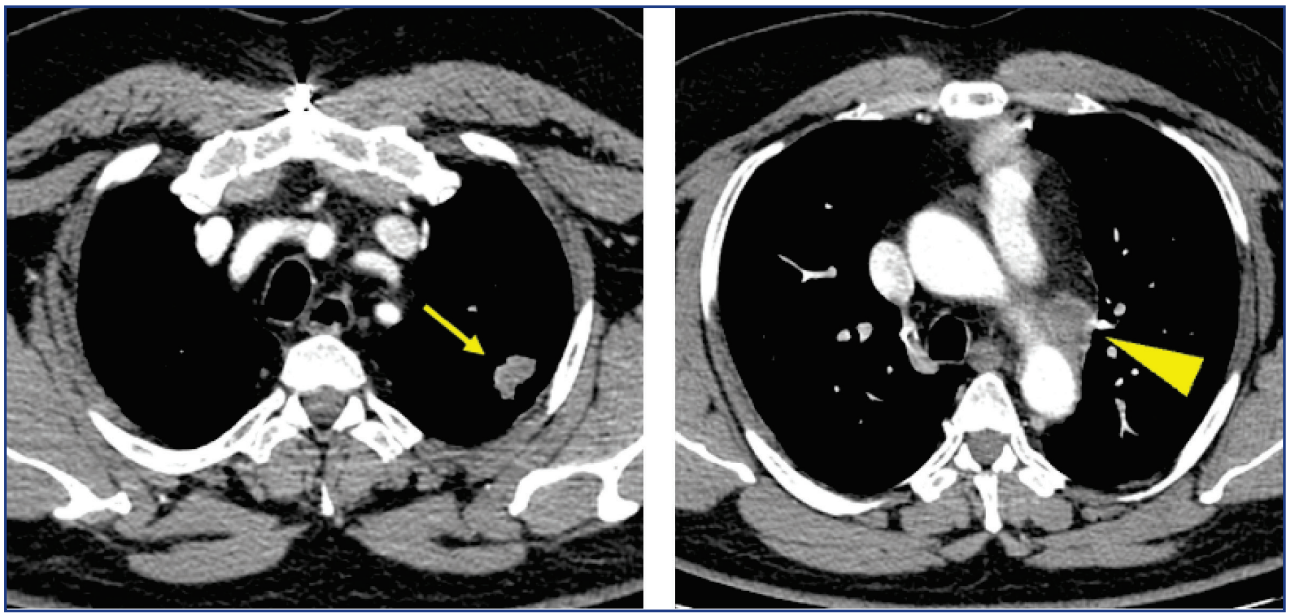

Figure 5 – Lung adenocarcinoma (T1c) 2 cm in the left upper lobe (yellow arrow) with single-position subaortic lymphadenopathy (arrowhead) (N2a) in a 51-year-old man. According to the TNM-9 classification, this patient is classified as T1cN2aM0, which corresponds to stage IIB. In contrast, the TNM-8 classification would classify this patient as T1cN2M0, corresponding to stage IIIA.

Table 2 – Grouping of lung cancer stages according to TNM-9 [5, 9, 10]

Stage	Combinations (T, N, M)
IA1	T1mi/T1a, N0, M0
IA2	T1b, N0, M0
IA3	T1c, N0, M0
IB	T2a, N0, M0
IIA	T2b, N0, M0 or T1, N1, M0
IIB	T2a/b, N1, M0 or T1, N2a, M0 or T3, N0, M0
IIIA	T1–3, N2b, M0 or T4, N0, M0
IIIB	T3–4, N2b, M0 or T1–2, N3, M0
IIIC	T3–4, N3, M0
IVA	Any T, any N, M1a, or M1b
IVB	Any T, any N, M1c1, or M1c2

Note: A high-resolution CT scan (≤1 mm) should be used for visual assessment, and only the solid tumor component should be measured. Atelectatic and inflammatory changes are not taken into account when determining the tumor size, but are automatically equated to T2 in the absence of signs of invasion into neighboring structures.

Regional lymph node (N) lesion categories include N0, N1, and N3, while N2 is now subdivided into N2a, when a single mediastinal lymphatic station is involved, and N2b, when two or more stations are involved. Clarification of the number of affected stations is recognized as an important prognostic factor.

The M categories remain the same: M0, M1a, and M1b, but the M1c category is now subdivided into M1c1 when there are multiple metastases within the same organ system (e.g., bone lesions only) and M1c2, when two or more organs metastatically are affected. The importance of a comprehensive assessment of oligometastatic disease, as well as the possibility of future integration of the molecular and biological characteristics of the tumor into the staging system, is separately emphasized.

Conclusion: The TNM-9 classification provides an enhanced and clinically sound anatomical framework, building upon the improvements introduced in TNM-8. Many of the changes in TNM-9 logically build upon the TNM-8 methodology, based on a global analysis of survival data from more than 70,000 patients. Particular attention is paid to improving the stratification of stages depending on the number of lymphatic stations, the number and localization of metastases, as well as the configuration of multiple tumor foci.

Understanding and active implementation of the TNM-9 classification by radiologists will significantly improve the accuracy of staging and the quality of multidisciplinary management of patients with lung cancer.

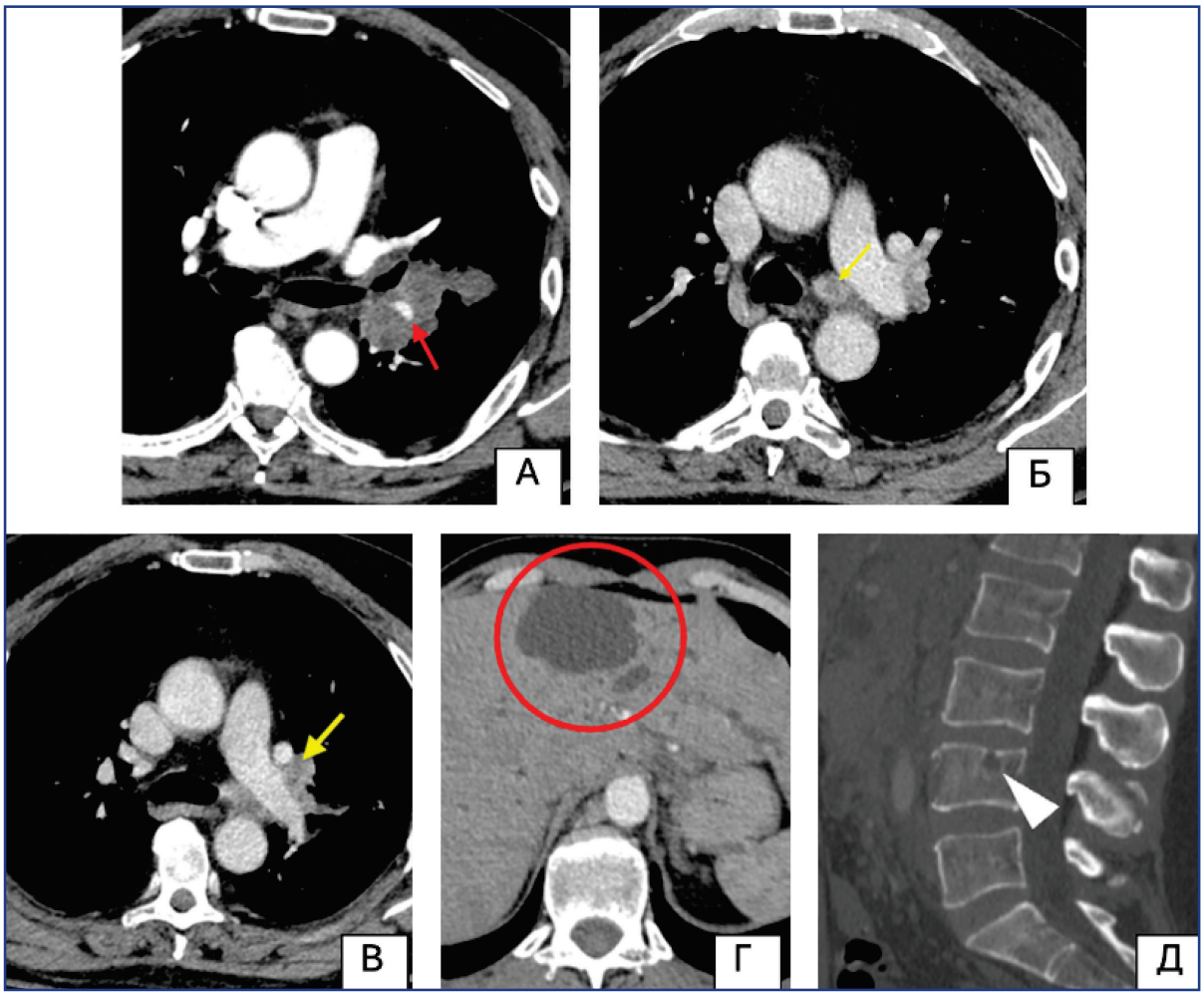

Figure 6 – Lung adenocarcinoma infiltrating the left pulmonary artery (T4) (red arrow on A), in a 58-year-old man. Ipsilateral lymphadenopathy is also visualized in the paratracheal (yellow arrow on B) and bronchopulmonary groups (yellow arrow on B) (N2b), as well as metastases in the liver (red circle on G) and in the vertebral body L4 (white arrowhead on D) (M1c2) followed by stage IVB (stage unchanged according to TNM 9)
[Source: Author's collection]

TNM	Описание	N0	N1	N2a	N2b	N3
T1a	до 1 см	IA1	IIA	IIB	IIIA	IIIB
T1b	от 1 до 2 см	IA2	IIA	IIB	IIIA	IIIB
T1c	от 2 до 3 см	IA3	IIA	IIB	IIIA	IIIB
T2a	от 3 до 4 см висцеральная плева/центральная инвазия	IB	IIB	IIIA	IIIB	IIIB
T2b	от 4 до 5 см	IIA	IIIB	IIIA	IIIB	IIIB
T3	от 5 до 7 см инвазия соседних структур отдельные узлы в той же доле	IIB	IIIA	IIIA	IIIB	IIIC
T4	от 7 см инвазия крупных магистральных структур отдельные узлы в других долях того же лёгкого	IIIA	IIIA	IIIB	IIIB	IIIC
M1a	узлы в противоположном лёгком злокачественый плеврит/перикардит	IVA	IVA	IVA	IVA	IVA
M1b	единичные внегрудные метастазы	IVA	IVA	IVA	IVA	IVA
M1c1	множественные метастазы в 1 системе	IVB	IVB	IVB	IVB	IVB
M1c2	множественные метастазы в нескольких системах	IVB	IVB	IVB	IVB	IVB

Figure 7 – Stages of lung cancer according to TNM-9 with color differentiation of changes: yellow indicates new positions, green indicates positions carried over from the previous edition unchanged [adapted from: 9]

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АНДАТПА

ӨКПЕ ОБЫРЫНЫҢ TNM-9 ЖІКТЕМЕСІНІҢ ЕРЕКШЕЛІКТЕРІ ЖӘНЕ TNM-8 ШЕКТЕУЛЕРІНІҢ ИНТЕГРАЦИЯСЫ

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Өзектілігі: *Өкпе обыры бүкіл әлемде сонымен қатар Қазақстандада онкологиялық аурулар арасында сырқаттанушылық пен өлім-жітім бойынша алдыңғы орындарды иеленеді. Диагностика мен емдеу әдістері уздіксіз жетілдіріліп жатқан жағдайда, ісік процесін дәл сатылау пациенттерге ем жүргіз тактикасын таңдауда маңызды рөл атқарады. 2017 жылы енгізілген tumor-node-metastasis (TNM) жіктемесінің 8-ші басылымы сатылауға қатысты маңызды өзгерістер енгізіп, оның дәлдігін арттырған болатын. Алайда жиналған мәліметтер медиастинальды лимфа түйіндері мен жайылмалы метастаздарды бағалауда қосымша нақтылықты қажет ететінін көрсетті. Осыған байланысты, 2025 жылдың 1 қаңтарынан бастап маңызды өзгерістерді қамтитын TNM-нің 9-шы басылымы қолданысқа енді және бұл радиологиялық практикаға бейімделуді талап етеді.*

Зерттеудің мақсаты *– Өкпе обырының TNM жіктемесінің 8-ші және 9-шы редакцияларын салыстыра талдау жүргізіп, сатылаудың дәлдігін арттыру және ем кезіндегі мультидисциплинарлық жоспарлауды тиімді ұйымдастыру мақсатында негізгі өзгерістерді анықтау.*

Әдістері. *Осы зерттеуде TNM жіктемесінің 9-шы редакциясын 8-ші редакциямен салыстырғанда енгізілген өзгерістер құрылымды түрде қаралып, негізінен N және M категорияларының трактовкасына назар аударылды. Талдау барысында Өкпе обырын зерттеу бойынша халықаралық қоғамның (IASLC) клиникалық ұсыныстары және ісік процесінің сатылауындағы қазіргі әдістемелерді көрсететін заманауи басылымдар пайдаланылды.*

Нәтижелері. *TNM жіктемесінің тоғызыншы редакциясында N және M категориялары нақтыланып, N2a/N2b және M1c1/M1c2 жаңа подкатегориялары енгізілді. Сонымен қатар, T және N категорияларының кейбір комбинацияларының сатылауы қайта қаралды. Лимфа түйіндерінің анатомиялық егжей-тегжейлі сипаттамасы мен метастаздардың жүйелік сипатына ерекше мән берілді.*

Қорытынды. *TNM-9 жаңа ережелерін түсіну сатыны дәлірек бағалауға, мультидисциплинарлық консилиумдардағы қарым-қатынасты жақсартуға және емдеу шешімдерін оңтайландыруға маңызды.*

Түйінді сөздер: *өкпе обыры, сатылау, TNM, TNM-9.*

АННОТАЦИЯ

ОСОБЕННОСТИ КЛАССИФИКАЦИИ TNM-9 ПО РАКУ ЛЁГКОГО И ИНТЕГРАЦИЯ ОГРАНИЧЕНИЙ TNM-8

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Актуальность: *Рак лёгкого занимает лидирующие позиции по заболеваемости и смертности среди онкологических заболеваний в Казахстане и во всём мире. В условиях постоянно совершенствующихся методов диагностики и лечения точное стадирование опухолевого процесса играет ключевую роль в выборе тактики ведения пациентов. Восьмое издание классификации Tumor-Node-Metastasis (TNM), внедрённое в 2017 году, внесло значимые изменения в подход к стадированию, повысив его точность. Однако накопленные данные продемонстрировали необходимость дальнейшей детализации, особенно в оценке медиастинальных лимфоузлов и системного метастазирования. В связи с этим с 1 января 2025 года вступило в силу 9-е издание TNM, содержащее важные изменения, которые требуют адаптации в радиологической практике.*

Цель исследования *– провести сравнительный анализ 8-й и 9-й редакций классификации TNM при раке лёгкого и выявить ключевые изменения с целью повышения точности стадирования и участия в мультидисциплинарном планировании лечения.*

Методы: *В настоящем исследовании проведён структурированный обзор изменений, внесённых в 9-е издание классификации TNM по сравнению с 8-м изданием, с фокусом на трактовку категорий N и M. Для анализа использованы клинические рекомендации Международного общества по изучению рака лёгкого (IASLC), а также современные публикации, отражающие актуальные подходы к стадированию опухолевого процесса.*

Результаты: *В 9-м издании классификации TNM были уточнены категории N и M с введением новых подкатегорий N2a/N2b и M1c1/M1c2. Кроме того, пересмотрено стадирование ряда комбинаций категорий T и N. Особое внимание уделено необходимости более детальной анатомической характеристики лимфатических узлов и системного характера метастазирования.*

Заключение: *Понимание новых положений TNM-9 важно для точной оценки стадии, улучшения коммуникации на мультидисциплинарных консилиумах и оптимизации лечебных решений.*

Ключевые слова: *рак лёгкого, стадирование, TNM, TNM-9.*

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