

Advances in cytology analysis of canine mast cell tumors with the IDEXX inVue Dx Cellular Analyzer

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Background

Mast cell tumors (MCT) are among the most common cutaneous neoplasms in dogs. Although MCTs may show classic features, they often mimic benign lesions and should always be considered a differential when assessing cutaneous and subcutaneous masses. MCTs account for approximately 7%–10% of all masses (14%–21% of skin tumors) and are clinically important due to variable behavior and metastatic risk, particularly in high-grade tumors and certain locations. Accurate diagnosis prior to surgery is critical for planning and prognosis.^{1–4} Fine needle aspirate (FNA) cytology is a minimally invasive method to assess cutaneous and subcutaneous lesions, typically allowing veterinarians to plan effective treatment for MCT. Submission of cytology samples for clinical pathology review provides expert assessment and is highly predictive of histopathology.^{5,6} However, clinical pathology reports commonly contain probability-modifying terms that may lead to clinician confusion, identifying a need to better describe subjective confidence in cytology.^{7,8}

The IDEXX inVue Dx™ Cellular Analyzer represents a revolutionary advance in veterinary diagnostics: an automated cytology analyzer that aims to overcome the limitations of traditional glass-slide cytology interpretation, expanding access to automated and objective MCT results at the point-of-care in real time. The artificial-intelligence-powered analyzer visualizes FNA samples in a three-dimensional fluid state within a cartridge, utilizing multi-color brightfield and fluorescent imaging to identify and differentiate elements of the sample. The analyzer assesses cell morphology, optical properties, and spatial distribution, leveraging data (e.g., cell classifications and relative proportions) to provide an evaluation of FNA samples that include MCT on its automated reports. Captured images and data can subsequently be sent to a pathologist for confirmatory review, combining rapid in-clinic evaluation with expert review.

IDEXX inVue Dx analyzer provides objective reporting standards

The analyzer automatically produces discrete result categories that reflect increasing certainty of MCT. Automated IDEXX inVue Dx analyzer results range from no mention of mast cells or MCT, “low proportion of mast cells,” “MCT suspected,” to “MCT detected,” which correspond to increasing diagnostic gradations of confidence as defined by an interval likelihood ratio (iLR) for each category. The iLR represents the scalar change in odds of disease following a diagnostic result. Therefore, an iLR < 1 indicates a decrease in odds of MCT while an iLR > 1 indicates an increase in odds of MCT (e.g., iLR = 10 would indicate a 10-fold increase in odds of MCT post-test).⁹

The iLR framework is well suited to cytology, where findings often support probabilistic rather than definitive diagnoses. The IDEXX inVue Dx analyzer is particularly well suited to this approach because interval assignment and likelihood ratio calculation are performed programmatically and consistently across all cases, enabling standardized, objective, and clinically relevant reporting.

Evaluation methods for IDEXX inVue Dx analyzer MCT results

Paired FNA samples from 656 held-out lesions were consecutively collected as part of the diagnostic workup of dogs presenting for cutaneous or subcutaneous masses to their primary veterinarians. Each sample was prepared for evaluation with the IDEXX inVue Dx analyzer, and a separate aspirate from the same lesion was prepared as traditional glass slides. To account for expected variation in diagnostic sample material between the two aspirates, expert clinical pathologist review established the reference truth by reviewing all available pathology data, including manual evaluation of IDEXX inVue Dx analyzer images and data and digitized glass slides for all 656 cases. For each result category, continuity-corrected interval-specific likelihood ratios were calculated, as defined by this equation:

$$\text{iLR} = P(i | \text{MCT}) / P(i | \text{not MCT}).$$

Performance of IDEXX inVue Dx analyzer

MCT results

Different analyzer confidence categories showed strong discriminatory performance. “MCT detected” and “MCT suspected” both had very high likelihood ratios, estimated at iLR 189.2, 90% CI: 84.6–660.7, and iLR 73.5, 90% CI: 32.3–394.3, respectively. Therefore, a “MCT detected” result was 189 times more likely to occur in true MCT cases than in non-MCT cases, and an “MCT suspected” result was nearly 74 times more likely. “Low numbers of mast cells” indicated limited likelihood of MCT (iLR 3.7, 90% CI: 0.9–13.2), while no mention of mast cells or MCT had a decreased likelihood of MCT (iLR 0.2, 90% CI: 0.1–0.3), meaning mast cell proliferation (mast cell tumor or mastocytic inflammation) was possible when the analyzer returned a result of low proportion of mast cells, but when the analyzer report made no mention of mast cells or MCT, an MCT was unlikely. A nondiagnostic sample would also not return any mention of mast cells or MCT, rather a message stating the reason that the sample was of insufficient diagnostic quality, e.g., poorly cellular. The results for all 656 cases are presented in table 1.

Conclusion

These findings demonstrate that the analyzer can stratify lesions by confidence in the diagnosis of an MCT, providing clinicians with objective guidance for further confirmatory testing or surgical planning. Probabilistic reporting from the IDEXX inVue Dx™ Cellular Analyzer allows both a rapid in-clinic assessment and an objective, standardized evaluation of samples, addressing a key challenge faced by general practitioners in real-world settings.

Using iLRs to describe performance of an automated cytology result with varying levels of confidence enables first-of-its-kind, standardized clinical pathology reporting of objective confidence, delivering a standard that has never before been available to clinicians to understand cytology results more clearly.

Table 1. Interval likelihood ratios of mast cell tumor based on IDEXX inVue Dx Cellular Analyzer output, n = 656 masses.

Result	MCT negative	MCT positive	LR	90% CI	
Nondiagnostic	83	2			
No mention of mast cells or MCT	514	8	0.2	0.1	0.3
Low proportion of mast cells (mast cell proliferation possible)	4	1	3.7	0.9	13.2
MCT suspected	2	16	73.5	32.3	394.3
MCT detected	1	25	189.2	84.6	660.7

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