WORKING SMARTER

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Using digital pathology to improve remote diagnosis in Malawi

An opinion at a distance is an oft-quoted benefit of digital pathology. The authors of this article describe how they discovered a practical application.

There are estimated to be more than one million new diagnoses of leukaemia and lymphoma globally each year. In low-income countries such as Malawi, where there may be limited or no access to additional diagnostic methods (e.g. molecular tests) owing to inadequate infrastructure and financial restrictions, there is even greater reliance upon microscopic assessment. A diagnosis critically influences a patient's management, such as the type and duration of chemotherapy. The accuracy of diagnosis also significantly affects the long-term outcome for the patient. The paediatric oncology unit at Queen Elizabeth Central Hospital (QECH), one of the large government hospitals in Malawi, sees between 160 and 180 new patients a year. Haematological malignancies such as Burkitt lymphoma and acute lymphoblastic leukaemia are among the most frequent diagnoses.

Current limitation

As part of the longstanding partnership between the oncology team in Malawi and the team in Newcastle, we have developed several initiatives. These include a relatively inexpensive yet reliable method to support rapid diagnosis of cytology samples and blood smears using telepathology, which assists the Malawi clinicians in the treatment of children with cancer.

Currently, cancer diagnosis at QECH involves spreading and air-drying fresh samples from patients (peripheral blood films, fine needle aspirates, bone marrow aspirates), then staining using a rapid stain (RapiDiff stain kit by Clinical Services Laboratories). The microscope operator (Dr George Chagaluka) identifies the regions of each slide to photograph and the images are reviewed by a highly trained haematologist in the UK via a low-tech image transfer system with associated online diagnostic information management system. However, the variable quality of the images coupled with the inability to view whole slides reduces the ability to make a diagnosis (48% of samples were non-diagnostic). The lack of accurate diagnosis may potentially compromise treatments offered to the children at QECH. Furthermore, power outages are common, the internet speed is slow and it is problematic to service and maintain complex machinery. Therefore, a solution that is relatively resistant to these problems but still maintains efficacy is preferred.

Digital pathology and artificial intelligence

Modern whole-slide scanners are becoming an essential tool in pathology laboratories in high-income countries. These machines can digitally capture the slide until the entire area of the tissue section is covered, thus enabling transfer of high resolution whole-slide images that potentially improve the accuracy of diagnosis. This might however be at the expense of a much greater time input, compared with review of a few selected photographic images.

Deep learning is a novel computational method within artificial intelligence (AI) that can identify patterns within large and complex whole-slide datasets and generate classifiers of disease biology or clinical response to treatment. Deep learning can analyse digitised images and understand their defining characteristics (within interrelated 'layers' of data) in a way that far exceeds the human brain's ability to recognise using conventional learning and pattern recognition.

Whole-slide scanners and AI hold huge potential for revolutionising the efficiency of healthcare systems through automation. However, there are distinct differences in the challenges and benefits between high-income countries and low-income countries when developing and validating the next generation of computational diagnostic methods in digital pathology. There is a risk that the advantages AI and other modern technologies will bring to healthcare systems in high-income countries will not be matched in low-income countries. This would yet further increase the inequality between patient experiences in these countries, unless there are methods to distribute the so-called 'algorithmic wealth' of analytics and data science.

Multi-team collaboration

An inter-institutional collaboration is being established between Newcastle University's Faculty of Medical Sciences, Interdisciplinary Computing

Professor Elizabeth Molyneux and Dr George Chagaluka trialling manual whole-slide scanning.

and Complex BioSystems (ICOS), the Northern England Haemato-Oncology Diagnostic Service (NEHODS), Newcastle Molecular Pathology Node and the Department of Paediatrics at Queen Elizabeth Hospital, Blantyre, Malawi to bridge this gap and focus on AI. This collaboration between institutions in high- and low-income countries is perfectly suited to evaluate a distributed AI model, which leverages Newcastle's haematology and pathology expertise to support diagnostics and healthcare in this lower-income country, using an AI-enabled portable whole-slide scanner.

The plan and the fundraiser

The project involves the placement of a portable low-cost commercial product, Microvisioneer. This allows the microscope operator to acquire the whole-slide image directly from the microscope through an area-scanning camera installed on the microscope's camera port and an AI system that prepares digital images for transfer to the reference centre to aid pathological diagnosis.

It is important to note that the project started in January 2019, leaving only two months to construct the system before the team travelled to Malawi for the routine annual visit. The traditional routes of seeking financial support for academic research were not feasible in this case owing to the long application processing time. In recent years, the rise of crowdfunding campaigns has been used to raise funds for medical research. GoFundMe, one of the most successful dedicated crowdfunding websites, has raised over $5bn since its launch in 2010.

Therefore, we set up a crowdfunding campaign (see: https://gofundme.com/fund-a-digital-microscopic-scanner-for-malawi), with help from the Royal College of Pathologists and ChronicleLive. To date, £807 has been raised from 26 donors through GoFundMe and £4,800 was received from a Chinese donor (Jerry Duan).

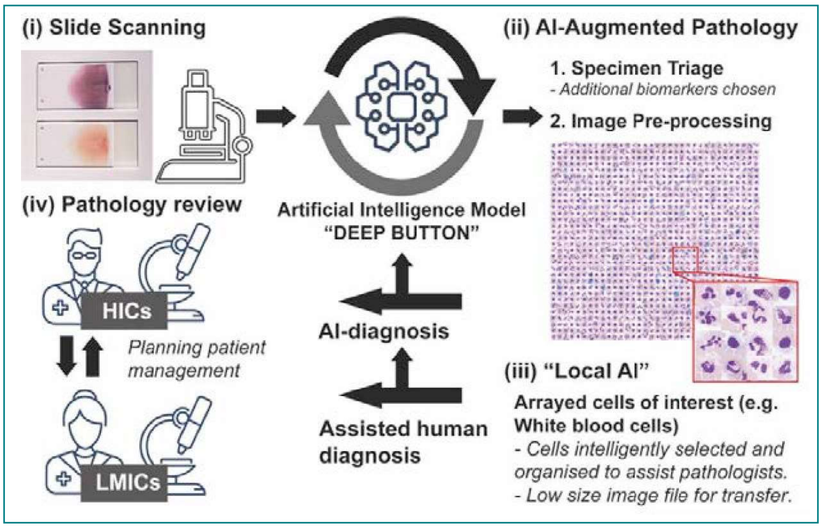

Figure 1: The designed workflow of telepathology at Queen Elizabeth Central Hospital.

Next steps

The system is currently being set up in Malawi and has the potential to improve remote access to pathology expertise as a point-of-care device, hence improving the standard of care for children with cancer in Malawi. This system could be rapidly and widely distributed at relatively low cost across many institutions where there is a twinning arrangement between less well-resourced and well-resourced centres, significantly enhancing the impact of the system. Perhaps most importantly, the potential scalability of the system – the availability of digital whole slides collected from Malawi – will provide the AI model with further high-quality input data, and the diagnostic accuracy and ability to accommodate disease variation will improve iteratively with wider use. Further strengthening partnerships with low- and middle-income countries (LIMCs) will accelerate the development of new clinical diagnostics, research collaborations, training and outputs shared between the UK, Africa and other LMICs.

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