THE APPLICATION OF MOBILE APP-BASED ACOUSTIC UROFLOWMETRY IN REAL LIFE

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Hypothesis / Aims of Study

Uroflowmetry is a non-invasive measurement of urine flow rate with some privacy. Current uroflowmetry is designed to observe patient's urination while maintaining privacy. However, some patients cannot void well because of the unfamiliar environment or inconvenient/unnatural timing to void. The need for comfortable, convenient and even portable, home-based device has led to the development of technology in uroflowmetry. Traditionally, the flow rate was calculated by weight transducer, spinning disc or change in capacitance. Acoustic uroflowmetry is a novel technique to capture and analyze sounds generated during voiding, offers clinical-grade results including flow curves, maximal flow rate, average flow rate, voided volume and voiding time. Based on the technology, we implemented a mobile application to check urine flow at home. The mobile app uses the internal microphone of a smartphone and requires no additional hardware for its work. In this research, we investigated how people use the app in their daily lives and environment and what type of flow patterns would be captured from them.

Design and Methods

A mobile app was distributed to test groups, in which persons who consented to participate the test and agreed to terms of use and privacy policy conducted the test from November 17, 2018, to January 4, 2019. Test users installed the distributed app on their iPhones and recorded the urinating sound with the app. The app analyzed the recorded sound and showed the results in a minute. A flow curve, the maximal flow rate (Qmax), average flow rate (Qavg), voided volume and voiding time were included in the result. Test users checked their own measurement results easily on the screen of the app.

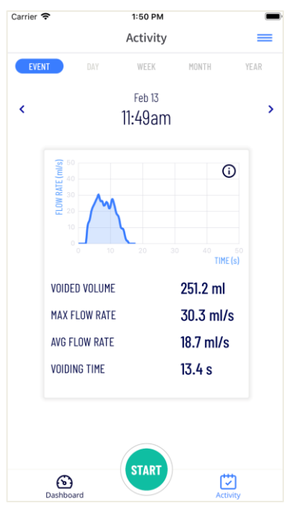


Figure 1. Measurement Result.

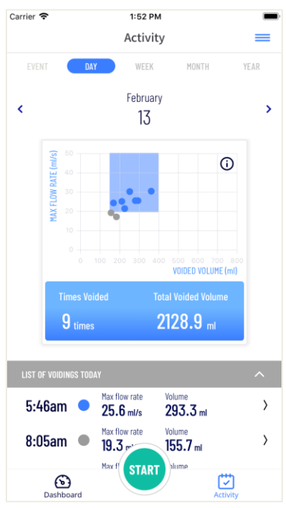


Figure 2. Daily Summary.

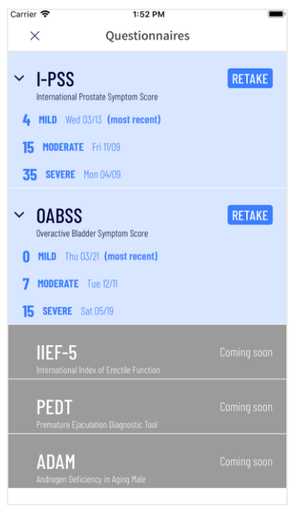


Figure 3. Symptom Scores.

Results

A total of 67 men (Korean or American) participated in the trial. Mean age was 41.6 years old (24 – 56 years old). Out of the 67 users, 9 measured not once after installation and registration, so they were screened out. 58 of users measured their urine flow at least once, 19.1 times on average per users. The researchers collected 1107 recordings in total. After analysis of the measured data, 265 were classified as invalid and the rest of the 842 were successfully processed to provide a flow curve and parameters for each voiding event.

Mean Qmax and Qavg are 22.3 ml/s (3.5 - 49.4 ml/s) and 12.4 ml/s (1.7 - 33.8 ml/s), respectively. Mean voided volume is 252.9 ml (33.1 ml - 982.8 ml). Chart 1 and 2 show the distribution of Qmax and Voided volume per range. Average of voiding time was 22.3 sec (5.8 - 77.4 sec). Well-known flow patterns from conventional uroflowmetry were also captured in the test. Fig 1 shows the most common and representative flow patterns selected from the measurement results.

Chart 1. Distribution of Qmax.

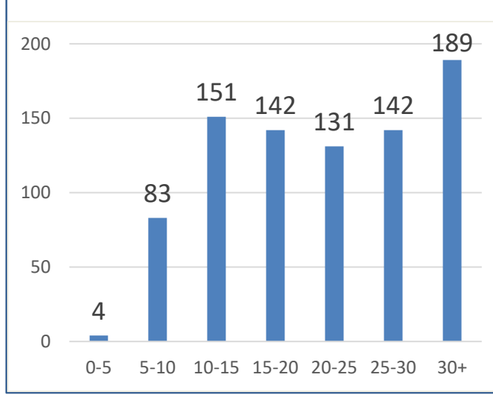
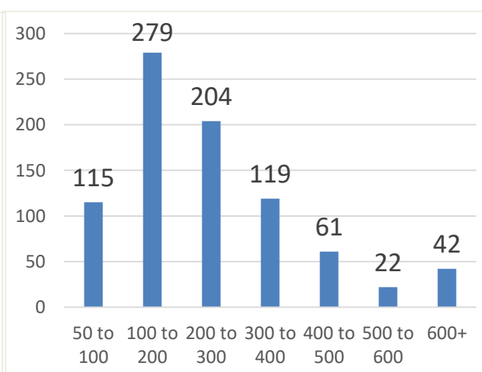


Chart 2. Distribution of Voided Vol.



Discussion

Results which were classified as invalid were mostly due to ambient and background noise during the urination. Most common sources of the noise were ventilation fan, voices and different objects (e.g., door slamming, flushing, tap water) in the bathroom. All the test participants self-reported himself as healthy and normal and were not during urological treatment. However, some pre-symptomatic flow patterns such as obstructed and a long decreasing tail was observed. 34.8% of valid results showed Qmax between 10 ml/s and 20 ml/s, and 10.3% did less than 10ml/s. 30.5% of valid results were measured with the voided volume less than 150 ml (Volume measured less than 50 ml were screened out).

The app was easy to use. Most of the test users learned how to use by themselves based on the basic usage guideline, without any challenges. Participants who measured every voiding event in a day could check a voiding diary of the day, including frequency, the number of total voids and total voided volume of the day. Some participants reported that they first recognized how many times to go to the bathroom a day, and the diary and data led them to reflect upon how their days were and what their habit was. For instance, what made them go bathroom less or more than they did yesterday, or it seemed that they had more coffee and tea than they had in the previous week. The mobile app-based acoustic flowmetry can be an easy-to-use, decent tool to monitor one's urine flow in the daily natural setting. Subtle and subjective nature of LUT symptoms makes the symptoms hard to be identified and often impedes appropriate diagnosis and treatment. This app could help patients monitor their status in a quantitative and longitudinal way. Also, it is expected to greatly improve adherence in creating a voiding diary by eliminating the inconveniences of measure cup and manual entry of data.

Self-reporting features for such as urgency, fluid intake, etc. and health tips can be easily integrated into the app. Those would improve adherence and outcome in the process of lifestyle modification or behavioral change as a patient-physician engagement tool. This mobile-based self-monitoring tool for LUTS could be applied for prescreening of patients at home, outcome monitoring between office visits, post-operative monitoring to assess voiding function after pelvic organ surgeries and telemedicine in urology. Also, this tool would help various researchers in the field collect a large set of real-world data and discover real-world evidence in a time- and cost-efficient way.

Figure 4. Various Flow Patterns.

Conclusions

This study investigated the potential of this technology and mobile app to be used as a self-monitoring tool for checking urine flow at home. Test participants of 58 males in the US and Korea measured and checked their urine flow using the app. Typical urine flow patterns similar to the results from clinical uroflowmetry were captured. Further validation and efficacy studies would be required for broader use of this mobile app as a patient-physician engagement tool.

References

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