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UNRAVELLING THE ROLE OF TRACE ELEMENTS IN RENAL STONE DISEASE: INSIGHTS FROM SERUM, URINE, AND STONE ANALYSIS OF 350 INDIVIDUALS

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INTRODUCTION AND OBJECTIVES: Trace elements influence oxidative balance, crystal nucleation, and inhibition or promotion of nephrolithiasis, yet their association with stone formation remains underexplored.

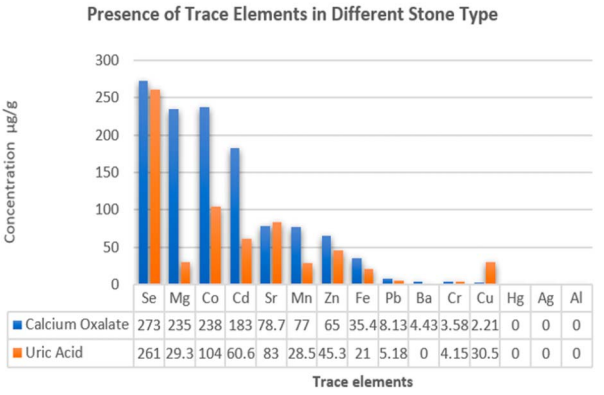
METHODS: This was a prospective observational study that enrolled patients undergoing Percutaneous Nephrolithotomy at our centre. Exclusion criteria included metabolic disorders, intestinal disease, skeletal fractures, recurrent urinary infections with calculi, gout, or renal insufficiency. Quantitative analysis of trace elements—Sr, Zn, Se, Co, Fe, Cr, Cu, Mn, Mg, Cd, Hg, Ba, Pb, Ag, and Al—was performed on serum, urine, and stone samples.

RESULTS: A total of 350 individuals were enrolled, including 200 patients with kidney stones and 150 healthy controls. Stone analysis revealed a predominance of calcium-containing stones (182/200), primarily calcium oxalate (88%), followed by brushite (2.5%) and hydroxyapatite (1%). Among non-calcium stones, uric acid comprised 8% and protein stones 0.5%. Serum aluminium, magnesium, chromium, and barium levels were significantly reduced in stone formers (Figure 1). Urinary levels for these metals did not differ significantly. Serum and urine manganese were markedly lower in patients than in controls. Other metals (Fe, Cu, Pb, Se, Sr, Zn) showed no significant differences, while Hg and Ag were undetectable. Subsequent regression analysis showed a negative association of serum Al, Cd, Cr, Co, Mn, Mg and Fe, and of urinary Mn, with the formation of kidney stones. Stone analysis revealed high concentrations (>100 µg/g) of Se, Co, Mg, and Cd. Moderate levels (50−100 µg/g) were noted for Sr, Mn and Zn, while Fe, Pb, Cr, Ba, and Cu were seen in much lower proportions. Cd and Ba were higher in calcium oxalate stones than in uric acid stones, while Cu levels were higher in uric acid stones (Figure 2). No significant differences were observed for other elements.

CONCLUSIONS: Stone formers exhibit distinct alterations in trace element profiles, with significant negative correlations between serum Al, Cd, Cr, Co, Mn, Mg, Fe and formation of kidney stones.

Trace elements (ppb)/ml	Blood			Urine		
	Cases (n=200)	Control (n=150)	*P-value*	Cases (n=200)	Control (n=150)	*P-value*
Sr	56.35 (33.15–98.73)	59.05 (34.58–107.17)	*0.40*	76.83 (30.04 - 145.06)	79.76 (35.78 - 139.00)	*0.57*
Zn	6632.85 (5571.72–7752.19)	6562.58 (5577.70–9512.56)	*0.10*	260.39 (73.24 -554.69)	232.75 (113.50- 505.60)	*0.91*
Se	144.85 (124.68–167.01)	145.20 (124.73 - 162.96)	*0.67*	10.68 (5.35 - 19.89)	9.20 (3.91 - 16.92)	*0.10*
Co	1.44 (0.32 –5.19)	4.45 (1.90– 7.12)	***<0.01***	0.1 (0.0 - 3.20)	1.15 (0.0 – 5.70)	***0.04***
Fe	427548.04 (344975.32 - 486458.72)	433564.82 (374646.75 - 498647.10)	*0.14*	422.42 (5.33 - 770.45)	263.57 (11.50-703.70)	*0.22*
Cr	64.73 (43.45 –79.95)	75.24 (53.00 –94.08)	***<0.01***	26 (0 - 63)	29 (18 – 65)	*0.09*
Hg	0(0-0)	0(0-0)	--	0(0-0)	0(0-0)	---
Cu	955.02 (843.61–1098.89)	939.84 (833.38–1110.96)	*0.61*	0.4 (0.0 - 38.93)	0.0 (0.0 – 47.67)	*0.92*
Mn	27.80 (16.87–38.61)	37.70 (21.50 - 49.45)	***<0.01***	2.1 (0.0 – 15.65)	9.37 (3.40 – 29.00)	***<0.01***
Mg	36269.77 (30430.93 – 43337.0)	42725.35 (32702.17 – 61235.56)	***<0.01***	12214.33 (3022.50 - 31252.18)	14070.80 (3456.90 - 28751.14)	***0.49***
Cd	1 (0-2)	1 (1-2)	***<0.01***	0 (0 – 1)	0 (0 – 1)	***0.05***
Ba	45 (26 – 113)	35 (11 –79)	***0.002***	0.0 (0.0 – 69.82)	0.0 (0.0 – 58.00)	*0.96*
Ag	0.00 (0.00 - 1.18)	0.00 (0.00 - 4.76)	*0.39*	0.0 (0.0 - 1.04)	0.0 (0.0 – 0.0)	---
Pb	4.22 (1.68 - 7.85)	3.72 (1.71 - 6.70)	*0.33*	0.0 (0.0 – 11.80)	0.0 (0.0 – 10.60)	*0.88*
Al	983.55 (329.32–2660.62)	2383.32 (981.34–5862.21)	***<0.01***	0.1 (0.02 – 250.06)	0.2 (0.03 – 1.02)	*0.78*

Figure 2: Stone-wise Analysis for Presence of Trace Elements in Kidney Stones



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RISK-STRATIFIED PRE-OPERATIVE URINE TESTING FOR URETEROSCOPY USING A MODIFIED DELPHI CONSENSUS APPROACH

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INTRODUCTION AND OBJECTIVES: The American Urological Association guidelines state that urinalysis must be performed prior to surgical intervention for nephrolithiasis. However, guidance on optimal urine testing timing and type is limited, particularly for patients with factors that may influence their risk profiles, such as stents, nephrostomy tubes (PCN), or bladder drainage, and current guidelines do not account for many real-world infection risk scenarios. We sought to develop a risk-stratified consensus roadmap for pre-operative urine testing in patients undergoing ureteroscopy (URS).

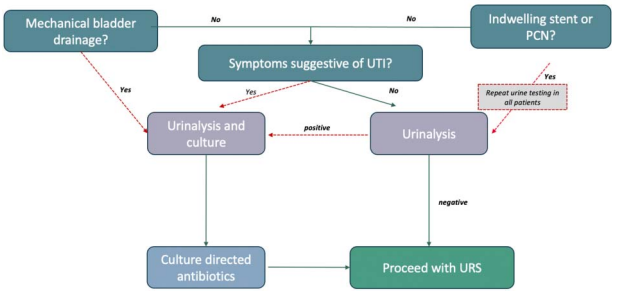
METHODS: A modified Delphi consensus panel was convened through the Michigan Urological Surgery Improvement Collaborative Reducing Operative Complications from Kidney Stones (MUSIC ROCKS). Panelists evaluated common clinical scenarios, including (1) asymptomatic nephrolithiasis, (2) indwelling ureteral stent or PCN, and (3) mechanical bladder drainage i. e., foley, suprapubic tube (SPT) or intermittent straight catheterization (ISC). Consensus was achieved over three survey rounds (July-September 2025) and defined by stable responses across two consecutive rounds and ≥80% agreement in rounds one and two or ≥70% in round three.

RESULTS: Twenty-six of 32 panelists (81%) completed all rounds, representing both academic and community urologists. The panel agreed that patients with symptoms of urinary tract infection (UTI) should undergo urinalysis and culture; if positive, culture directed pre-operative antibiotics are recommended. For asymptomatic patients, a negative urinalysis alone was considered sufficient to proceed with URS. In patients with a stent or PCN placed for sepsis, repeat urine testing was recommended prior to URS regardless of dwell time. If placed for colic with negative cultures at the time of placement, repeat testing was also advised. No consensus was reached regarding urine testing modality. Patients with mechanical bladder drainage should undergo pre-operative urine culture (Figure 1).

CONCLUSIONS: Using a modified Delphi approach, we developed consensus recommendations for pre-operative urine testing for URS. This work highlights clear areas of agreement and future study. Ongoing efforts aim to create a risk-stratified framework to

optimize testing type, timing, and antibiotic use, balancing infection prevention with antibiotic stewardship.

Figure 1: Stepwise approach to pre-operative urine testing in patients undergoing URS for nephrolithiasis



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