Journal of the American Society of Cytopathology (2023) **12**, 251–257

Available online at www.sciencedirect.com

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journal homepage: www.jascyto.org/

A brief review of the WHO reporting system for lung cytopathology

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https://doi.org/10.1016/j.jasc.2023.04.002

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Received 5 March 2023; received in revised form 31 March 2023; accepted 3 April 2023

KEYWORDS
Lung cytology;
IAC;
WHO reporting systems for cytopathology;
Nomenclature;
IARC;
lung FNAB;
EBUS-FNA

The International Academy of Cytology has joined with the International Agency for Research on Cancer to bring together a group of experts in lung cytopathology to develop a WHO Reporting System for Lung Cytopathology (WHO System). This System aims to improve and standardize the reporting of cytopathology, facilitate communication between cytopathologists and clinicians, and improve patient care. The WHO System describes 5 categories for reporting lung cytopathology: 'Insufficient/Inadequate/Nondiagnostic', 'Benign', 'Atypical', 'Suspicious for malignancy', and 'Malignant', each one with a clear descriptive term, a definition, a risk of malignancy, and a suggested management algorithm. The key diagnostic cytopathologic features of each of the lesions within each category have been established by consensus through an Expert Editorial Board, who are also the authors of this review and selected for each reporting system and chosen based on their expertise in the field and/or diversity of geographical representation. Many other co-authors from around the world also contributed. The assignment of writing and editing responsibilities used the same model as that used for the WHO Classification of Tumours (https://whobluebooks.iarc.fr/about/faq/). The WHO System provides the best practice application of ancillary testing, including immunocytochemistry and molecular pathology, and guides in sampling and processing techniques to optimize the handling and preparation of specimens. The WHO System was created by the authors to be applicable globally and is based on cytomorphology with possibilities for additional diagnostic management of the patient. The authors are aware that local medical and pathology resources would differ, especially in low- and middle-income countries. The WHO Tumour Classification for Thoracic Tumors, Fifth Edition, is directly accessible through the online WHO System.

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Introduction

An international standard for reporting lung cytopathology has been developed and published by the International Academy of Cytology (IAC), the International Agency for Research on Cancer (IARC), and the World Health Organization (WHO).[1,2] The aims of this project are in line with other cytopathology reporting systems to offer better standardization of the report, improve patient care, facilitate research, and provide cytopathologic correlation with the entities described in the WHO Classification of Tumours, with links on the Web site between the 2 series.

Recently, our group published a comprehensive overview of this new WHO Reporting System for Lung Cytopathology (WHO System) in *Acta Cytologica*.[2] In this current brief review for the *Journal of American Society of Cytopathology*, our goal is to provide to the readership a more concise overview of the reporting system for the practical application in the daily use.

The Editorial Board that has developed and written the WHO Reporting System for Lung Cytopathology (WHO System) acknowledges the advances achieved by the 2 most recent previous reporting systems, The Papanicolaou Society of Cytopathology (PSC) System for Reporting Lung Cytopathology published in 2016[3] and The Japan Lung Cancer Society (JLCS) and Japanese Society of Clinical Cytology (JSCC) System published in 2020.[4] The PSC System is a 6-tiered reporting system incorporating 'Nondiagnostic', 'Negative (for malignancy)', 'Atypical', 'Neoplastic, benign and other', 'Suspicious (for malignancy)', and 'Malignant' categories.[3,5] The JLCS/JSCC System proposed a 4-tiered reporting system with the following categories: 'Negative for malignancy', 'Atypical cells', 'Suspicious for malignancy', and 'Malignancy'.[4] In that system, inadequate cases are not categorized because they are excluded in an initial step. Although these 2 proposals had merit in that they attempted to systematize the nomenclature, the WHO System[1,2] is a system that can be used internationally in all medical infrastructure settings, providing options for management that recognize the variation in the availability of ancillary diagnostic and prognostic testing modalities in low- and middle-income countries. The WHO System emphasizes the importance of cell preparation techniques, and for the first time has established by the consensus of the Expert Editorial Board the key diagnostic cytopathologic features of each lesion found in each category. The WHO System has also established best-practice recommendations for the use of immunocytochemistry (ICC), in situ hybridization, and molecular techniques since these are extremely important diagnostic modalities in the rapidly developing targeted therapy in lung cancer.[6]

The WHO Reporting System for Lung Cytopathology has 5 categories that can be stratified by their risk of malignancy (ROM): 'Insufficient/Inadequate/Nondiagnostic', 'Benign', 'Atypical', 'Suspicious for malignancy', and 'Malignant'.[1,2] The standardized structured report should state 1 of these 5 descriptive category terms as a heading. A laboratory and its cytopathologists should select one of the terms, 'Insufficient/Inadequate/Nondiagnostic', and use this term consistently. The structured report headed by a category can include a brief cytopathologic description noting, where possible the presence or absence of key diagnostic features. This is followed by a diagnostic summary in which the cytopathologist should give as specific a diagnosis of the lesion as possible, such as squamous cell carcinoma, or, if the diagnosis is uncertain, provide the most likely differential diagnoses (Fig. 1). A working group consisting of members of the IAC and the International Collaboration on Cancer Reporting is establishing a minimum data set of core and noncore components to be included in the reports of lung malignancies diagnosed by small biopsies and cytopathology specimens.

There are a few published papers showing the ROM for each of the WHO System categories, and most other papers have used the previous nomenclature systems and their categories.[3,5,7] The ROM provided in this WHO System first edition will need to be refined through future research by cytopathologists.[1] The categories are linked to recommendations as to further workup and diagnostic management, which are dependent on the availability of medical resources and local practices (Table 1). In lung cytopathology the ROM can also vary depending to the sampling methodology (Table 2).

An international Web-based survey was developed by the IAC in consultation with the Lung Expert Editorial Board to establish a picture of current lung cytopathology practice among the international community of cytopathology. The survey was based on an earlier survey developed and utilized to assist the authors of the IAC Yokohama System for Reporting Breast Fine Needle Aspiration Biopsy Cytopathology.[8] The Lung Cytopathology survey demonstrated a diverse practice among various laboratories and countries using a wide spectrum of techniques for specimen processing and handling and various reporting systems. The information obtained assisted the editors and authors to develop the WHO System.

Diagnostic categories

Insufficient/Inadequate/Nondiagnostic

The category is defined as a specimen that lacks sufficient material in quantity or quality for a reliable diagnosis. This category is used for cases where there is insufficient material due to low cellularity, poor preparation, fixation or staining, and obscuring by blood, inflammatory cells, or other material. The term 'Nondiagnostic' has been used by some cytopathologists for this category to include not only

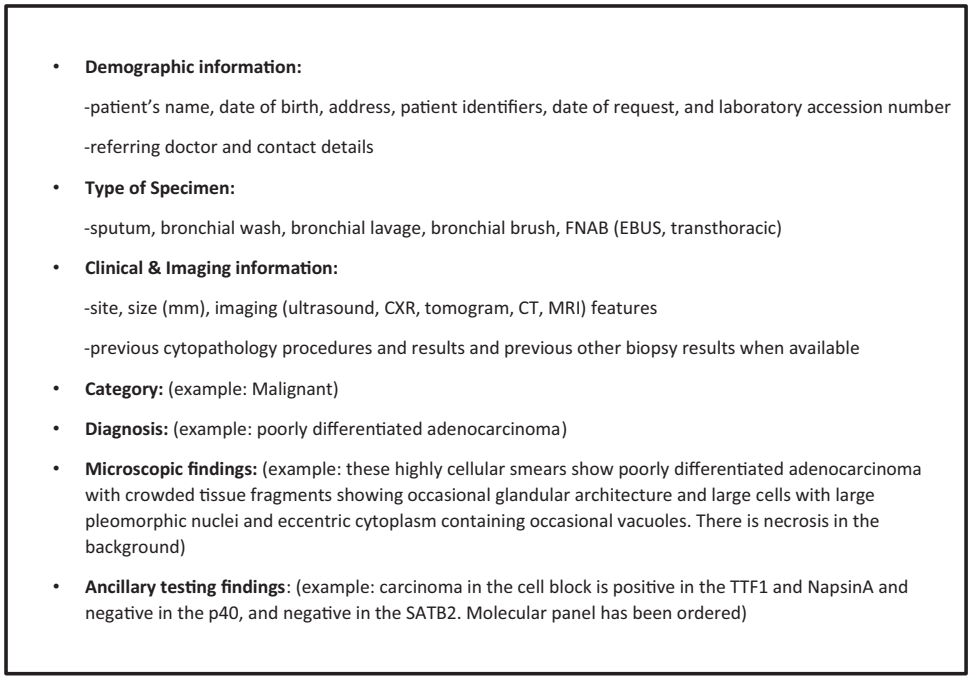

Figure 1 Example of Standardized Cytopathology Report. The WHO System has established the key components of the standardized report, but the final formatting and inclusions will depend on the local IT system, local usage, and local practice. The Category uses the established descriptive category terminology and never a number. The Diagnosis should provide a specific diagnosis or, if this is not possible, then a differential diagnosis. The Microscopy findings are optional if there is a distinct specific diagnosis made, and should focus on the key cytopathologic diagnostic findings, particularly when the diagnosis includes a differential diagnosis. Any Ancillary testing findings are added to the cytopathology report in 1 integrated report as supplementary reports.

these cases of insufficient material, but also cases where there is considerable benign material on the slides, but the material appears not to be representative of a mass lesion or lung nodule seen on imaging. In this situation, an alternative approach is to categorize what is seen on the slides as 'Benign' and add a caveat to the report, that "the material may not represent the lesion seen on imaging". Either approach is acceptable, and an institution or cytopathology service should select one term, 'Insufficient', 'Inadequate', or 'Nondiagnostic' and apply it routinely. The reasons for an 'Insufficient/Inadequate/Nondiagnostic' specimen should be documented in the report. If there are any atypical cells the case is immediately regarded as 'Atypical' or 'Suspicious for malignancy'. The 'Insufficient/Inadequate/Nondiagnostic' category harbors a ROM of approximately 40% to 60%,[3,5] depending on the mode of sampling and imaging characteristics of a lung mass.[9] It is recommended that the reasons for inadequacy in a specimen should be reported with the aim to improve the diagnostic yield of a repeat examination[8]—for example, if an initial inadequate predominantly oropharyngeal sputum is received, the recommendation to repeat should be accompanied by a specific statement that an adequate 'deep cough' is required to produce an adequate sputum. After unsuccessful noninvasive or minimally invasive procedures, such as sputum, bronchial wash (BW), and bronchial brush (BB), endoscopically guided fine-needle aspiration biopsy (FNAB) or transthoracic computed tomography−guided FNAB can be utilized. Clinical, imaging, and pathologic correlation are required to establish further diagnostic management.

Benign

A specimen categorized as 'Benign' shows unequivocal cytopathologic features that may or may not be diagnostic of a specific inflammatory process or benign neoplasm, which are found in all types of samples of respiratory cytopathology, such as granulomatous inflammation or pulmonary hamartoma. Correlation with imaging is required wherever available. If the cytopathologic findings do not correlate with the imaging, which may be indeterminate or suspicious, then this should be clearly stated as a caveat in the report and particularly in its conclusion, that "the cytopathologic material may not represent the lesion seen on imaging". Recommendations for further diagnostic workup should be given. The ROM reported for this category is in the range from 20% to 40%.[2,4,6] The final diagnosis should be established utilizing the 'Triple Test' with the correlation of the cytopathology findings with the clinical and imaging presentation.[10] This is especially important in benign

Table 1 The WHO Reporting System for Lung Cytopathology on FNAB: implied ROM and clinical management options by diagnostic category.

Diagnostic category	Estimated ROM	Clinical management options
Insufficient/Inadequate/Nondiagnostic	43%-53%	Correlate with CLIN-IMG-MICRO, ideally discuss at an MDT meeting, and perform repeat FNAB with or without CNB
Benign	19%-64%	Correlate with CLIN-IMG-MICRO; if these confirm a benign diagnosis, then routine follow-up at 3-6 months; if no correlation, perform repeat FNAB with or without CNB
Atypical	46%-55%	Correlate with CLIN-IMG-MICRO, and ideally discuss at an MDT meeting; if all show a benign diagnosis, then routine follow-up at 3-6 months; if no correlation, perform repeat FNAB with ROSE with or without CNB
Suspicious for malignancy	75%-88%	Correlate with CLIN-IMG-MICRO, and ideally discuss at an MDT meeting; if all 4 support a diagnosis of malignancy, consider definitive treatment; if no correlation that lesion is malignant, perform repeat FNAB with ROSE with or without CNB
Malignant	87%-100%	Correlate with CLIN-IMG-MICRO, and ideally discuss at an MDT meeting; if all 4 support a diagnosis of malignancy, provide definitive treatment; if no correlation that lesion is malignant, consider repeat FNAB with ROSE with or without CNB

Abbreviations: CLIN-IMG-MICRO, clinical, imaging, and microbiologic findings; CNB, core needle biopsy, including endobronchial biopsy; FNAB, fine-needle aspiration biopsy, including endobronchial ultrasound–guided and transthoracic FNAB; MDT, multidisciplinary team; ROM, risk of malignancy; ROSE, rapid onsite evaluation.

International Academy of Cytology — International Agency for Research on Cancer — World Health Organization Joint Editorial Board. WHO Reporting System for Lung Cytopathology [Internet; beta version ahead of print]. Lyon (France): International Agency for Research on Cancer; 2022 [cited 2023 02 27]. (IAC-IARC-WHO cytopathology reporting systems series, 1st ed.; vol. 1). Available from: https://tumourclassification.iarc.who.int/chapters/48.

neoplasms such as hamartoma where the material may resemble normal lung elements. If a specific diagnosis is not established, a repeat study may be recommended, or, in some cases, further more invasive evaluation such as core needle biopsy (CNB) or, if clinically appropriate, limited resection should be performed.

Atypical

A specimen categorized as 'Atypical' shows features predominantly seen in benign lesions and minimal features that may raise the possibility of a malignant lesion, but with insufficient features either in number or quality to diagnose

Table 2 The WHO Reporting System for Lung Cytopathology on sputum sample, bronchial washing (BW), and bronchial brushing (BB): implied ROM and clinical management options by diagnostic category.

Diagnostic category	Estimated ROM	Clinical management options
Insufficient/Inadequate/Nondiagnostic	Sputum sample: 0%-100% BW: 38%-81% BB: 0%-75%	Consider repeating the sampling or use BB/BW (in case of sputum sample) and/or FNAB, depending on CLIN-IMG-MICRO
Benign	Sputum sample: 0%-42% BW: 38%-42% BB: 32%-38%	Correlate with CLIN-IMG-MICRO; if these confirm a benign diagnosis, then routine follow-up at 3-6 months; if no correlation, consider new sampling
Atypical	Sputum sample: 86%-100% BW: 62%-86% BB: 79%-100%	Correlate with CLIN-IMG-MICRO; if these are 'Benign', repeat; if 'Atypical' or 'Suspicious for malignancy', perform BB/BW or FNAB with or without CNB
Suspicious for malignancy	Sputum sample: 100% BW: 83%-100% BB: 75%-100%	Correlate with CLIN-IMG-MICRO, and perform BB/BW or FNAB with or without CNB; these cases need to be discussed at MDT meetings
Malignant	Sputum sample: 100% BW: 98%-100% BB: 94%-100%	Correlate with CLIN-IMG-MICRO, and perform BB/BW or FNAB with or without CNB to confirm diagnosis before definitive treatment

Abbreviations: CLIN-IMG-MICRO, clinical, imaging, and microbiologic findings; CNB, core needle biopsy, including endobronchial biopsy; FNAB, fine-needle aspiration biopsy, including endobronchial ultrasound–guided and transthoracic FNAB; MDT, multidisciplinary team.

International Academy of Cytology — International Agency for Research on Cancer — World Health Organization Joint Editorial Board. WHO Reporting System for Lung Cytopathology [Internet; beta version ahead of print]. Lyon (France): International Agency for Research on Cancer; 2022 [cited 2023 02 27]. (IAC-IARC-WHO cytopathology reporting systems series, 1st ed.; vol. 1). Available from: https://tumourclassification.iarc.who.int/chapters/48.

a benign or malignant process or lesion. The main situations leading to an 'Atypical' categorization include the intrinsic characteristics of the targeted lesion, the expertise of the operator, technical issues related to obtaining and preparing the material, and the experience of the pathologist who is interpreting the specimen.[11,12] Reactive changes such as metaplasia and hyperplasia, infections (particularly viral), post-therapy changes, and acute respiratory distress syndrome, are commonly associated with an 'Atypical' categorization. It is recommended that clinical and imaging findings are reviewed before categorizing a specimen as 'Atypical'.[6,12] Rates of the 'Atypical' category vary between different practices and cytopathology specimen types. In published series, approximately 3% to 5% of the cases were placed in this category.[5,13] The ROM is reported as in the range of 50% to 60%, which is regarded as far from ideal, but they are only few published studies.[3,5,7] After cytopathologic categorization as 'Atypical', correlation with imaging and clinical findings is required. If the imaging features are atypical or concerning for malignancy, further investigation is warranted.

Suspicious for malignancy

A specimen categorized as 'Suspicious for malignancy' demonstrates some cytopathologic features suggestive of malignancy but with insufficient features either in number or quality to make an unequivocal diagnosis of malignancy. The category is used in respiratory cytopathology to indicate a degree of uncertainty regarding the diagnosis of malignancy and offers a risk stratification for a malignant diagnosis maintaining its high positive predictive value.[3,4,12] The category remains subjective with a high rate of interobserver disagreement,[14] as the threshold for the diagnosis of malignancy depends on the pathologist's experience, the type of cytopathologic preparation, and the degree of cellular atypia. The category is used particularly to avoid a false-positive diagnosis of malignancy, which can lead to unnecessary intervention. When a case is categorized as 'Suspicious for malignancy', the report should include a statement as to which specific malignancy or malignancies in a differential diagnosis are suspected, including non-small cell carcinoma, neuroendocrine tumours, small and large cell neuroendocrine carcinomas, lymphoma, sarcoma, and metastatic carcinomas. Although there are no defined cytopathologic criteria for this category, significant cytopathologic atypia is present including nuclear enlargement, anisonucleosis, nuclear crowding, varying chromatin, variability in cell size and shape, presence of large or irregular nucleoli, and other features associated with malignancy. In contrast, well-differentiated adenocarcinoma of lung with or without a lepidic pattern, can result in sheets of cells with a low degree of nuclear atypia that may be categorized as 'Suspicious for malignancy' due to the lack of overtly malignant characteristics. Reactive atypia mimicking carcinoma can occur after radiotherapy and/or chemotherapy and may result in categorization as 'Suspicious for malignancy'. The use of ancillary techniques such as ICC may assist in the changing a 'Suspicious for malignancy' to a 'Malignant' categorization, such as when metastatic tumors and neuroendocrine tumors are suspected, but generally the quality and quantity of the suspicious cells may still prevent definitive classification. Rates for this category vary between different practices and cytopathology specimen types. In a recent publication, approximately 5% of the cases were placed in this category.[5] The ROM of the 'Suspicious for malignancy' category is approximately 82%, with a range of 54.5% to 90%.[3,5,7] After a 'Suspicious for malignancy' diagnosis, all relevant clinical and imaging information should be reviewed, to determine a management plan, to in order to avoid unnecessary additional risks and costs, and consultation with a more experienced cytopathologist may be helpful to reach the threshold of malignancy in an otherwise limited specimen.

Malignant

A specimen classified as 'Malignant' demonstrates unequivocal cytopathologic features of malignancy. The 'Malignant' category should only be used when there is a full constellation of cytopathologic findings and no discrepant features. Wherever possible, the neoplasm should be subclassified based on the key diagnostic cytopathologic features and ICC, if needed. Based on cytomorphology, good accuracy (ie, greater than 70%) can be achieved in differentiating between non-small cell carcinoma, including adenocarcinoma and squamous cell carcinoma, and small cell neuroendocrine carcinoma. In the case of primary epithelial tumours, differentiation between adenocarcinoma and squamous cell carcinoma can be achieved using a limited ICC panel consisting of TTF1 and p40. The 'Malignant' category also includes low-grade neuroendocrine tumors, previously known as carcinoid and atypical carcinoid, and neuroendocrine carcinomas of predominantly small or large cell types, which can be diagnosed by cytopathology and confirmed by use of ICC markers. The other malignant neoplasms included in this category are salivary gland type carcinomas, mesenchymal tumours and secondary malignancies. Rates of 'Malignant' categories can vary between different institutions and countries, and in a recent series approximately 20% of the cases were placed in this category.[4] The reported ROM for cytopathology specimens categorized as 'Malignant' is greater than 90% and in most cases approaches 100%.[3,5,7,15] A cytopathology categorization as 'Malignant' should be correlated with the clinical and imaging findings and if it is concordant, surgical management if appropriate can proceed, while if systemic treatment is planned in the more common situation of advanced disease, definitive therapy can be commenced particularly if material is available for prognostic and predictive biomarkers.

Conclusion

The WHO System[1,2] is designed to improve communication between clinicians and cytopathologists. Each specimen type and its category have a specific initial ROM and this will directly influence clinical diagnostic management algorithms. The WHO System also defines through the first international consensus the key diagnostic cytopathologic criteria for each lesion or tumor, which is essential to improve the quality of diagnostic assessment and reporting of lung cytopathology. The WHO System also offers the most up-to-date guidelines for using ancillary tests, such as ICC and molecular pathology, and, most importantly, it offers thorough explanations of sampling and processing procedures to facilitate the handling and preparation of cytopathology samples. The WHO System is based on cytomorphology and offers options for additional diagnostic management of the patient. The WHO System acknowledges that local medical and pathology resources and infrastructure will vary, especially in low- and middle-income countries. By raising awareness of cytopathology's role in the era of personalized medicine based on molecular data, the WHO System will increase the profile and use of cytopathology. It also provides a direct and dynamic link to the WHO Classification for Thoracic Tumours, Fifth Edition.

Funding sources

There are no funding sources.

Conflict of interest disclosures

The content of this article represents the personal views of the authors and does not represent the views of the authors' employers and associated institutions. Where authors are identified as personnel of the International Agency for Research on Cancer/World Health Organization, the authors alone are responsible for the views expressed in this article and they do not necessarily represent the decisions, policy, or views of the International Agency for Research on Cancer/World Health Organization.

References

1. International Academy of Cytology – International Agency for Research on Cancer – World Health Organization Joint Editorial Board. WHO Reporting System for Lung Cytopathology. In: *IAC-IARC-WHO cytopathology reporting systems series*. 1st ed. Lyon (France): International Agency for Research on Cancer; 2022.
2. Schmitt FC, Bubendorf L, Canberk S, et al. The World Health Organization Reporting System for Lung Cytopathology. *Acta Cytol*. 2023;67:80–91.
3. Layfield LJ, Baloch Z, Elsheikh T, et al. Standardized terminology and nomenclature for respiratory cytology: the Papanicolaou Society of Cytopathology guidelines. *Diagn Cytopathol*. 2016;44:399–409.
4. Hiroshima K, Yoshizawa A, Takenaka A, et al. Cytology Reporting System for Lung Cancer from the Japan Lung Cancer Society and Japanese Society of Clinical Cytology: An Interobserver Reproducibility Study and Risk of Malignancy Evaluation on Cytology Specimens. *Acta Cytol*. 2020;64:452–462.
5. Canberk S, Montezuma D, Aydin O, et al. The new guidelines of Papanicolaou Society of Cytopathology for respiratory specimens: assessment of risk of malignancy and diagnostic yield in different cytological modalities. *Diagn Cytopathol*. 2018;46:725–729.
6. Canberk S, Engels M. Cytology samples and molecular biomarker testing in lung cancer-advantages and challenges. *Virchows Arch*. 2021;478:45–57.
7. Yoshizawa A, Hiroshima K, Takenaka A, et al. Cytology Reporting System for Lung Cancer from the Japan Lung Cancer Society and the Japanese Society of Clinical Cytology: an extensive study containing more Benign Lesions. *Acta Cytol*. 2022;66:124–133.
8. Field AS, Kurtycz DFI, Raymond WA, Schmitt F. The International Academy of Cytology Yokohama System for Reporting Breast Fine Needle Aspiration Biopsy Cytopathology: analysis and discussion of the response to a web-based survey. *Cancer Cytopathol*. 2021;129:450–459.
9. MacMahon H, Naidich DP, Goo JM, et al. Guidelines for Management of Incidental Pulmonary Nodules Detected on CT Images: from the Fleischner Society 2017. *Radiology*. 2017;284:228–243.
10. Borczuk AC. Neoplastic and nonneoplastic benign mass lesions of the lung. *Arch Pathol Lab Med*. 2012;136:1227–1233.
11. Idowu MO, Powers CN. Lung cancer cytology: potential pitfalls and mimics - a review. *Int J Clin Exp Pathol*. 2010;3:367–385.
12. Layfield LJ, Baloch Z. Atypia in pulmonary cytology: morphologic spectrum and causes. *Diagn Cytopathol*. 2022;50:164–171.
13. Savic S, Glatz K, Schoenegg R, et al. Multitarget fluorescence in situ hybridization elucidates equivocal lung cytology. *Chest*. 2006;129:1629–1635.
14. Layfield LJ, Esebua M, Dodd L, Giorgadze T, Schmidt RL. The Papanicolaou Society of Cytopathology guidelines for respiratory cytology: reproducibility of categories among observers. *Cytojournal*. 2018;15:22.
15. Boler AK, Banu N, Bose K, Roy S, Bandyopadhyay A. Reproducibility of "the Papanicolaou Society of Cytopathology system for reporting respiratory cytology" - A retrospective analysis of 101 cases of CT-guided FNAC. *Diagn Cytopathol*. 2020;48:701–705.