Urine Microscopy for Internal Medicine Residents: A Needs Assessment & Implementation of Virtual Teaching Sessions

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Abstract

**Background:** Though urine microscopy is an important step in the initial evaluation of a patient with kidney disease, internal medicine residents have minimal exposure to this technique during their training. The goal of this study was to understand knowledge of and attitudes towards urine microscopy among internal medicine residents, and to implement virtual urine microscopy teaching sessions.

**Methods:** A voluntary, anonymous, online survey was sent to all the categorical internal medicine residents training (n = 131) at the Icahn School of Medicine at Mount Sinai (ISMMS). The survey included thirteen questions to assess attitudes towards, experience with, and clinical interpretation of urine microscopy specimens. In response to the survey results, we implemented virtual urine microscopy teaching sessions using video conferencing software which incorporated real-time urine sediment analysis with nephrology fellows and attending nephrologists.

**Results:** The survey response rate was 45% (59/131). Forty-seven percent (28/59) of respondents reported performing urine microscopy at least once during their training and 75% (44/59) of respondents did not feel comfortable performing urine microscopy. The majority of residents (92%, 54/59) reported they felt urine microscopy was very helpful or somewhat helpful in the evaluation of patients with AKI. Overall, 41% percent of responses to clinical interpretation questions were considered correct. Following survey completion, virtual urine microscopy sessions were held monthly and well received by the participants.

**Conclusions:** Our study found that internal medicine residents perceive urine microscopy as a helpful diagnostic tool, though lack the skills to perform and interpret urine microscopy sediments. Virtual educational sessions using video conferencing software are a technically feasible approach to teaching urine microscopy to internal medicine residents. Future studies include a study of the impact of these sessions on learning of urine microscopy.
Introduction

Urine microscopy is an important step in the diagnostic evaluation of a wide range of kidney pathologies (1–4). Although urine microscopy is often performed via automated methods based on flow cytometry or software recognition, a thorough manual evaluation of the urine sediment has been shown to be a low-cost and clinically useful tool in the diagnosis of kidney disease (1,4,5). Its utility as a diagnostic aid ranges from glomerular, tubular, and metabolic disorders as well as toxin ingestions and hemodynamic kidney injury (1–4,6,7). Urine microscopy has also been shown to be a useful prognostic tool, specifically in acute tubular necrosis (6,7) and is both inexpensive and non-invasive (1–4). With the current prevalence of acute kidney injury (AKI) reported as high as 20% in hospitalized patients, education on how to perform this procedure should be available to clinicians caring for patients with AKI (8–10).

Despite urine microscopy findings being taught during pre-clinical training, internal medicine trainees generally do not receive formal education on performance and interpretation of urine microscopy - unless they happen to learn this during their nephrology rotation. Previous reports on potential reasons to explain the low interest in nephrology as a specialty choice consistently highlight lack of diverse exposure to the field and the paucity of procedures (11,12). In addition to improving clinical reasoning skills and patient management, exposure to and teaching of urine microscopy to trainees during internal medicine residency has the potential to increase interest in nephrology as a future career choice. Moreover, studies have found inter-observer variability while analyzing urine microscopy, even between attending nephrologists, indicating a need for enhanced education on urine microscopy analysis at all training levels (13,14).

In this study, we administered an anonymous survey to assess internal medicine residents’ knowledge of and attitudes toward urine microscopy. The results of this assessment were used to develop a virtual urine microscopy teaching sessions for internal medicine residents, during which participants viewed urine sediment analysis in real-time with attending nephrologists and nephrology fellows.
Methods

Survey
An anonymous, online, voluntary survey (Google Forms, Mountain View, CA) was sent to all categorical internal medicine residents (n=131) enrolled at the Icahn School of Medicine at Mount Sinai (ISMMS). The survey (Supplement) included thirteen questions that addressed demographics, and both attitudes towards and experience with urine microscopy. Three content questions asked for clinical interpretation of an image of a white blood cell cast, uric acid crystals, and acanthocytes. A 5-point Likert scale was used to assess attitudes and experiences. These clinical interpretation questions were validated by two nephrologists that did not participate in the study.

Virtual Urine Microscopy Teaching Sessions
After survey completion, voluntary urine microscopy teaching sessions were scheduled every month for all internal medicine residents after discussion with residency program leadership. Sessions were held via video conferencing software (Zoom Video Communications, San Jose, CA). A mobile device (iPhone 5C, Apple Inc. Cupertino, CA), installed with the Zoom application, was connected to an Olympus BH-2 microscope via microscope adapter (iDu Optics) (Figure 1). This device was then connected via lightning cable to a computer to share the microscope view with all participants (Figure 3). Fresh urine samples were collected from hospitalized patients shortly before the session and urine sediment slides were prepared prior to the session using standard technique. Sessions were structured first with a 15 minute introduction to urine microscopy, and then 45 minutes of real-time viewing of the urine sediment with teaching of urine microscopy findings with clinical correlation that was led by nephrology fellows. Attending nephrologists were also in attendance. Urine sediments were viewed under light microscopy with different objectives (4X, 10X, 40X), phase contrast (40X), and with a polarizer. Sediments were also viewed after Sternheimer-Malbin staining. All participants were able to use the “Annotation” feature to draw or point to structures seen under the microscope.
Statistical analysis

Chi-square analysis and student’s t-tests were used to compare survey results between post-graduate year (PGY) groups (PGY-1, PGY-2, PGY-3). Comparison of post-graduate group means (PGY-1, PGY-2, and PGY-3) of Likert scale questions was performed using Kruskal-Wallis One-Way ANOVA with Dunn’s multiple comparisons post-test. All statistics were performed with GraphPad Prism 8 (San Diego, CA). P values < 0.05 were considered statistically significant.

This study was approved by the ISMMS Institutional Review Board.

Results

Demographics, Experience, and Comfort Level with Urine Microscopy

Survey response rate among categorical internal medicine residents was 45% (59/131). Of the respondents, 58% (34/59) identified as women and 41% (24/59) as men. All respondents were between 25-36 years of age. Of the 59 respondents, 31% (18/59) were postgraduate year one (PGY-1), 42% (25/59) PGY-2 and 27% (16/59) PGY-3.

Survey question responses are summarized in Table 1. Forty-seven percent (28/59) of respondents reported performing urine microscopy at least once during their training. PGY-3 respondents were more likely (75%, 12/16, p=0.03) to have previously performed urine microscopy than PGY-2 (40%, 10/25) or PGY-1 (33%, 6/18). Overall, 12% (7/59) felt “somewhat comfortable” performing this procedure and none reported feeling “very comfortable” (Table 1). Seventy-five percent of respondents felt “not very comfortable” or “not at all comfortable” while performing urine microscopy.

Respondents entered qualitative comments including: “Would like to learn how to spin urine”, “I’ve never done it! I wish we learned more about it”, “I did a nephrology rotation in med school and we spun urine on all our consults. I found it super informative and interesting!” and “It was a really cool
experience that I was able to have thanks to the nephrology fellow. It helped crystallize my book learning with real world experience”. No negative comments were entered.

**Perceived Utility and Performance on Clinical Interpretation Questions**

When asked their perception of the utility of urine microscopy in the clinical workup of AKI, 92% (54/59) felt it was “very helpful” or “somewhat helpful” (Table 1). Higher training level was associated with a higher perceived value in urine microscopy, with 100% (16/16) of PGY-3, 96% (25/26) PGY-2 respondents, and 78% of PGY-1 (14/18) responded feeling either “very helpful” or “somewhat helpful” ($P=0.03$)

Overall, 40%, 37% and 46% of clinical interpretation questions were answered correctly by PGY-1, PGY-2 and PGY-3 respectively (Figure 2A). Correct responses to the three questions did not correlate with PGY status (PGY-1: $p=0.1$; PGY-2: $p=0.2$, PGY-3: $p=0.8$). Percentages of correct responses to individual questions are summarized in Figure 2A. Prior experience with urine microscopy was not associated with higher performance on the content questions (Figure 2B). Similarly, comfort level with urine microscopy was not associated with higher performance on the content questions (Figure 2C).

**Interest in Nephrology as a Career Choice**

In response to a question about interest in nephrology as a career choice, 15% (9/59) of respondents reported feeling “very interested” or “somewhat interested”, while 73% reported feeling “not very interested” and “not at all interested” (43/59). Seven percent (4/59) of the respondents reported nephrology as the current specialty of choice. Most popular specialties of interest within this cohort were cardiology, gastroenterology, pulmonary/critical care, and hospital medicine with 25%, 25%, 10%, and 10% respectively. Of the 15% (9/59) respondents who reported feeling “very interested” or “somewhat interested” in nephrology as a career choice, 55% (5/9) reported having performed urine microscopy *at least once* during their training. Of those “not very interested”, “not at all interested”, or
“neutral” regarding their interest in nephrology as a career choice, 46% (23/50) reported performing urine microscopy at least once during their training.

**Virtual Urine Microscopy Sessions**

Sessions were scheduled monthly and attended by 15 residents on average. Urine samples from at least three patients were reviewed at each session.

**Discussion**

Our survey results found that the majority of internal medicine residents feel that urine microscopy is an important tool to aid in the diagnosis of AKI, though they do not feel comfortable performing this skill. Somewhat surprisingly, residents’ comments suggest an interest in wanting to learn more about this procedure - despite a lack of interest in nephrology as a specialty. Residents with a higher level of training were more likely to view microscopy as an important diagnostic tool or have experience with this technique, which is likely a reflection of their clinical exposure. Responses to content questions revealed a significant knowledge gap in the clinical interpretation of urine microscopy sediments.

Responses and comments from our survey revealed an overall positive attitude towards urine microscopy, suggesting willingness to learn this skill. Of note, those with an interest in pursuing nephrology as a subspecialty did not report more experience in performance of urine microscopy when compared to the rest of the cohort. Our study found that 15% of respondents had some interest in nephrology, similar to previous reports (15).

Interest in nephrology as a career remains low, with only 60% of the offered positions filled in the match recently (11,12,15). Studies have shown a lack of diverse exposure to the field and dearth of procedures as potential reasons for low interest (11,12,15). Though procedures within a specialty generally may be attractive as a means for reimbursement, urine microscopy has the potential to improve understanding of nephrology pathophysiology, provide unique exposure to the field beyond
traditional clinical experiences, and ultimately increase interest in nephrology as a career choice. Interestingly, the proportion of internal medicine residents who had performed urine microscopy in the past was similar between those with an interest in nephrology as a career and those without. Existing literature supports the use of virtual and online teaching tools in medical education, which has now been accelerated by the coronavirus disease 2019 (COVID-19) pandemic which necessitates social distancing (16–19). We found that when necessary resources and technology are available, virtual urine microscopy teaching sessions are a simple feasible method to teach internal medicine residents a technique that can help with their clinical reasoning skills and management of patients with AKI - while increasing exposure to nephrology during the COVID-19 pandemic. Other institutions may be able to replicate these virtual sessions to similarly teach trainees urine microscopy, or other topics via microscopy (e.g. kidney pathology). Further, learning urine microscopy may be especially helpful for clinicians who plan to practice in primary care or settings with limited nephrology resources.

Limitations of this study include selection bias, as our survey was voluntary. It is possible that our respondents were more interested in nephrology topics than those who did not answer the survey, though the majority did not indicate an interest in nephrology as a subspecialty choice. Data available for analysis was also limited, as we only included three questions to assess clinical interpretation of urine microscopy images. Additional questions were not included to improve our survey response and completion rate. All respondents answered all questions before submission. As these clinical interpretation questions were multiple-choice questions with 5 options, it is possible that respondents may have answered each question correctly by chance 20% of the time. Of note, knowledge questions on the survey asked for clinical interpretation of white blood cell casts, acanthocytes, and uric acid crystals, rather than identification of urine sediment elements. Though it has been reported that white blood cell casts are highly sensitive for acute interstitial nephritis they may not always reliably predict histologic diagnosis. As white blood cell casts may be present in exudative glomerulonephritis, both acute interstitial nephritis and glomerulonephritis (selected by 8/59, 13.6%) were considered to be
correct responses (4,20). Finally, our study is a single-center study at a large academic institution with available technology resources, and thus generalizability may be limited.

Conclusions

In conclusion, we found that internal medicine residents perceive urine microscopy as a helpful diagnostic tool, though lack the skills to perform and interpret urine microscopy sediments. Implementation of virtual urine microscopy sessions with real-time viewing of urine microscopy samples has the potential to improve residents’ knowledge of this skill set and possibly interest in nephrology as a specialty choice. Future studies include systematic evaluation of our sessions, including a re-assessment of knowledge of and attitudes toward urine microscopy. Future plans also include expansion of these sessions to include trainees and nephrologists from around the world.

Disclosures

S. Farouk reports Other Interests/Relationships: Editorial Boards: Clinical Transplantation, Journal of Nephrology, and American Journal of Kidney Diseases. M. Sparks reports Honoraria: Elsevier-Nephrology Secrets; Scientific Advisor or Membership: American Board of Internal Medicine, Nephrology Board, Board of Director, NephJC, Media and Communications Committee -ASN, Editorial Board- American Journal of Kidney Diseases, Kidney360, Kidney Medicine, KCVD Membership & Communications Committee- AHA, KCVD Scientific & Clinical Education Lifelong Learning Committee (SCILL)- AHA, NKF North Carolina- Medical Advisory Board. All remaining authors have nothing to disclose.

Funding

S. Farouk is funded by a grant from KidneyCure and the American Society of Nephrology, William and Sandra Bennett Clinical Scholars Program. M. Sparks is funded by a grant from the Renal Research Institute.

Author Contributions

J Chancay: Conceptualization; Formal analysis; Investigation; Methodology; Project administration; Validation; Writing - original draft; Writing - review and editing
M Eswarappa: Data curation; Formal analysis
L Sanchez Russo: Investigation; Methodology; Project administration
M Sparks: Data curation; Formal analysis; Investigation; Methodology; Project administration; Resources; Supervision; Writing - original draft; Writing - review and editing
S Farouk: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Resources; Supervision; Validation; Visualization; Writing - original draft; Writing - review and editing
References:
Table 1. Attitudes toward and comfort level with urine microscopy. Means between post-graduate year (PGY) groups were calculated and compared using the Kruskal-Wallis one-way ANOVA with Dunn’s multiple comparisons post-test. Post-test analysis for “How helpful do you think urine microscopy is?” PGY-1 vs. PGY-2, p=0.8; PGY-1 vs. PGY-3, p>0.9999, PGY-2 vs. PGY-3, p=0.8; Post-test for “How comfortable do you feel performing urine microscopy?” PGY-1 vs. PGY-2; p=0.052, PGY-1 vs. PGY-3, p=0.3, PGY-2 vs. PGY-3, p>0.9999.

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<th>All (n = 59)</th>
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<th>PGY-3 (n = 16)</th>
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Figure Legend

Figure 1. Centrifuge and microscope with mobile device and adapter

Figure 2. Performance on urine microscopy clinical correlation. A. Mean percentage of urine microscopy clinical interpretation questions correctly answered, by training level. Error bars represent standard error. (AIN: acute interstitial nephritis; GN: glomerulonephritis; TLS: tumor lysis syndrome; GN: glomerulonephritis; PGY: Post-graduate year). Chi-square analysis was used to compare performance by PGY group for each question. AIN $P=0.1$, TLS $P=0.2$, GN $P=0.9$. B. The mean percentage of correct responses to all 3 questions were compared to whether or not the trainee had indicated that they had performed urine microscopy ("not sure" was included in the "no" group). No difference was seen in either group (unpaired t test, $P=0.5$). C. The mean percentage of correct response was compared to the 5 different urine microscopy comfort levels (Likert scale). No differences were identified using Kruskal-Wallis test and Dunn's multiple comparisons $P=0.8$, all comparisons $P>0.9999$.

Figure 3. Screenshots of virtual urine microscopy session (via Zoom), with an annotation bar. (Top) Light microscopy, 40X. Unstained sample with struvite stone (gray) and transitional epithelial cell (blue). (Bottom) Phase contrast, 40X, polarized sample with struvite stone (red), transitional epithelial cell (green), and monomorphic red blood cells (gray)
Figure 2