CAIRIBU UROBIOME RESEARCH INTEREST GROUP (URIG)

KNOWLEDGE EXCHANGE

EXECUTIVE SUMMARY 10/16/2026



Goal: Facilitate knowledge exchange and spur collaborations in urobiome research and adjacent fields

Aaron Miller, PhD

Biofilm Formation, But Not Antibiotic Resistance, Defines Kidney Stone Associated Bacteria

Clinical Importance of Kidney Stones:

- Dr. Miller began his presentation by establishing the increased prevalence of kidney stones, stating that the burden has nearly doubled within the last 20 years. The most common types of kidney stones are calcium oxalate (CaOx).
    - Kidney stone recurrence is about 20% in 5 years and 31% in 10 years.

Infectious-Metabolic Stone Dichotomy:

- Dr. Miller stated that urease-producing (urea-splitting) bacteria alter urine chemistry, prompting infection-originating stones to form. This adds to prior knowledge and assumptions that CaOx stones are formed in a biochemically sterile environment where supersaturation, inhibitors, and crystal retention define the disease.
- He explained that these two stone dichotomies overlap when bacteria form biofilm and injure the epithelium, where CaOx crystals can aggregate and form stones. **Importantly, bacterial signatures are observed in CaOx stones both with and without symptoms of infection.**
- Dr. Millller also noted that CaOx kidney stones have evidence of dissolution and recalcification, which is a relatively new observation, which may be related to bacterial production of quorum sensing molecules. **These phenomena, Dr. Miller said, demonstrate evidence of a living, dynamic environment in the kidneys.**

Antibiotics and Kidney Stones:

- Dr. Miller provided evidence that antibiotic exposure increases odds of future kidney stone formation due to altered urobiome characterized by fewer uro-protective bacteria and more uropathogenic bacteria.
    - Whether antibiotic resistance contributes to stone formation remains unclear and will be further studied.

Quantifying Biofilm Attachment and Antibiotic Resistance in Bacteria:

- Dr. Miller isolated CaOx stones and urine from a cohort of patients, identified the bacteria, and tested it for antibiotic resistance using antibiotics commonly used in urology.
- **The taxonomic profile he discovered was unique in each sample** (kidney stone, kidney stone urine, healthy urine, and recurrent UTI urine). In the samples he assessed, Dr. Miller said that kidney stones appeared to be primarily driven by the bacteria *Kocuria*.
- In conclusion, Dr. Miller stated that his lab has found that bacterial biofilm is driven by the environment from which the bacteria were derived, not by the type of bacteria, whereas, contrastingly, antibiotic resistance is antibiotic- and bacteria-specific.
    - Treatment wise – Dr. Miller suggested that future biomarkers should be developed to target biofilms and metabolites, not specific bacterial taxa and not via experimental approaches that utilize specific antibiotics.

Aaron W. Miller, PhD, is a Principal Investigator in the Departments of Urology and Microbial Sciences in Health at Cleveland Clinic, with research focused on understanding how the human microbiome contributes to urologic disease. His laboratory integrates microbial culture, multi-omic profiling, functional genomics, metabolomics, and translational models to define mechanisms linking microbial communities with kidney stone disease, urinary tract disorders, biofilm formation, and host metabolism. A major focus of his work is microbial oxalate metabolism and the development of microbiome-based diagnostics and therapeutics for hyperoxaluria and kidney stone prevention.

Aayushi Uberoi, PhD

Host Microbiome Interactions at the Skin Surface

Skin as a Barrier:

- Dr. Uberoi began her presentation by stating that skin is the first barrier all mammals have to the environment, if this barrier becomes compromised, pathogenic bacterial exposure occurs.
- Different biogeographies of the skin dictate what bacteria can live there. Thus, Dr. Uberoi said, **skin microbiomes are topographically diverse and temporally complex**.
- Dr. Uberoi explained that the commensal skin microbiome regulates the epithelial barrier permeability and resides in the stratum corneum. They are further controlled, she noted, from junctions within deeper skin layers.

Identifying Microbially Regulated Pathways in Murine Skin:

- Using transcriptomics, her team found that epithelial microbiota regulated immune function whereas the commensal microbiota regulated epithelial differentiation.
- Using specific pathogen free mice and germ-free mice, Dr. Uberoi's lab has identified different stratum corneum layers and that specific pathogen free mice have more skin layers.
- Acknowledging that healthy, intact barriers should have less water loss at the skin's surface, Dr. Uberoi stated that **trans-epidermal water loss recovery shows wild-type mice recover its skin epithelium much quicker than germ free mice.**
- She further explained that skin microbiotas regulate expression of aryl hydrocarbon receptor (AHR), which regulates epithelial differentiation and inflammation. Loss of AHR in epidermis impairs barrier repair.

AHR in Humans:

- **AHR is one of many xenobiotic sensors on which Dr. Uberoi's lab is focused.** Dr. Uberoi said she is specifically interested in the different signals and outcomes of these xenobiotic sensors and the metabolites that originate from sweat and sebum.
- Dr. Uberoi explained that tryptophan metabolites are regulators of AHR and that AHR inhibition in gnotobiotic mice appear to affect barrier resistance.
- Future aims include studying the interactions between the microbiome, host, and exposome for clinical treatments such as wound healing, cancer, and atopic dermatitis.

Aayushi Uberoi, PhD, is a Principal Investigator and Assistant Professor in the Departments of Pathology and Immunology at Washington University in St. Louis. Her labs research seeks to understand how resident microbial communities at the skin surface interact with epithelial cells to shape barrier function and tissue homeostasis. They investigate how these interactions change during perturbations, and how microbial signals influence the host response.