Commentary: Improving the Efficiency of the Ova and Parasite Examination Using Cloud-Based Image Analysis

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Summary

In Holmström *et al.'s* proof-of-concept study, "Point-of-care mobile digital microscopy and deep learning for the detection of soil-transmitted helminths and *Schistosoma haematobium*,"[1] the authors use two emerging technologies that have the potential to shake up the routine ova and parasite (O&P) examination. First, the authors used a portable digital microscope that costs "approximately that of a midrange smartphone" to capture images of a quality comparable to using a × 10 objective lens on a traditional microscope.[2] Many studies have investigated the utility of rugged, portable digital microscopes, but this system was different from most in that it has motorized movement capability, which works to capture numerous representative fields from a single slide. Second, the authors trained a commercially available cloud-based image analysis software, WebMicroscope (https://webmicroscope.com/imageanalysis/), to perform a two-step analysis pipeline. The first algorithm in the pipeline identified objects of interest (i.e., rare events) that were suspected to be parasite eggs. The second algorithm classified the identified objects based on morphology as either an artifact or an *Ascaris* egg, a *Trichuris* egg, or a hookworm egg.

In the test set used to challenge the O&P analysis pipeline, the large majority (90%) of eggs analyzed were from *Ascaris*. One hundred and ninety-five *Ascaris* eggs were present, and the software identified all of them as such with only 13 false-positive events. The system was also able to detect and discriminate *Trichuris* and hookworm eggs in stool. *Schistosoma* eggs were able to be identified manually in urine using the microscope system, but the article does not describe the development of software to detect the *Schistosoma* eggs. Notably, the study was designed to focus on the sensitivity of the software over the specificity of the software as images without eggs were not analyzed, so the potential false-positivity rate if the pipeline were to be used in clinical practice is unclear.

Comments

Image analysis software is on the verge of becoming mainstream in clinical microbiology as a growing number of laboratories are converting to digital plate reading of bacterial cultures as a component of total laboratory automation.[3] Laboratories and manufacturers are exploring ways to add image analysis software to the digital plate reading process to further improve efficiencies.[4,5] Another analysis platform that has been used in infectious disease diagnosis is CellaVision, which was designed for assisting with manual white blood cell differentials. CellaVision has been used successfully to detect malarial parasites in digitized peripheral blood smears.[6] In Holmström *et al.'s* discussion of their study of O&P examinations, they suggest that their hardware and software solution could be further developed to facilitate O&P examinations in resource-limited environments, which is true. However, further developing and clinically validating a Holmström system to be used in the routine O&P examination workflow in resource-rich settings would also be appropriate.

This proof-of-concept study reveals an opportunity to improve the efficiency of clinical microbiology practice. Implementing a clinical testing system similar to what is described by Holmström *et al.* would be a leap forward in clinical parasitology in the United States. The Holmström study trained an off-the-shelf, cloud-based image analysis tool that was developed for general pathology to successfully identify and classify ova from parasites in a stool specimen. Having this software available in the cloud facilitates sharing of the algorithm with other laboratories that could potentially validate and use the software for clinical testing purposes. A resource that is needed, which could help to expedite the development of effective artificially intelligent O&P image analysis tools, is the formal curation of a freely available image library comprised of well-annotated images that developers can use to train and test software classifiers, similar to the MicrobIA project for bacterial cultures (www.microbia.org).

If an image analysis solution could be validated for clinical use in O&P examinations, it could do to the O&P examination what CellaVision has done to the manual white blood cell differential.[7] When implemented, the Holmström system would present a number of candidate images to a technologist who could quickly visually analyze the images and determine whether the software's classification of the objects as stool artifacts or stool pathogens was correct (https://goo.gl/rKrbge). Clinical validation and laboratory implementation of an O&P solution that is similar to what Holmström *et al.* have described would be a huge advance for clinical parasitology. The system would have the potential to decrease the analysis time of the O&P examination from 8 to 10 min per specimen to just seconds.[1]

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