Data Analytic Platform Provides Insights for Reflexive Urine Culture Implementation at an Academic Medical Center

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ABSTRACT

Background: Pre-analytical diagnostic stewardship has focused on urinary samples given the high rates of contamination, low yield of true positives, and substantial burden on clinical microbiology workload. This study aimed to utilize CLARION™, a bioMérieux data analytic platform, to evaluate urinalysis (UA) and urine microscopy parameters to understand rates of urine culture contamination and create the framework for a standardized reflexive urine culture program.

Methods: A prospective analysis of urine microscopy, culture and sensitivity reports extracted from the laboratory information system at Tampa General Hospital (Tampa, FL) were evaluated from January 2021 to October 2022. Real-time data aggregation, modeling and visualization of the associations between urinalysis and urine microscopy parameters on urine culture were performed using CLARION. Positive UA was defined as nitrite positive and/or the presence of ≥ 5 white blood cells. Positive urine cultures were defined as ≥ 10,000 CFU/ml of no more than 2 pathogens. Multivariate logistic regression was performed to evaluate predictors of positive urine cultures.

Results: A total of 13,816 unique patient encounters occurred during the study period, with 78% in the outpatient/emergency setting and 22% in the inpatient setting. UA linked cultures with positive nitrates and WBCs ≥ 5 had a positive predictive value (PPV) of 96.8% for having a true pathogen in culture, with a marginal increase in the PPV to 97.6% when WBCs≥ 10. UA samples that had negative nitrites and ≥ 5 WBCs or ≥ 10 WBCs had PPVs of 73.1% and 83.2%, respectively (p<0.05). Using the reflexive criteria of WBCs ≥ 10 and/or positive nitrites, urine culture rates declined on average by 9% (p <0.05) (Figure 1).

Conclusion: The data analytic platform helped establish the UA reflexive criteria of WBCs ≥ 10 and positive nitrites as the parameters that yielded the highest positive predictive value of 98% and correlated significantly with positive urine cultures. The implementation of a reflexive urine culture protocol has the potential to improve the quality of urine cultures, reduce diagnostic workload and minimize antibiotic overutilization.

BACKGROUND

- Urinary tract infections (UTI) are one of the most common healthcare-associated infections, causing more than 8.1 million visits to health care providers each year.
- Urine cultures are frequently ordered as a part of a generalized workup for non-specific symptoms (for example, fevers without traditional UTI symptoms such as dysuria and frequency). This often results in false-positive urine culture results. Clinically, this is known as asymptomatic bacteriuria.
- False-positive urine cultures are associated with unnecessary antibiotic treatment and elevated catheter-associated UTI (CAUTI) rates.
- Reflex urine culturing, defined as only performing a urine culture if the preceding UA shows an elevated white blood cell count may improve the unnecessary use of antibiotics for false-positive urine cultures. (Lynch et al., 2020)

OBJECTIVE

- Our study aimed to utilize CLARION, a bioMérieux data analytic platform, to evaluate urinalysis (UA) and urine microscopy parameters to understand rates of urine culture contamination and create the framework for a standardized reflexive urine culture program.

METHODOLOGY

- A prospective analysis of urine microscopy, culture and sensitivity reports from the laboratory information system at Tampa General Hospital were evaluated from January 2021 to December 2022
- Real-time data aggregation, modeling and visualization of the associations between urinalysis and urine microscopy parameters on urine culture were performed using CLARION™
- CLARION is a secure, cloud-based clinical informatics software as a service that connects and integrates disparate data to provide advanced insights into lab workflow and diagnostic stewardship
- Positive Urinalysis categorizations were divided into two groups: ≥5 white blood cells (WBCs) and ≥ 10 WBCs, with or without the presence of nitrites
- Positive urine cultures were defined as ≥ 10,000 CFU/ml of no more than 2 uropathogens
- Urine contamination was defined as urine culture with ≥ 10,000 CFU/ml of skin flora, mixed/urogenital flora and/or > 2 uropathogens
- Multivariate logistic regression was performed to evaluate predictors of positive urine cultures

RESULTS

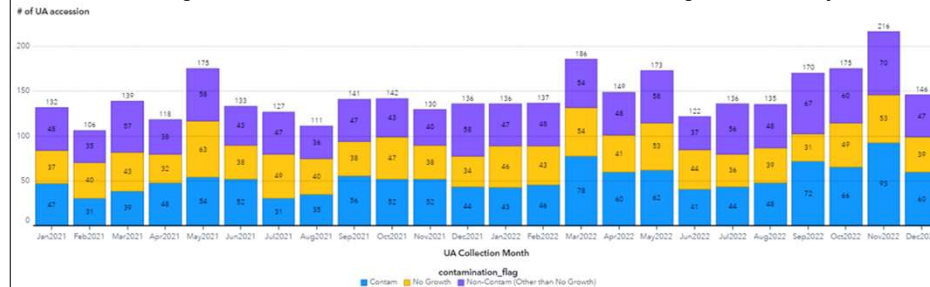**Figure 1: Distribution of Culture Results for Patients with a Negative Urine Analysis**

Figure 2: Distribution of Culture Results with Reflexive Criteria Simulation
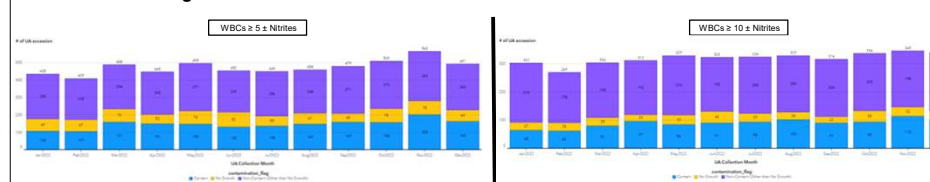

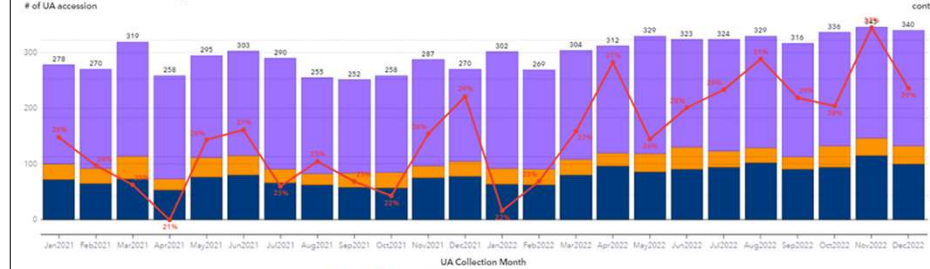**Figure 3: Urine Contamination Rates with Reflexive Criteria Simulation**

Table 1: Urine Contamination Rates with Reflexive Criteria Simulation

Nitrite	WBC		Urine Culture		Total
			Negative	True Positive	
Negative	< 5	Count, PPV %	1026	1189, 53.7	2215
	≥ 5	Count, PPV %	1488	4264, 74.1	5752
	≥ 10	Count, PPV %	649	3226, 83.3	3875
	≥ 20	Count, PPV %	649	3225, 83.3	3874
Positive	< 5	Count, PPV %	25	259, 91.2	284
	≥ 5	Count, PPV %	56	1576, 96.6	1632
	≥ 10	Count, PPV %	35	1332, 97.4	1367
	≥ 20	Count, PPV %	35	1332, 97.4	1367

DISCUSSION

- A total of 15,145 unique patient accessions occurred during the study period, with 78% in the outpatient/emergency setting and 22% in the inpatient setting.
- The distribution of cultures that are contaminated or have no growth amongst patients with a negative UA is 66% (Figure 1).
- UA linked cultures with positive nitrates and WBCs ≥ 5 had a positive predictive value (PPV) of 96.6% for having a true pathogen in culture, with a marginal increase in the PPV to 97.4% when WBCs ≥ 10 (Table 1).
- UA samples that had negative nitrites and ≥ 5 WBCs or ≥ 10 WBCs had PPVs of 74.1% and 83.3% respectively (Table 1).
- Using the reflexive criteria of WBCs ≥ 10 and/or positive nitrites, urine contamination rates declined on average by 3% (p <0.05) (Figure 3).
- This study did not include data related to symptomatology, therefore a true pathogen in culture may not be reflective of an urinary tract infection.
- The impact of a reflexive urine culture protocol on high risk populations including pregnant women, patients undergoing urological procedures or with underlying immunosuppressive conditions has not been evaluated.

CONCLUSIONS

- CLARION helped establish the UA reflexive criteria of WBCs 10 ≥ and + nitrites as the parameters that yielded the highest PPV of 97% and correlated significantly with positive urine cultures.
- To mitigate the loss of a substantial amount of true positives, a more conservative criteria WBCs ≥ 10 regardless of nitrites will be used for implementation.
- Implementation of a standard protocol has the potential to improve the quality of cultures, reduce diagnostic workload and potentially minimize antibiotic overutilization.

REFERENCES

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