Performance of Digital Image Analysis of Urinary Cytology Specimens Using Gynecologic Cytology Analysis Algorithms

Elise Gelwan MD[1], Brad Knesel MS, CT(ASCP), MB[2], Christopher J. VandenBussche MD, PhD[1]
[1]The Johns Hopkins Medical Institutions, Baltimore MD
[2]CellSolutions, LLC

Abstract

Introduction: The BestCyte® Cell Sorter, developed by CellSolutions (Greensboro, N.C.), is a digital slide imaging system that is designed to screen liquid-based Papanicolaou smears. The imaging analysis software identifies atypical cells based on various cytomorphologic criteria for subsequent review. We investigated whether this same technology could be successfully applied to urine cytology specimens.

Methods: Fifty three de-identified urine cytology specimens were digitally scanned and analyzed by Cell Sorter. Cells deemed "atypical" by the software were reviewed by a board-certified cytopathologist who was blinded to the original diagnosis previously made on the glass slide specimen. Algorithms used for digital screening included "atypical cells" (Figure 1), "clusters" (Figure 2), and "N/C ratio" (Figure 3). A "digital diagnosis" was made and compared to glass slide diagnosis. Follow-up biopsy results were also recorded.

Results: The glass slide diagnoses were: negative for urothelial atypia or malignancy (NUAM), 21 cases; atypical urothelial cell of undetermined significance (AUCUS), 22 cases; atypical urothelial cells cannot exclude high-grade (AUC-H), 4 cases; and high-grade urothelial carcinoma (HGUC), 6 cases. There was exact agreement between the glass slide and digital diagnoses in 33 of 53 cases (62.3%), and the remaining 20 cases were only off by one diagnostic category (37.7%). Discrepancies are presented in Table 1.

Conclusions: There was good agreement between the digital and glass slide diagnoses. The greatest number of discrepancies occurred in the AUCUS category. Additional "fine tuning" of the digital analysis system using urinary cytology rather than gynecologic cytology algorithms is likely to improve diagnostic accuracy.

Methods

- 53 de-identified urine cytology specimens were digitally scanned and analyzed by BestCyte® Cell Sorter
- Cells flagged as atypical by Cell Sorter were reviewed by a cytopathologist blinded to the original glass slide diagnosis
- A "digital diagnosis" was made and compared to the glass slide diagnosis

Results

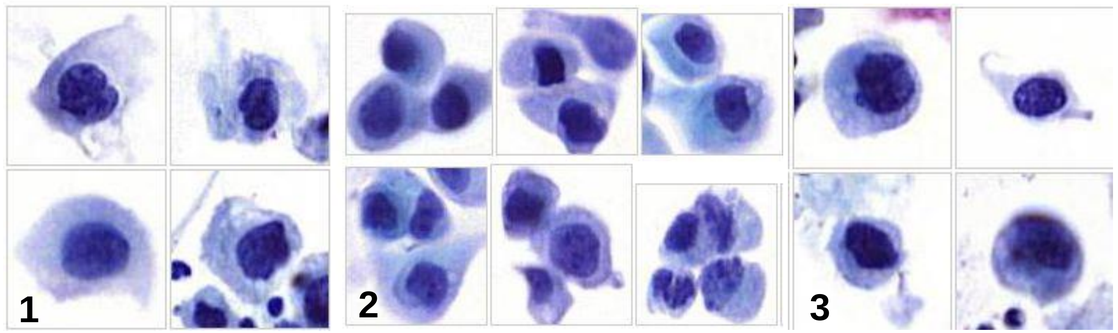

Figure 1. Examples of cells identified as "atypical" by the digital image analysis algorithm.
Figure 2. Examples of cells in clusters as identified by the digital image analysis algorithm.
Figure 3. Examples of cells with high N/C ratios as identified by the digital image analysis algorithm.

	Digital Slide			
Glass Slide	NUAM	AUCUS	AUC-H	HGUC
NUAM	19	2	0	0
AUCUS	14	7	1	0
AUC-H	0	0	3	1
HGUC	0	0	2	4

Table 1. Concordance between digital and glass slide diagnoses (NUAM = negative for urothelial atypia or malignancy; AUCUS = atypical urothelial cells of uncertain significance; AUC-H = atypical urothelial cells, cannot exclude HGUC; HGUC = high-grade urothelial carcinoma).

Figure 4. A, CellSolutions F50 is a liquid based cytology slide preparation system utilizing dual filter technology. **B,** CellSolutions BestCyte™ utilizes a high throughput scanning system (48 slides/hr) that fully digitalizes and saves each slide. The imaging software sorts and displays the digital images of individual cells and cell clusters on a high resolution monitor (2560x1440 pixels) to preserve image quality.

Results

Glass Slide Diagnosis	Digital Diagnosis	Biopsy Result
NUAM	NUAM	BENIGN
NUAM	NUAM	BENIGN
AUCUS	AUCUS	BENIGN
AUCUS	AUCUS	LGUC
AUCUS	AUCUS	LGUC
AUCUS	AUCUS	LGUC
AUCUS	AUC-H	BENIGN
AUCUS	NUAM	HGUC
HGUC	HGUC	HGUC
HGUC	HGUC	HGUC
HGUC	HGUC	BENIGN
HGUC	AUC-H	HGUC

Table 2. Digital and glass slide diagnoses for the 12 cases with follow-up bladder biopsies (LGUC = low-grade urothelial carcinoma; HGUC = high-grade urothelial carcinoma).

- There was exact agreement between the glass slide and digital diagnoses in 33 of 53 cases (62.3%); the remaining 20 cases were only off by one diagnostic category (37.7%) (Table 1).
- The greatest number of discrepancies occurred in the AUCUS category; of the 22 cases called AUCUS on original glass slide diagnosis, 15 had a discrepant digital diagnosis (14 NUAM, 1 AUC-H) (Table 1).
  - The case called AUC-H on digital diagnosis had a benign follow-up biopsy (Table 2).
  - One of the cases called NUAM on digital diagnosis had a follow-up biopsy showing HGUC (Table 2).

Conclusions

- There was good agreement between the digital and glass slide diagnoses
- The greatest number of discrepancies occurred in the AUCUS category
- Fine tuning of the digital analysis system using urinary cytology algorithms will likely improve diagnostic accuracy

Disclosures: This study did not require a funding source. CellSolutions provided specimen preparation, technical support, and slide scanning only. Dr. VandenBussche has received research support from Sienna Cancer Diagnostics.