Artificial intelligence in the fight against river blindness

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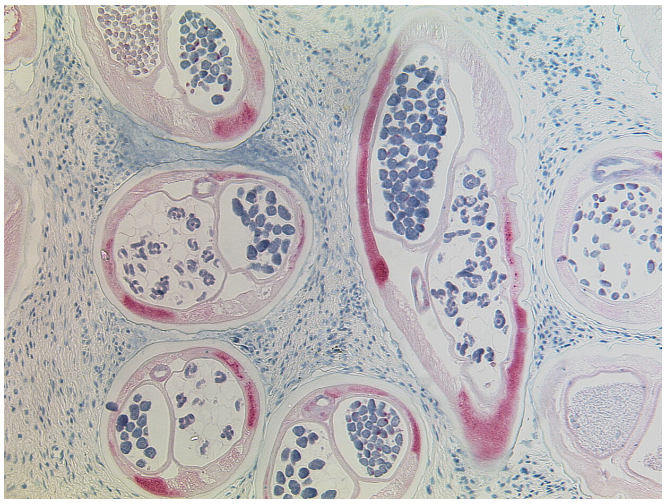

Histological section of Onchocerca volvulus, the cause of river blindness, under the microscope: Sections of a living female worm with offspring in the uteri. The symbiotic bacteria are stained in red. Credit: Institute of Medical Microbiology, Immunology and Parasitology (IMMIP) / University Hospital Bonn

More than 21 million people in Africa are infected with the nematode *Onchocerca volvulus*, the cause of river blindness. Around one in ten of those affected goes blind. Parasitologists at the University Hospital Bonn are looking for new, more effective weapons against the insidious parasite. The evaluation of the success of treatment is important. They now want to develop a method in which artificial intelligence (AI) automatically evaluates tissue samples from patients under the microscope. The aim is to reduce the time required and to establish an objective standard for analysis. The project is supported by the Bill & Melinda Gates Foundation.

The black fly bite mainly infects people in sub-Saharan Africa with larvae of the nematode *Onchocerca volvulus*, the trigger of onchocerciasis, also known as river blindness. First, the larvae grow into sexually mature worms, which prefer to live in nodules under the skin. Females can grow up to 60 centimeters and produce up to 1,000 offspring a day, known as microfilaria. These spread to the eye via the lymph channels in the skin. There the cornea becomes inflamed and its destruction leads to blindness. Additionally, the "baby worms" are ingested and spread further by other black flies feeding on sufferers' blood.

The WHO recommends that all persons in affected areas be treated with the standard drug ivermectin, which kills the offspring of the worms without damaging the adult worm. This means that, despite this treatment, new generations of microfilaria can emerge relatively quickly and are again spread by black flies, causing symptoms of vision impairment and skin inflammation. In order to eradicate the disease for good, treatment must therefore be carried out comprehensively throughout affected areas over many years. "It is important to find substances that kill adult worms directly," explains Prof. Dr. Achim Hörauf, Director of the Institute of Medical Microbiology, Immunology and Parasitology (IMMIP). The institute, which is based at the University Hospital Bonn, is one of the leading institutions in the development of such new therapies.

Antibiotics in the fight against the worm

Key to this issue is a symbiosis discovered by Prof. Hörauf. For millions of years, the nematode *Onchocerca volvulus* has harbored bacteria that it needs to survive. If these bacteria die, the parasite also dies sooner or later. "Antibiotics with an efficacy spectrum that specifically targets these bacteria are therefore a chance to permanently prevent the transmission of river blindness," said Prof. Hörauf. The antibiotic doxycycline, the prototype of an active substance discovered by Hörauf's group, is used worldwide for the treatment of filaria in hospitals, but is not well-suited for mass treatment in remote areas with poor infrastructure.

This is because the antibiotic must be taken daily over a period of four to six weeks in order to develop its full effect. The Bonn-based parasitologists are therefore continuing their worldwide research alliance in order to find faster-acting alternatives with shorter treatment times that will eradicate the nematode *Onchocerca volvulus* once and for all. The Bill & Melinda Gates Foundation has been supporting this task financially for some time now.

AI to accelerate the development of therapies against the worm

In order to evaluate the success of such treatments, the nodules must be removed from the patient's skin and analyzed. Experts use the microscope to look at thin, so-called histological, sections of these nodules in order to assess sex, vitality and embryonic development of the nematodes and the presence of symbiotic bacteria. "This process is very time-consuming and depends directly on the experience of the people making the assessments," says Dr. Ute Klarmann-Schulz, summarizing the motivation behind the decision of her interdisciplinary working group at IMMIP to optimize this analysis process. "In Dr. Daniel Kühlwein, staff member of the Center of Excellence for Artificial Intelligence at the global consulting firm Capgemini, we were able to convince an expert in the field of artificial intelligence for cooperation."

With his support, the working group led by Klarmann-Schulz at the University Hospital Bonn intends to develop an AI system that will automate the evaluation of histological sections. They use already existing deep learning models for object recognition. "The pre-trained AI systems can basically already see, which means they can recognize lines, for example," explains Kühlwein. "We use transfer learning to train them for our new particular application." The AI system learns to recognize and evaluate worms from microscope images of histological sections from numerous clinical studies that the Bonn-based parasitologists have already conducted with their African partners. Exploiting this know-how, the scientists aim to reduce the time required for the evaluation and establish an objective standard for the analysis.

More information: Further information is available at gcgh.grandchallenges.org/grant … ology-onchocerciasis

Provided by University of Bonn