Emerging technologies for home-based semen analysis

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SUMMARY
With about 70 million cases of infertility worldwide, half of which are caused by male factors, sperm analysis is critical to determine male fertility potential. Conventional semen analysis methods involve complex and manual inspection with a microscope, and these methods are labor intensive and can take several days. Due to unavailability of rapid, convenient, and user-friendly semen analysis tools, many men do not seek medical evaluation, especially in resource-constrained settings. Furthermore, as conventional methods have to be conducted in the laboratories, many men are unwilling to be tested as a result of social stigma in certain regions of the world. One solution can be found in at-home sperm analysis, which allows men to test their semen without the hassle of going to and paying for a clinic. Herein, we examine current at-home sperm analysis technologies and compare them to the traditional laboratory-based methods. In addition, we discuss emerging sperm analysis approaches and describe their limitations and future directions.

INTRODUCTION
Around 40–50% of the 70 million cases of infertility worldwide are caused by male factors (Center for Disease Control and Prevention (CDC) Infertility FastStats, 2013; Knowlton et al., 2015; Garolla et al., 2014; Global et al., 2014; Huang et al., 2014; Norsrati et al., 2014; Tung et al., 2014). Male infertility is caused by abnormal characteristics in several parameters, including sperm motility, morphology, velocity, semen volume, sperm concentration, and sperm count (Hammoud et al., 2008; Safae et al., 2012; Aitken et al., 2013a,b; Brown et al., 2013; Chen et al., 2013; Lewis et al., 2013; Worrilow et al., 2013; Zahedi et al., 2013; Norsrati et al., 2016). To determine male fertility potential, sperm analysis of these main parameters is necessary. Each of these parameters can be assessed through standard sperm analysis methods using microscopes and counting chambers. Motility is scored by evaluating each individual spermatozoon in a given sample, counting the numbers of progressive, non-progressive, and immotile spermatozoa, and comparing the values to find an average percentage of motility. Morphology is assessed by visual analysis through microscopy. Spermatozoa are counted, numbered, and then assessed based on head shape, midpiece shape, and tail (principal piece) (WHO, 2010). The velocity of progressive spermatozoa is determined by measuring the speed in μm per second. Semen volume is largely measured by calculating the weight of the semen, assuming the density of 1 g/mL. It can also be quantified using direct measurement with a marked vessel, although transfer between different vessels is not recommended due to volume loss. Sperm concentration is determined by counting the number of spermatozoa per aliquot of sample. Dilutions may need to be made in order to ensure that there are 200 sperm cells per replicated aliquot. A given volume can then be used in calculations to determine the concentration. Finally, sperm count is calculated by multiplying the sperm concentration by semen volume (WHO, 2010).

As these conventional sperm analysis methods involve complex, manual inspection with a microscope, they are labor intensive and can take several days. Additionally, the results of these methods are subjective and prone to human error (Henkel, 2012; Norsrati et al., 2016). Other methods, such as computer-assisted semen analysis (CASA), which uses algorithms to automatically track spermatozoa, are also effective and are able to present qualitative information on sperm motility. However, CASA-