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Editorial

The Evolution of Cytopathology Reporting: Standardization, Precision, and Future Directions

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Cytopathology has undergone a significant transformation in recent decades, driven by advances in diagnostic techniques, molecular pathology, and the need for standardized communication between pathologists and clinicians. The introduction and continuous refinement of structured reporting systems have provided a critical framework for ensuring diagnostic accuracy, reproducibility, and optimal patient management.

With the review on the World Health Organization (WHO) Reporting System for Soft Tissue Cytopathology in this issue of the *Journal of Clinical and Translational Pathology*, this editorial brings together a series of articles highlighting major reporting systems in cytopathology, demonstrating their evolution, impact, and future directions.[1]

Standardized reporting systems address several key challenges in cytopathology. They provide clear diagnostic categories, define the risk of malignancy (ROM) for each category, and offer management recommendations.[1] These frameworks are essential for maintaining consistency across institutions and pathologists, facilitating interdisciplinary communication, and supporting clinical decision-making. Among the reporting systems discussed in this editorial are The Paris System for Urinary Cytology, The Bethesda System for Reporting Cervical and Thyroid Cytopathology, The Yokohama System for Breast Cytology, The Milan System for Salivary Gland Cytopathology, and the emerging WHO-International Academy of Cytology (IAC) universal reporting systems for multiple organ sites.

The WHO-IAC Reporting Systems represent a significant step toward global standardization in cytopathology.[1] By providing a universal lexicon for cytopathology, these systems bridge diagnostic gaps across regions with varying levels of resources. The WHO-IAC systems have already been implemented in key areas such as lung,[2,3] pancreaticobiliary,[4,5] lymph node,[6] and soft tissue cytopathology,[7] and are currently expanding into liver, breast, kidney and adrenal, and head and neck cytopathology. Their structured approach ensures consistency, enhances diagnostic reproducibility, and facilitates clinical decision-making in diverse healthcare settings.

The pioneering system of systematic cytopathology reporting was the Bethesda System for Reporting Cervical Cytology, discussed in the article by Wang *et al*.,[8] which has played a pivotal role in the early detection and management of cervical cancer. Since its inception in 1988, the Bethesda System has standardized cervical cytology reporting, ensuring clear communication of findings and appropriate clinical follow-up. Recent updates incorporate advancements in HPV testing and reflect evolving guidelines for cervical cancer screening. This system was followed by the Bethesda System for Reporting Thyroid Cytopathology, as reviewed by Han and Fan.[9] This system has undergone multiple revisions to refine risk stratification and incorporate molecular diagnostics. The third edition, recently published, introduces key updates in histologic terminology and risk assessment. These changes underscore the dynamic nature of cytopathology and the continuous need to integrate emerging scientific knowledge into practice.[10] While the Bethesda System established the paradigm for organ-specific standardization, subsequent systems like the Paris System addressed unique diagnostic challenges in their respective fields, demonstrating how cytopathology reporting continues to evolve to meet clinical needs.

The Paris System for Reporting Urinary Cytology (TPS), reviewed by Chen and Lin, has evolved significantly since its introduction in 2016 and subsequent update in 2022.[11] By emphasizing high specificity in detecting high-grade urothelial carcinoma while reducing unnecessary indeterminate diagnoses, this system has improved diagnostic accuracy and clinical utility. The review provides a comprehensive update on TPS 2.0, including its impact on clinical practice and the role of molecular testing in urinary cytology.[12]

Similarly, breast cytology has benefited from standardized reporting through The Yokohama System, which stratifies breast lesions into five diagnostic categories with defined ROM and management strategies.[13] The article by Yu *et al*.[14] emphasizes the significance of this system in improving diagnostic confidence and reducing unnecessary interventions. Although breast cytology is being replaced by core-needle biopsy in several scenarios, this methodology is still used in many countries and continues to be very helpful, as demonstrated in our practice.[15] At this moment, the WHO is preparing a reporting system that will replace the Yokohama System but maintain its structure.

The Milan System for Reporting Salivary Gland Cytopathology has similarly provided much-needed clarity in classifying salivary gland lesions, as explored in the review by

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Wang and Wang.[16] Since its introduction, it has enhanced risk stratification, facilitating better clinical decision-making and surgical planning. Updates to this system continue to refine diagnostic criteria and incorporate emerging molecular markers.[17]

Other critical reporting systems covered in this editorial include The International System for Reporting Serous Fluid Cytopathology, which standardizes the evaluation of effusion specimens.[18] When handled and examined correctly, effusion specimens can enable fast and reliable diagnoses, with a profound impact on clinical management.[19] Building on the foundation of other cytology reporting nomenclature systems, the IAC and the American Society of Cytopathology assembled a team of experts to develop a standardized reporting system for serous effusion cytology, called the International System for Reporting Serous Fluid Cytology (TIS). Grounded in the latest research and expert consensus, TIS aims to provide a framework to minimize reporting variability.[20] To maintain its viability and flexibility, it is essential to periodically review and update the language, criteria, and impact of the system. In line with this, the system is currently under review for the launch of a second edition of TIS.

The two already well-established WHO Reporting Systems for Lung and Pancreaticobiliary Cytopathology are also reviewed.[2–5] The concept and development of these WHO reporting systems have been almost universally positively received and supported by the cytopathology community, and they are generating a lot of research in an attempt to establish more refined ROM rates and their implications for patient management.

The recently launched WHO Reporting System for Lymph Node, Spleen, and Thymus Cytopathology marks a crucial advancement in the classification and risk stratification of lymphoid and hematopoietic disorders.[6] Fine-needle aspiration biopsy has proven to be a highly effective diagnostic tool for lymph node disorders, offering minimal invasiveness, rapid turnaround time, and cost-effectiveness, while providing ample cellular material for diagnostic and therapeutic studies. The implementation of this WHO system promotes uniformity and reproducibility in cytological diagnoses and enhances risk stratification based on cytopathologic findings. A critical aspect of its success is recognizing the potential pitfalls of fine-needle aspiration biopsy interpretation, including sampling errors and diagnostic challenges, particularly in lymphoma cases. The active participation of hematopathologists, hematologists, and oncologists will be essential for refining and widely adopting this system. Further multicentric studies with diverse epidemiological cohorts and larger sample sizes will be instrumental in validating its clinical utility and ensuring its integration into routine practice.

The recently introduced WHO Reporting System for Soft Tissue Cytopathology, reviewed by Bui, represents a significant advancement in the classification of soft tissue neoplasms.[7] This system categorizes soft tissue lesions into six diagnostic groups: Non-Diagnostic, Benign, Atypical, Soft Tissue Neoplasms of Uncertain Malignant Potential, Suspicious for Malignancy, and Malignant. The structured classification enhances risk assessment, improves communication among pathologists and clinicians, and facilitates more consistent diagnosis and treatment strategies. The integration of molecular diagnostics and immunocytochemistry in soft tissue cytopathology aligns with the broader trend of incorporating ancillary testing into modern reporting systems, ultimately refining diagnostic accuracy and patient management.

As new WHO-IAC systems for liver, breast, kidney and adrenal, and head and neck cytopathology emerge, they will further contribute to a harmonized, globally applicable framework for cytopathologic diagnoses. The ongoing expansion of these systems reflects the need for a comprehensive, evidence-based approach to cytopathology reporting, ensuring that pathologists worldwide have access to standardized tools that enhance diagnostic precision and improve patient outcomes.

Collectively, the articles included in this editorial highlight the transformative role of structured reporting in cytopathology. While each system addresses a specific anatomical site, they share common goals: improving diagnostic precision, minimizing interobserver variability, and optimizing patient management. The integration of molecular testing into these systems represents the next frontier, offering enhanced risk assessment and personalized treatment options.[21] As cytopathology continues to evolve, future efforts should focus on refining reporting criteria, integrating artificial intelligence and digital pathology, and expanding the use of ancillary molecular tests. The ongoing development and adoption of these structured reporting systems will undoubtedly contribute to improved diagnostic accuracy and better patient outcomes worldwide. While these reporting systems have transformed practice, their implementation faces challenges, including variable adoption in resource-limited settings and the need for continuous updates to incorporate molecular diagnostics, highlighting the importance of international collaboration and training initiatives.

We hope that the reporting systems discussed in this editorial serve as valuable resources for cytopathologists, clinicians, and researchers, fostering further advancements in the field and reinforcing the essential role of standardized reporting in modern pathology.

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Dr. Schmitt has been an editorial board member of the *Journal of Clinical and Translational Pathology* since May 2023.

Author contributions

FS is the sole author of this editorial.

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