Electronic Supplementary Material (ESI) for Analyst.

Supporting Data Table S1: Tests (T), indicator (I) or observation (O) commonly used to assess kidney function and damage in CKD.

Order	Risk factor	Standard Value	Threshold	Dependence
T1	Glomerular filtration rate (GFR)	90 mL/min/1.73 m^2 in young adults	15 mL/min/1.73 m^2	Age, sex, and body size
T2	Serum creatinine (SC-1)	Males: 0.74-1.35 mg/dL Females: 0.59- 1.04 mg/dL	As kidney function declines, serum creatinine levels rise	Varies by age, sex, and muscle mass but for many adults,
T3	Albumin-to-creatinine ratio (ACR)	< 30 mg/g	30-299 mg/g	Not provided
T4	Blood urea nitrogen (BUN)	7-20 mg/dL	Not provided	BUN levels increase with decreasing kidney function
T5	Serum phosphorus (SP)	2.5-4.5 mg/dL	Not provided	High phosphorus levels might be seen as CKD progresses
T6	Serum calcium (SC-2)	8.5-10.2 mg/dL	Not provided	Calcium levels can be affected in CKD, often decreasing as the disease progresses
T7	Hemoglobin (HG)	Males: 13.8-17.2 g/dL Females: 12.1-15.1 g/dL	Anemia (low hemoglobin) is common in CKD and might necessitate treatment	Varies by age and sex but typically
T8	Parathyroid hormone (PTH)	10-65 pg/mL.	Not provided	PTH can increase in CKD due to disturbances in calcium and phosphorus metabolism
T9	Potassium (P)	3.5-5.0 mEq/L	Not provided	Hyperkalemia (high potassium levels) can occur in advanced stages of CKD
I1	Ultrasound (Ult)	Not provided	Not provided	kidney size, cysts, tumors, obstructions, and other structural abnormalities
O1	Symptoms (SYM)	Not provided	Not provided	fatigue, nausea, itching, muscle cramps, and swelling can become more prominent

Data from https://www.uptodate.com/contents/uremic-toxins?search=uremic%20toxins&source=search_result&selectedTitle=1~59&usage_type=default&display_rank=1

Supporting Data Table S2: Lower limit of qualitative and quantitative techniques and limitations (challenges) for uremic toxins analysis

Method	Lower Limit of Detection	Limitations (challenges)
Electrochemical/Colorimetric	Nanomolar to picomolar (nM to pM)	interference from complex matrices or non-specific binding; limited sensitivity and specificity compared to other techniques
Fluorescence/FTIR	Picomolar to femtomolar (pM to fM)	background fluorescence or quenching effects; interference by water vapor and other contaminants affecting sensitivity
ELISA/CMIA	Picogram to nanogram (pg to ng)	long incubation times and complex sample preparation; interference and limited dynamic range
GC/MS	Femtogram to picogram (fg to pg)	complex sample preparation. slower compared to other methods; may require derivatization for some analytes
Label-mediated SERS	Picomolar to femtomolar (pM to fM)	variability in signal intensity and specificity depending on the labeling strategy and surface properties
Labelled SERS	Picomolar to femtomolar (pM to fM)	additional steps for labeling; signal variability due to labeling efficiency and stability