



Full length article

The clinical utility of intrapartum screening urinalysis for the prevention of postpartum pyelonephritis

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ABSTRACT

Objectives: Urinary tract infection (UTI) is the most common bacterial infection to complicate pregnancy. Medical authorities recommend screening for asymptomatic bacteriuria (ASB) in pregnancy; albeit there is no consensus on ideal timing and frequency for testing. Due to the persistent physiologic changes of pregnancy postpartum, a recent trend to perform urinalysis upon presentation for delivery has been adopted at our institution and various satellite hospitals to putatively minimize cases of postpartum pyelonephritis. The aim of this study is to examine whether routine testing with urinalysis and screening for ASB following suspicious urinalysis with treatment can decrease the incidence of postpartum pyelonephritis, and to determine whether certain urinalysis parameters are more predictive of a positive urine culture.

Study design: A retrospective chart review study of all term deliveries was conducted over two years at the American University of Beirut Medical Center, a university teaching hospital. A total of 2359 deliveries of women with no increased susceptibility to UTIs were reviewed. None had urinary symptoms upon presentation. Urinary parameters including time of urinalysis and urine culture collection with respect to time of delivery, corresponding results and mode of urine collection were correlated to intrapartum course, incidence of ASB and of postpartum pyelonephritis.

Results: The incidence of ASB among women presenting for delivery was 4.83 %, with *Escherichia coli* as the most commonly detected pathogen. The presence of nitrite on urinalysis was significantly associated with a positive urine culture (p-value < 0.001). Women with history of antenatal ASB or UTI were more likely to have ASB intrapartum with an odds ratio of 3.14 (95 % CI 1.71–5.75, p-value < 0.001). Intrapartum urinalysis with subsequent diagnosis and treatment of ASB did not significantly affect the incidence of postpartum pyelonephritis (p-value 0.280). Similarly, intrapartum urinalysis in the setting of positive history of antenatal ASB or UTI did not increase the incidence of postpartum pyelonephritis compared to women with no such history (p-value 0.659).

Conclusions: Urinalysis screening intrapartum does not decrease the incidence of postpartum pyelonephritis. Universal urinalysis screening intrapartum is not warranted and should be reserved for women reporting urinary symptoms and/or women at high risk of UTI.

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Introduction

Urinary tract infection (UTI) is the most common bacterial infection to complicate pregnancy [1]. The incidence of

asymptomatic bacteriuria (ASB) in pregnancy, characterized by the presence of bacteria in urine in the absence of signs and symptoms, reaches 2–10 %. Of those, up to 40 % develop pyelonephritis [2]. Pyelonephritis in pregnancy is associated with perinatal complications including septicemia, respiratory distress, low birth weight, and preterm birth [3,4], making it one of the most common non-obstetrical reasons for antepartum hospitalization [5]. Thus, ASB in pregnancy warrants treatment to decrease the risk of these complications. The United States Preventive Services Task Force (USPSTF), American College of Obstetricians and Gynecologists (ACOG) and Infectious Diseases Society of America recommend screening for ASB at least once during pregnancy [4,6]. However, little evidence is available on the

Abbreviations: UTI, urinary tract infection; ASB, asymptomatic bacteriuria; USPSTF, United States Preventive Services Task Force; ACOG, American College of Obstetricians and Gynecologists; GBS, group B streptococcus; CFU, colony forming unit.

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optimal timing and frequency of screening. Many obstetricians screen for ASB during the first antenatal visit while others adopt an arbitrary screening pattern.

Over the past years, we noticed a trend at our institution and various satellite hospitals, towards screening for ASB upon presentation for delivery by implementing a process of initial assessment with urinalysis followed by urine culture only in women with positive urinalysis. The rationale of such practice might be to decrease the incidence of postpartum pyelonephritis given the persistence of physiologic changes predisposing to ASB during the puerperal period. To date, no study has analyzed routine urinalysis screening of pregnant women intrapartum to substantiate such practice. This is greatly needed in an era where physicians are urged to practice cost-effective medicine without compromising quality of patient care. The aim of this retrospective chart review study is to examine whether routine testing with urinalysis and screening for ASB in women with positive urinalysis presenting for delivery have any clinical use in decreasing the incidence of postpartum pyelonephritis, and to determine whether certain urinalysis parameters are more predictive of a positive urine culture.

Materials and methods

We identified all pregnant women over the span of two years delivering at the American University of Beirut Medical center (AUBMC), a large tertiary care academic hospital. We performed a retrospective chart review of antenatal, delivery and postpartum

records of these women. We limited our study to uncomplicated pregnancies with no symptoms suggestive of UTI upon intrapartum presentation and no increased susceptibility to UTIs. Therefore, we excluded women less than 18 or more than 45 years old at the time of delivery, with known history of genitourinary disease/malformations, sickle cell disease, or uncontrolled diabetes. We also excluded preterm deliveries including deliveries following preterm premature rupture of membrane and women with history of antibiotic use two weeks prior to presentation including women with history of antenatal pyelonephritis maintained on suppressive antibiotics.

We collected data of all women meeting the inclusion criteria including sociodemographic factors, medical history, surgical history, and antenatal complications.

The intrapartum course was reviewed for presenting complaint, group B streptococcus (GBS) screening status, gestational age at delivery, number of pelvic exams and urinary catheterization performed during labor, duration of various stages of labor, delivery mode, prophylactic antibiotic administration and delivery complications. Special attention was given to urinary parameters such as time of urinalysis and urine culture collection relative to delivery time and respective results, and mode of urine collection (free catch or bladder catheterization). Follow-up visits up to six weeks postpartum were reviewed for development of pyelonephritis. Hospital charges for urinary testing at our medical center were obtained from the hospital's billing department. As per CDC guidelines, a diagnosis of ASB was made if the quantitative count was greater or equal to 10⁵ colony forming unit (CFU)/mL of

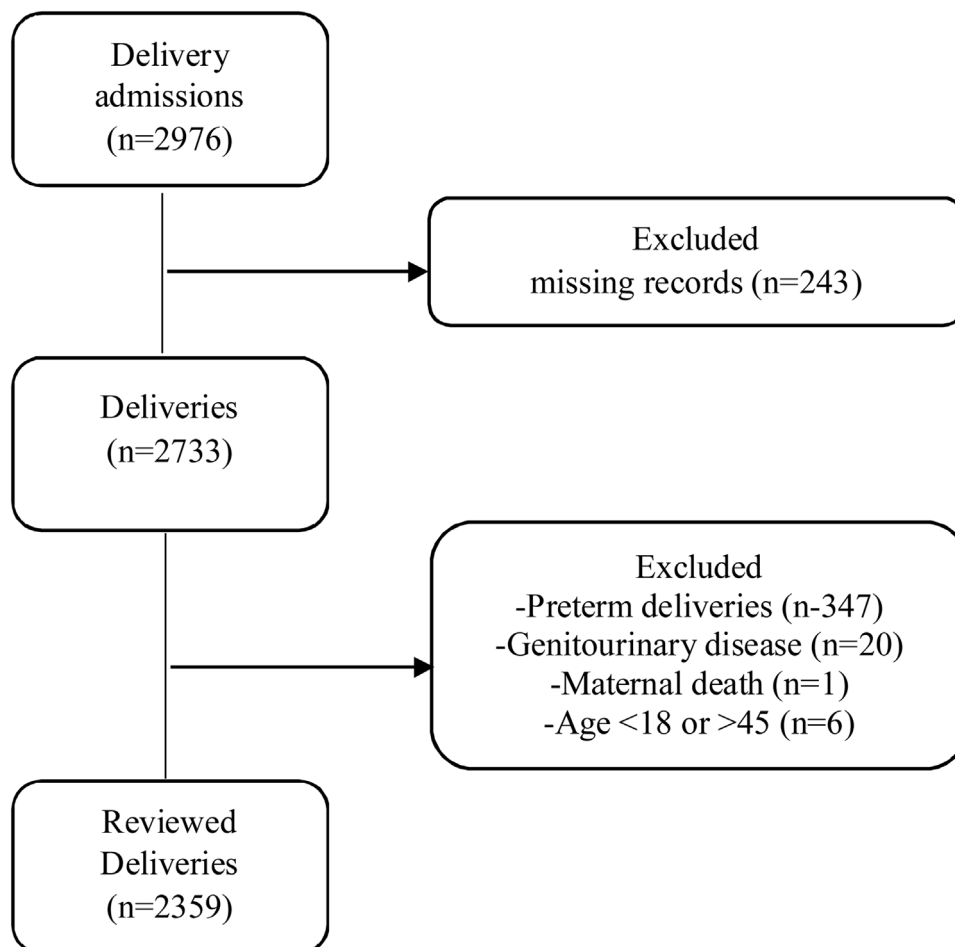


Fig. 1. Stratification of excluded deliveries within the 24-month study period.

one or more isolated bacterial species [7] or greater or equal to 10^4 CFU/mL of GBS [8].

Descriptive characteristics of our cohort were reported as mean and standard deviation for continuous variables and as frequency/proportion for categorical variables. Independent two sample *t*-test was used to compare numerical univariates between women diagnosed with ASB or not and women developing postpartum pyelonephritis or not. Pearson's Chi-square test and Fischer exact test were used to compare categorical variables and for identification of urinalysis markers predictive of ASB, presented as odds ratio (OR) and corresponding 95 % confidence interval. All factors found significant at bivariate analysis level (p-value <0.05) were entered in an unconditional multivariate logistic regression model to ascertain factors that were independently associated with ASB using a 0.1 cut-off for exclusion. Statistical analysis was performed using SPSS 25 statistical software package (IBM, Armonk, NY, USA). All statistical tests were two-sided with significance level set at p-value <0.05. Institutional review board (IRB) approval was secured before conducting this study.

Results

We identified 2976 deliveries at our medical center during the 24-months study period. 2359 women met the inclusion criteria (Fig. 1).

Most women presenting intrapartum (74.3 %) were screened for ASB following a suspicious urinalysis which included the presence of white blood cells (>10–25/HPF), leukocyte esterase (>10–25/ μ L), nitrite, or bacteria per our laboratory reference values. Urine testing was not performed in the remaining 25.7 % of patients due to the primary physician's preference. Table 1 summarizes demographic and delivery data of women for whom urine testing was performed intrapartum.

The incidence of ASB among women with a positive urinalysis was found to be 4.83 %. Urinalysis parameters noted to correlate with a positive microbial culture included turbidity of the urine sample (p-value 0.04), presence of nitrite (p-value <0.001), red blood cells (p-value 0.003), proteinuria (p-value 0.017), and glucosuria (p-value 0.041) (Table 2).

Escherichia coli was the most common pathogen detected (55 %), 18 % of which were multi-drug resistant, followed by

Klebsiella pneumonia (11 %), enterococci (6 %) and GBS (5 %). Remaining pathogens included *Proteus mirabilis*, *Pseudomonas aeruginosa*, *Citrobacter*, *lactobacilli* and *diphtheroid*.

Women with history of antenatal ASB or UTI were more likely to have ASB intrapartum with an OR of 3.14 (95 %CI 1.71–5.75, p-value <0.001). Conversely, women who received intrapartum antibiotics whether for a positive GBS culture, prophylactically before cesarean section or for chorioamnionitis, were less likely to have intrapartum ASB with an OR of 0.58 (95 %CI 0.39–0.87, p-value 0.008). This association was still significant when adjusting for the timing of urine collection with respect to antibiotic administration: women who received antibiotics before urine culture collection compared to women who did not receive antibiotics or received antibiotics after urine culture (OR 0.572, 95 %CI 0.38–0.86, p-value 0.007). Associations between the incidence of intrapartum ASB and age, BMI, parity, smoking status, alcohol status, gestational diabetes, hypertensive disorders of pregnancy, delivery mode and length of hospital stay were not significant (p-value >0.05) (Table 3).

When considering vaginal deliveries only, similar results were noted (Table 4): among 1408 vaginal deliveries, intrapartum urinalysis was performed in 912 (64.77 %), 388 of which had positive urinalysis necessitating subsequent urine culture. The incidence of ASB among women with a positive urinalysis was noted to be 4.69 %. ASB intrapartum was more likely among women with history of antenatal ASB or UTI with an OR of 2.38 (95 % CI 1.11–5.11, p-value <0.023) and among women with negative GBS rectovaginal screening (p-value 0.016). The results of urine culture obtained during delivery or immediately after were not significantly associated with length of labor stages, number of pelvic exams, performance of urinary catheterization, number of urinary catheterizations, or incidence of pelvic lacerations and episiotomies (Table 5). We could not analyze the effect of foley catheterization in women undergoing cesarean sections because we lacked data on the timing of urine sample collection with respect to the timing and duration of foley catheter insertion.

A review of postpartum visits and hospital admissions showed a 0.9 % incidence of postpartum pyelonephritis. Intrapartum urinary screening with subsequent diagnosis and treatment of ASB did not significantly affect the incidence of postpartum pyelonephritis (0.5 % vs 1 %, p-value 0.280). Similarly, intrapartum urinary screening in the setting of history of antenatal ASB or UTI did not influence the incidence of postpartum pyelonephritis compared to women without such history (0.9 % vs 1.2 %, p-value 0.659). Over the two-year study period, 20 women were found to have postpartum pyelonephritis, 17 of which had a screening urinalysis performed intrapartum with subsequent urine culture requested in 10 women for positive urinalysis. Only three of the 20 women who developed postpartum pyelonephritis had positive intrapartum urine culture, all of which grew *Escherichia coli* and were subsequently treated. Given the low incidence of postpartum pyelonephritis and our study design, correlations between postpartum pyelonephritis and number of intrapartum pelvic exams, catheterizations among other intrapartum considerations would not be adequately powered to have statistical or clinical value.

Discussion

Many studies demonstrate that treatment of ASB detected antenatally lowers the rate of pyelonephritis [9]. Randomized studies between 1960s–1980s, unanimously favor screening and antimicrobial treatment of ASB in pregnancy on account of decreased incidence of pyelonephritis from 20 to 35% to 1–4 % [7]. A recently published systematic review including 12 trials of pregnant women screened for ASB antenatally and randomized

Table 1
Demographic and delivery data: Categorical Variables.

Variable	Number of women (percentage)
BMI, Kg/m²	
Normal (18.5–24.9)	262 (14.9)
Overweight (25–29.9)	822 (46.9)
Obese (\geq 30)	668 (38.1)
Smoking Status	
Non-smoker	1562 (89.1)
Smoker	191 (10.9)
Parity	
Primiparous	752 (42.9)
Multiparous	1001 (57.1)
Antenatal ASB or UTI	
None	1637 (93.4)
At least one	117 (6.6)
Presentation to DS	
Labor	793 (45.2)
SROM	185 (10.5)
Induction of Labor	364 (20.8)
Schedule cesarean delivery	411 (23.4)
Mode of Delivery	
Normal vaginal delivery	768 (43.8)
Operative vaginal delivery	144 (8.2)
Scheduled cesarean delivery	575 (32.8)
Cesarean delivery after failed labor	157 (9)
Emergency cesarean	108 (6.2)

Table 2
Correlations between urinalysis parameters and urine culture results.

	Negative Urine Culture (N = 639)	Positive Urine Culture (N = 114)	OR	(95 %CI)	p-value
Turbid Color	348 (55.9)	73 (66.4)	1.559	(1.018,2.387)	0.040*
Nitrite	5 (0.8)	15 (13.6)	19.516	(6.933,54.934)	<0.001*
Protein	100 (16.1)	28 (25.5)	1.782	(1.104,2.897)	0.017*
ketones	101 (16.3)	16 (14.5)	0.875	(0.494,1.549)	0.646
Glucose	12 (1.9)	6 (5.5)	2.913	(1.070,7.934)	0.041*
Hg	291 (46.9)	57 (51.8)	1.216	(0.810,1.825)	0.345
Urobilinogen	11 (1.8)	3 (2.7)	1.560	(0.428,5.684)	0.453
WBC	115 (21.3)	21 (21.4)	1.008	(0.596,1.703)	0.977
RBC	331 (56.2)	76 (71.7)	1.975	(1.255,3.106)	0.003*
Bacteria	431 (70.1)	72 (67.3)	0.878	(0.566,1.363)	0.562
Leukocyte esterase	159 (25.5)	25 (22.7)	0.858	(0.531,1.388)	0.533

Data presented as n (%).

* Significant p-value<0.05.

Table 3
Correlations between demographic and intrapartum parameters and incidence of asymptomatic bacteriuria among all deliveries.

	Negative Urine Culture (N = 639)	Positive Urine Culture (N = 114)	OR	(95 %CI)	p-value
Age	30.53 ± 4.911	30.82 ± 5.048	–	(–1.266,0.702)	0.574
BMI	29.33 ± 4.651	29.77 ± 4.431	–	(–1.366,0.478)	0.345
Length of hospital stay	2.04 ± (0.834)	2.13 ± (1.01)	–	(–0.271,0.080)	0.286
Primi-parous	282 (44.1)	47 (41.2)	0.888	(0.593, 1.330)	0.565
Smoker	69 (10.8)	13 (11.4)	1.063	(0.567,1.995)	0.848
Alcohol status	16 (2.5)	3.5	1.414	(0.464,4.308)	0.527
Gestational diabetes mellitus	37 (5.8)	6 (5.3)	0.904	(0.372,2.194)	0.823
Hypertensive disorders of pregnancy, %	23 (3.6)	2 (1.8)	0.477	(0.111,2.054)	0.310
History of antenatal ASB or UTI	35 (5.5)	18 (15.8)	3.236	(1.762,5.943)	<0.001*
Vaginal deliveries	322 (50.5)	66 (57.9)	1.349	(0.902,2.020)	0.144
Cesarean delivery	316 (49.5)	48 (42.1)	0.741	(0.495,1.109)	0.144
Intrapartum antibiotics	369 (58.2)	51 (44.7)	0.581	(0.389,0.869)	0.008*

Data presented as n (%) or mean ± SD unless otherwise specified.

* Significant p-value<0.05.

Table 4
Correlations between intrapartum variables and incidence of asymptomatic bacteriuria among women undergoing vaginal deliveries.

	Negative Urine Culture (N = 322)	Positive Urine Culture (N = 66)	OR	(95 %CI)	p-value
Age	29.89 ± 4.886	30.92 ± 5.458	–	(–2.361,0.289)	0.125
BMI	28.45 ± 4.054	29.29 ± 4.167	–	(–1.928,0.236)	0.125
NVD	273 (84.8)	57 (86.4)	1.136	(0.529,2.445)	0.743
OVD	49 (15.2)	9 (13.6)	0.880	(0.409,1.892)	0.743
Primi-parous	150 (46.6)	27 (40.9)	0.794	(0.464,1.359)	0.399
History of antenatal ASB or UTI	25 (7.8)	11 (16.7)	2.376	(1.105,5.107)	0.023*
Positive GBS screening	63 (20.4)	5 (7.7)	0.325	(0.125,0.844)	0.016*

Data presented as n (%) or mean ± SD unless otherwise specified.

* Significant p-value<0.05.

Table 5
Correlations between intrapartum variables and incidence of asymptomatic bacteriuria among women undergoing vaginal deliveries (only for 332 patients where urine culture was collected during or immediately after delivery).

	Negative Urine Culture (N = 269)	N1	Positive Urine Culture (N = 63)	N2	OR	95 %CI	p-value
Stage 1 of labor (hours)	7.35 ± 5.090	251	7.78 ± 6.306	62	–	(–1.926,1.059)	0.568
Stage 2 of labor (minutes)	48.29 ± 45.152	252	50.07 ± 43.268	62	–	(14.497,10.943)	0.784
Stage 3 of labor (minutes)	5.19 ± 3.401	253	5.06 ± 2.079	62	–	(–0.767,1.010)	0.788
Number of pelvic exams	4.13 ± 1.721	105	4.06 ± 1.480	32	–	(–0.596,0.737)	0.834
Pelvic laceration	91.4 %	246	88.9 %	56	0.748	(0.306,1.829)	0.523
Urinary catheterization performed	41.3 %	59	50 %	19	1.424	(0.695,2.918)	0.333
Number of urinary catheterization(s)	1.41 ± 0.698	59	1.37 ± 0.761	19	–	(–0.336,0.413)	0.839

Data presented as % for categorical variables or mean ± SD for continuous variables unless otherwise specified. *Significant p-value<0.05.

either to treatment or control, similarly, demonstrates a 76 % reduction of pyelonephritis in the treatment group (pooled RR 0.24, 95 %CI 0.14–0.40, n = 2068) [10]. Yet, it is noteworthy that most available evidence is derived from studies published more than 4 decades ago with only two relatively recent studies in 1987

and 2015. A vast difference in incidence of pyelonephritis in untreated ASB is noted between earlier studies and the two more recent studies (7–36 % vs 2.2 % and 2.5 %, respectively) [10]. This substantially lower reported incidence of pyelonephritis in more recent studies underlines the benefit of screening and treating ASB.

Our incidence of intrapartum ASB based on positive urinalysis is similar to the 2–10 % reported incidence of antenatal ASB [2,6], even though all our patients were previously screened and treated for any antenatally detected ASB. Although such a finding could make one assume that screening and treatment of intrapartum ASB would have an analogous benefit of decreasing pyelonephritis rates postpartum, our results demonstrate otherwise.

Our review of postpartum clinic visits and hospital admissions demonstrated no significant difference in the incidence of postpartum pyelonephritis on account of urinalysis screening and treatment of ASB at the time of delivery versus no screening (0.5 % vs 1 %, p-value 0.280). One justification could be higher spontaneous clearance of intrapartum bacterial pathogens implicated in ASB regardless of whether treatment is provided or not. These findings were also demonstrated when comparing the incidence of postpartum pyelonephritis in pregnant women with a history of antenatal ASB or UTI if intrapartum urinalysis was performed compared to those with no intrapartum urinalysis screening (p-value 0.315) despite a significantly higher incidence of intrapartum ASB in the former group (OR 3.14, 95 % CI 1.71–5.75). As such, treatment of intrapartum ASB may be superfluous. In fact, this reinforces one of the main concerns of antimicrobial stewardship programs: obtaining urine cultures when not clinically required fosters inappropriate antimicrobial use and resistance [11–13].

When analyzing pathogens isolated intrapartum in ASB, detected microbes and frequency distribution closely mirrored findings reported during antenatal screening [14,15].

Most guidelines recommend screening for ASB using urine culture as gold standard for diagnosis. However, urine culture is expensive and needs at least 24-h for a preliminary result. Urinalysis is less expensive, and its results are readily available with a clinically acceptable predictability of UTIs [16]. Given our large data set, we looked at the association of various urinalysis parameters with a positive urine culture result. Although several parameters were found to be significantly associated with a positive urine culture at the bivariate level, only the presence of nitrite was found to be significantly associated with a positive urine culture when multivariate logistic regression was performed. However, since nitrite can only be produced by gram-negative organisms, relying only on the presence of nitrite will lead to underdiagnosing ASB due to gram-positive organisms. Since none of the other parameters are specific for UTI, it is not unreasonable to directly screen women with urine culture when indicated due to the presence of urinary symptoms or to perform urine culture in women with positive nitrite particularly given the predominance of gram-negative organisms' growth in positive cultures.

One of the major risk factors for UTIs is urinary catheterization. The Centers of Disease Control and Prevention (CDC) condemn urinary catheterization as a major contributor to all nosocomial UTIs [17]. While our data incidentally shows no difference in ASB detected via urine culture post positive urinalysis whether urinary catheterization is performed or not (p-value 0.333), this is limited by a small sample size not powered for detecting statistical significance for this outcome. Moreover, the average number of straight catheterizations performed in our population is low (1.46 ± 0.75) due to the policy instituted by our department to limit the number of catheterizations to a minimum in accordance with CDC recommendations. As such, it remains imperative to minimize catheter use in labor to minimize the risk of UTIs.

A major aspect worth considering when ordering laboratory tests is the economic burden on the healthcare system, particularly given the scarcity of resources to be allocated during the dire circumstances imposed by the COVID pandemic. At our hospital, the charge of urine culture and urinalysis is \$35.05 and \$16.6, respectively. Since screening for ASB intrapartum is of little value

when it comes to preventing postpartum pyelonephritis, substantial savings can be achieved if this practice is abandoned. With around 1200 deliveries annually at our institution, abandoning the practice of performing urinalysis with or without urine culture would save the health care system close to \$30,000 annually. This annual cost saving is only an estimate as charges vary between hospitals and various health insurance plans. The national cost saving is expected to be more substantial and in countries where the health care system is more costly, and/or where the annual number of deliveries is more elevated.

One of the major limitations of our study is its retrospective nature, with inherent potential errors in data collection and incomplete medical records documentation. This is especially important with regards to identification of patients with postpartum pyelonephritis as some could have been lost to follow-up post-delivery and others could have sought medical care elsewhere. Nevertheless, we believe these considerations while valid, are minimal given the hospital's setting as a tertiary care referral center. Most patients delivering at our institution, are compliant with postpartum follow up visits at our outpatient clinics. In the absence of adequately powered randomized trials, our findings pave the way to better quality of patient care. It would have been interesting to consider how the duration of cesarean deliveries and of foley catheter would affect incidence of ASB and recovered pathogens. However, such data could not be obtained given the collection of urine samples prior to cesarean deliveries precluding accuracy and analysis of such an association.

Conclusion

In an effort to implement cost-effective medicine without compromising quality of care, we evaluated the recently noted trend of intrapartum urinary screening and treatment of detected ASB based on positive urinalysis as to decrease risk and complications of postpartum pyelonephritis. Although such measures provide reassurance postpartum, our data demonstrates that such testing has no clinical use and does not alter the incidence of postpartum pyelonephritis. Therefore, universal urinalysis screening intrapartum is not warranted and should be reserved for women reporting urinary symptoms and/ or women at high risk of UTIs. Moreover, since most urinalysis parameters are not specific for detecting bacteriuria, it would be more cost effective to perform urine culture and only when deemed clinically necessary.

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None.

Declaration of Competing Interest

No potential conflict of interest was reported by the authors.

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