Evaluation of the APAS Independence as an Artificial Intelligence Tool for Urine Culture Reporting in a Clinical Hospital Setting

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Abstract

Background: Urine cultures can constitute up to 30-40% of the workflow in clinical microbiology laboratory and many cases submitted for culture are often reported as negative or of limited clinical significance. Staffing considerations represent contemporary challenges for microbiology labs and new tools are needed to address increasing demands and evolving diversification of microbiology workflow. The APAS Independence is a diagnostic test system for the automated assessment and enumeration of bacterial colonies on urine cultures from suspected cases of urinary tract infections. The present study aims to assess the accuracy of the APAS Independence for urine culture reporting in a routine clinical setting. **Methods:** A total of 6200 urine cultures, representing 50 unique bacterial organisms in varying amounts of quantitation, were tested with the APAS independence. Reporting rules/criteria incorporated in the APAS are shown in Figure 1. Application of the reporting rules allows an automated reporting structure into four categories associated with urine culture reporting which include: i) negative ii) denotation of high clinical significance involving >10^4 CFU/ml, iii) doubtful reporting/low clinical significance and iv) requires review. Separation into each category was assessed as percent agreement with manual clinical technologist review. **Results:** APAS Independence has 100% agreement in reviewing, interpreting, and removing "no growth" urine cultures from clinical practice. The ability of APAS Independence to correctly enumerate >10^4 CFU/ml among clinical urine cultures is 94%. Removing defects in media as a variable of reporting increased this percent agreement to 98%. Based on reporting rules 35.9% of urine cultures were correctly reported, auto verified and removed from the clinical workflow without the need for technologist review. **Conclusions:** Contemporary instrumentation incorporating active decision-making tools into clinical microbiology workflow is needed. Automation within clinical microbiology can help define workflow and optimize needed technology resources. The APAS Independence can help stratify urine culture work auto-verifying and clearing 35.9% of the urine cultures from clinical workflow. Automation provides the provision of highly accurate and quicker reporting. Ongoing work to evaluate the impact on workflow and relative value unit savings of this lab automation is occurring.

Materials & Methods

The APAS Independence is a modular automated culture plate reading instrument that screens plates and sorts them into significant and non-significant growth using digital image capture and computer algorithms.

A total of 6200 clinical urine cultures, representing 50 unique bacterial organisms in varying amounts of quantitation, were tested with the APAS independence under routine clinical conditions. Reporting rules/criteria incorporated in the APAS are shown in figure 1. Application of the reporting rules allows an automated reporting structure into four categories associated with urine culture reporting which include: i) negative ii) denotation of high clinical significance involving >10^4 CFU/ml, iii) doubtful reporting/low clinical significance and iv) requires review. Separation into each category was assessed as percent agreement with manual clinical technologist review

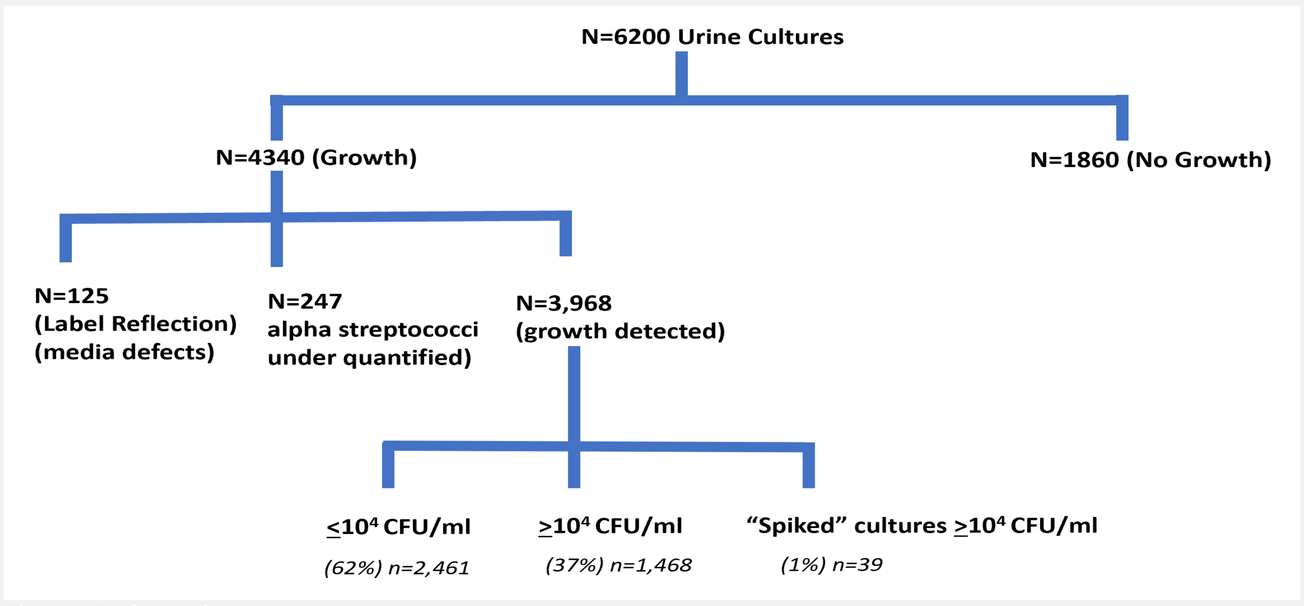

Figure 1. Study overview

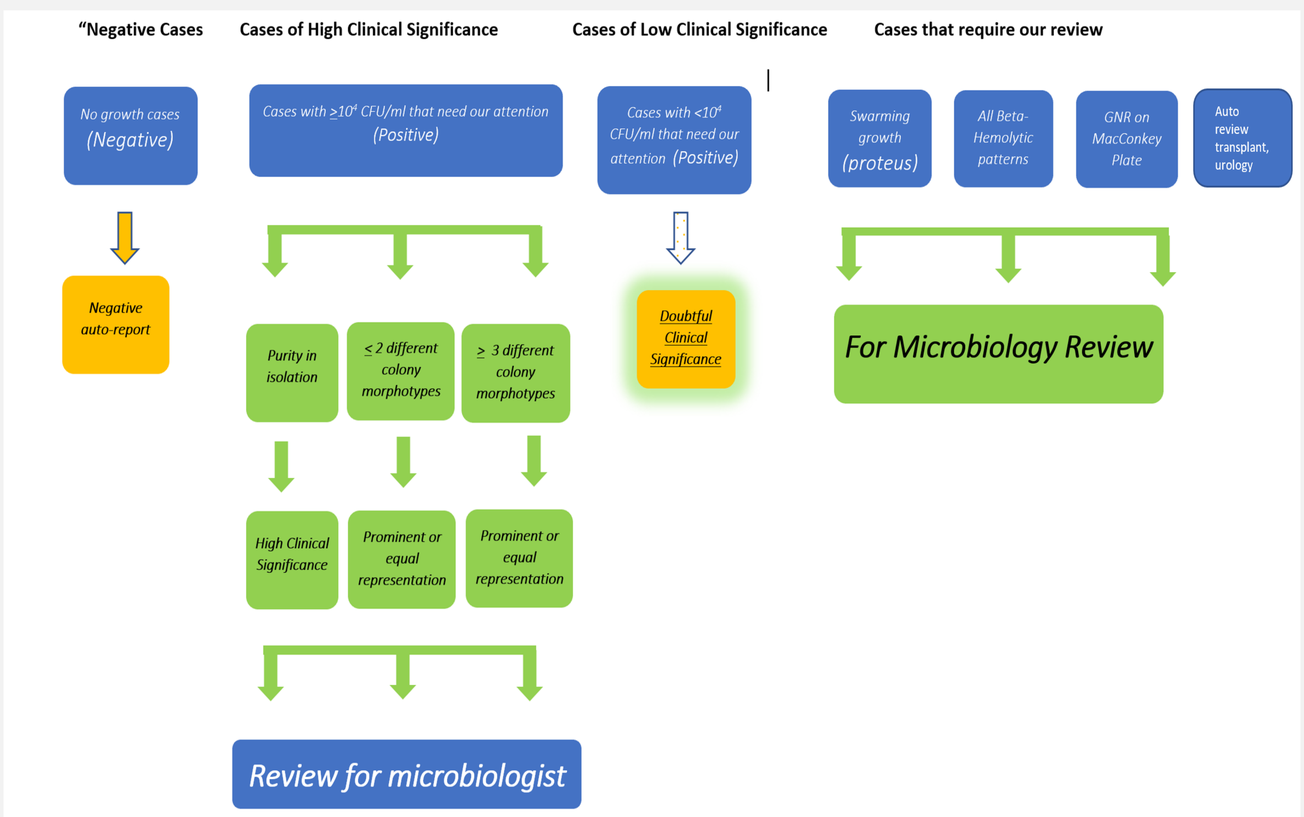

Figure 2. Reporting Structure Using the APAS Independence for UTI culture Assessment

Objectives

To evaluate the clinical performance of the APAS independence in its abilities to:

1) correctly enumerate bacteria present on UTI cultures
2) identify the Impact of the APAS independence on removing cultures from the clinical workflow

Results

Table 1. Clinical Evaluation of the APAS Independence for Urine Culture Assessment in Routine Clinical Practice

Study Metric	Technologist review	APAS review	% agreement with technologist review	Accuracy of initial Technologist Review	Accuracy of the APAS	Clinical Agreement of APAS decision with initial clinical reporting
No growth	1858/1860	1860/18060	100%	100%	100%	100%
Swarming growth (proteus spp.) detected*	70/70	70/70	100%	100%	100%	100%
Beta-hemolytic growth	200/200	197/200	98.5%!	100%	98.5%!	98.5%!
GNR growth detected on MacConkey media	1626/1626	1626/1626	100%	100%	100%	100%
≤10^4 CFU/mL growth	1468/1468	1221/1468	83%	100%	83% (adjusted accuracy 94%)	83% (adjusted accuracy 97%)
≥10^4 CFU/mL growth	2462/2464	2464/2464	99.9%	99%	100	99%

- ! 3 cases involved non-hemolytic Streptococci agalactiae (>10^4 CFU/mL) which where not detected by the APAS
- *125 cases were unable to photo captured by the APAS because of defects in the media (e.g. scrapes, gouges). Analysis of those cases which were captured by the APAS resulted in adjusted accuracy of 94%
- *247 cases were incorrectly enumerated by the APAS as <104 CFU/mL which exclusively involved cases where small alpha streptococci spp which were not detected by the APAS but were also not reported in clincal reporting by the laboratory. Clinical accuracy was observed as 97%

Table 2. Hennepin County Medical Center APAS Urine Culture Reporting

	Reporting Criteria	Impact on Clinical Workflow	Percentage of Clinical Cases
Positive =	* >10(4) cfu/ml &/or and GNR growth on the MacConkey plate * Detection of Beta-hemolysis on Sheep Blood Agar Plate	High priority Cultures	27%
Negative =	no growth	Auto Cleared from the workflow	16.2%
To Technologist Review	= >10(4) cfu/ml and/or swarming on the plate	Review for technologist– low priority	4%
HCMC "doubtful" classification	= <10(3) cfu/ml, no beta-hemolysis, no GNR on the MAC	Review for technologist –low priority	19.7%

Up to 35.9% (16.2% + 19.7%) of cases are auto-cleared by the APAS from the clinical workflow

Conclusion

- ✓ The APAS Independence was highly accurate in enumerating colony counts in urine cultures grown in the lab.
- ✓ Adding a reporting structure for cases involving <10^4 CFU/mL would successfully remove 35.9% from the workflow resulting in efficiency gains and reduced laboratory resources