

# Editorial on “An automated smartphone-based diagnostic assay for point-of-care semen analysis”

Sarah Coleman Vij, Ashok Agarwal

Department of Urology, Glickman Urologic and Kidney Institute, Cleveland Clinic Foundation, Cleveland, OH, USA

*Correspondence to:* Ashok Agarwal, PhD. Department of Urology, Glickman Urologic and Kidney Institute, Cleveland Clinic Foundation, 10685 Carnegie Avenue, Cleveland, OH 44106, USA. Email: agarwaa@ccf.org; Sarah Coleman Vij, MD. Department of Urology, Glickman Urologic and Kidney Institute, Cleveland Clinic Foundation, 10685 Carnegie Avenue, Cleveland, OH 44106, USA. Email: vijs@ccf.org.

*Provenance:* This is a Guest Editorial commissioned by Section Editor Bingrong Zhou, MD, PhD (Department of Dermatology, The First Affiliated Hospital of Nanjing Medical University, Nanjing, China).

*Comment on:* Kanakasabapathy MK, Sadasivam M, Singh A, *et al.* An automated smartphone-based diagnostic assay for point-of-care semen analysis. *Sci Transl Med* 2017;9. pii: eaai7863.

Submitted Sep 02, 2017. Accepted for publication Sep 14, 2017.

doi: 10.21037/atm.2017.09.12

**View this article at:** <http://dx.doi.org/10.21037/atm.2017.09.12>

The semen analysis is the cornerstone for the diagnosis of male infertility. Manual microscopic testing and computer-assisted semen analysis technology are expensive and require significant technical skill to use. Men are less likely to seek medical attention for fertility concerns than their female partners (1). Those who do seek medical attention tend to be better educated with higher status occupations (1). A delay in diagnosis of male factor infertility may prolong the infertility treatment process for the couple and result in unnecessary interventions for the female partner. A contributing factor to the hesitancy to seek medical help is the need to provide a specimen in an office setting which may cause embarrassment for some men. The idea of an ‘at-home’, affordable testing platform to screen for an abnormal semen analysis would obviate the need for a clinic visit and provide preliminary data to guide referrals. This might then hasten the time to treatment for any modifiable conditions causing infertility or sub-fertility. Existing modalities for “male fertility assessment” include the <sup>®</sup>Fertile Count<sup>™</sup> and Sperm Check<sup>®</sup>, both of which provide an indirect measurement of sperm concentration using chemical labeling of sperm-specific proteins. These tests do not provide a quantitative assessment of the sperm concentration nor do they provide motility or velocity assessments. Furthermore, these tests have not been studied extensively for their accuracy.

Su *et al.* described a lightweight and compact lens-free

microscope for use at home or in clinics without access to a formal andrology lab (2). Testing of this model was done in a small number of semen specimens, some of which had been cryopreserved and the analysis required an experienced user which limits its applicability (2). Smartphones are an ideal platform given that they are abundant, have computing power and internet access, have high resolution cameras and accommodate several types of attachments (3). Additionally, most adults globally are quite familiar with smartphones and should be able to transmit their results directly to a provider through this modality.

The use of mobile phones as a testing device in the medical realm has been applied for blood tests, bacterial detection, biomarker detection, viral detection and others (4-6). Kobori *et al.* describe a single-ball lens attachment for smart phones to enhance the magnification of the smart phone’s built-in camera. This enabled analysis of a semen sample with the use of a personal computer for manual counting and motility assessment. They demonstrated the use of this method correlated with the results from a computer-assisted semen analysis machine for concentration, motility and total motile count ( $P < 0.01$ ) (3). The use of the single-ball microscope developed by Roy *et al.* obviates the need for a bulky, expensive conventional table microscope which some platforms require (7). This low cost attachment can be used at home if the patient has access to a computer in addition to the smartphone.

Limitations of this study include small study population (50 patients) and the requirement of a computer in addition to a mobile device. Additionally, the authors did not show that the results would be replicated when the device was used by lay people rather than study personnel.

Kanakasabapathy *et al.* describe a novel device for the at-home semen analysis market that involves an optical attachment and a disposable microfluidic device for handling of the semen sample. The total cost of the equipment was less than \$5, fulfilling the need for a low-cost option for at-home testing, requiring no additional equipment such as a computer or bench microscope. When operated by untrained users, the device was able to identify patients below the WHO threshold of 15 million sperm/mL with a sensitivity of 95.83% (95% CI: 85.75% to 99.49%) and a specificity of 97.10% (95% CI: 92.74% to 99.20%) (8). The device also accurately assessed total sperm count, total motile count, motility, and linear and curvilinear velocities. Of the devices described in the literature thus far, this device has significant promise in regards to its accuracy when compared to more sophisticated and expensive computer-assisted semen analysis, its ease of use and mobile phone platform.

The primary goal of an at-home semen analysis is to identify men who need to seek attention from a male infertility specialist. Men with normal concentration need not see a specialist early in their efforts to conceive. Because no semen parameter accurately predicts time to pregnancy, some unnecessary referrals may occur (9). Ultimately, bringing young men to a physician is important as this population typically does not receive routine medical care, so an unnecessary referral may be the bridge between a young male patient and the medical community.

Identifying specific semen parameters that predict subfertility is challenging. The Longitudinal Investigation of Fertility and the Environment (LIFE) study examined the time to pregnancy in over 500 couples. No semen parameter reached statistical significance on multivariate analysis in regards to predicting time to pregnancy rate (9). Additionally, 15% of men with normal semen analyses have infertility whereas many men with abnormal semen analyses are fertile (10). Despite these limitations, the semen analysis remains the foundation of the fertility assessment of male patients and is heavily relied on by male infertility specialists.

The product that these authors describe may be best suited to identify the infertile or subfertile oligospermic population for referral as these patients may benefit from

therapeutic interventions by a male infertility specialist. A full fertility assessment requires a history and physical and is subject to the limitations of a semen analysis, whether it is performed at home or in an andrology lab. Marketing this product as an at-home fertility assessment could be misleading. As mentioned by the authors, their product can be used for post-vasectomy screening and may also be applicable for animal breeding, but it cannot replace a proper examination by a male infertility specialist. Advertisements for the product should clarify this fact.

In parts of the world where access to male infertility specialists is limited, many patients may not have options to further optimize their fertility despite a markedly abnormal result. The advent of virtual medical care in addition to mobile health technologies may enable patients to obtain consultation with a specialist. However, it is likely that further, specialized testing would be recommended. Such specialized testing and laboratory testing would require an andrology lab. Despite some of the limitations, the product described by the authors certainly has global applicability and their results should be congratulated.

### Acknowledgements

None.

### Footnote

*Conflicts of Interest:* The authors have no conflicts of interest to declare.

### References

1. Datta J, Palmer MJ, Tanton C, et al. Prevalence of infertility and help seeking among 15 000 women and men. *Hum Reprod* 2016;31:2108-18.
2. Su TW, Erlinger A, Tseng D, et al. Compact and light-weight automated semen analysis platform using lensfree on-chip microscopy. *Anal Chem* 2010;82:8307-12.
3. Kobori Y, Pfanner P, Prins GS, et al. Novel device for male infertility screening with single-ball lens microscope and smartphone. *Fertil Steril* 2016;106:574-8.
4. Zhu H, Sencan I, Wong J, et al. Cost-effective and rapid blood analysis on a cell-phone. *Lab Chip* 2013;13:1282-8.
5. Gallegos D, Long KD, Yu H, et al. Label-free biodetection using a smartphone. *Lab Chip* 2013;13:2124-32.
6. Zhu Y, Hu HL, Li P, et al. Generation of male germ cells from induced pluripotent stem cells (iPS cells): an in vitro

- and in vivo study. *Asian J Androl* 2012;14:574-9.
7. Roy S, Pantanowitz L, Amin M. Smartphone adapters for digital photomicrography. *J Pathol Inform* 2014;5:24.
  8. World Health Organization. WHO laboratory manual for the examination and processing of human semen. 5th ed. Geneva: World Health Organization, 2010.
  9. Buck Louis GM, Sundaram R, Schisterman EF, et al. Semen quality and time to pregnancy: the longitudinal investigation of fertility and the environment study. *Fertil Steril* 2014;101:453-62.
  10. Nallella KP, Sharma RK, Aziz N, et al. Significance of sperm characteristics in the evaluation of male infertility. *Fertil Steril* 2006;85:629-34.

**Cite this article as:** Vij SC, Agarwal A. Editorial on “An automated smartphone-based diagnostic assay for point-of-care semen analysis”. *Ann Transl Med* 2017;5(24):507. doi: 10.21037/atm.2017.09.12