

# DIGITAL PATHOLOGY – FUTURE PROOFING CANCER DIAGNOSTIC SERVICES



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Digital pathology is a technology which has the potential to revolutionise the way in which pathology services are delivered, offering a flexible platform for safety, quality and efficiency improvements in cancer diagnostics, while future-proofing an increasingly pressured medical specialty. Leeds Teaching Hospitals NHS Trust and the University of Leeds, in collaboration with Leica Biosystems, have completed an innovative pilot project to utilise digital diagnostic images, and are now in the process of a large scale clinical digitisation.

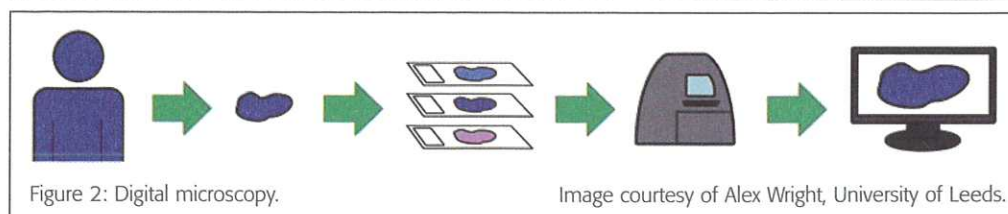
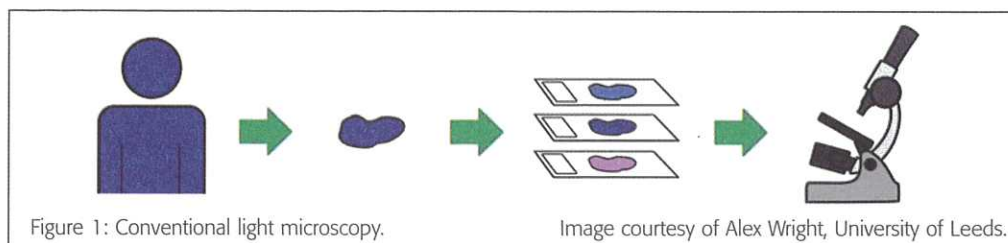
In conventional pathology workflows, tissue is taken from a patient, examined and dissected by a pathologist, mounted on glass slides and stained for a pathologist to view it down a microscope and make a diagnosis. (Figure 1). This pathway hasn't changed dramatically in 100 years. In digital pathology, an extra step is added to the pathway. Glass slides are scanned at high resolution using a microscope lens, and the acquired image is compressed and stored. The digital slide is then streamed to a pathologist, who can view the image using specialist software on a computer screen and make their diagnosis. The process of scanning a slide to create a diagnostic image is

known as whole slide imaging. (Figure 2)

So why would we want to use digital pathology? We are facing what Cancer Research UK have called "testing times". Diagnostic pathology services face the challenge of an increasing workload, both in terms of volume and data complexity of cancer specimens and pressure to maintain or improve on diagnostic turnaround times. In the UK, year on year, the volume of cellular pathology requests received by laboratories has increased by an average of 4.5%.<sup>1</sup>

The drive to identify pre-cancers and early stage cancers adds to the complexity of histopathological assessment,

when morphology can be harder, and more time consuming to interpret. Pathologists are required to identify subtler pathologies in smaller diagnostic specimens. In addition to an increase in specimen requests, the pathologist is required to take more blocks and make more slides for each cancer specimen. Increased demand has resulted in a negative impact on turnaround times, with data for England showing that the number of patients waiting more than 6 weeks for diagnostics in pathology has been increasing at approximately 17% per year since 2010–2011, with the majority of delays waiting for histopathology.<sup>2</sup> Data from the Royal College of Pathologists



show that 32% of cellular pathologists are over the age of 55 (615 people), and are expected to retire in the next 5 years.<sup>1</sup> Meanwhile, from August 2015 to June 2016, only 52 trainees in histopathology were recommended to the General Medical Council for completion of training.

Cancer Research UK highlights the need to ensure pathology services maximise efficiency, with networking and consolidation of pathology services prioritised. In light of increasing costs for staff overtime and outsourcing, optimisation of the pathology workforce is vital. Improved retention of near-retirement consultants, and increased efforts to drive recruitment in medical schools have been proposed, but these measures are not sufficient to solve the problem. The report recommends that departments and trusts should invest in infrastructure to support digital pathology, and that on-screen examination of histological slides should be used to enable more efficient networked services. This sentiment is echoed in the Nuffield Trust's publication—'The Future of Pathology' which states that 'without change it will be difficult to maintain an adequately skilled workforce in many areas of the country'.<sup>3</sup>

Given this perfect storm, how can we best future proof our cancer diagnostic services? At least part of the answer may lie in digital pathology.

Digital pathology has the potential to alleviate some of the pressures faced by the modern diagnostic departments, offering a flexible platform for safety, quality and efficiency improvements, whilst future-proofing pathology services and allowing closer matching of reporting capacity and demand. The principal benefits of a

digitized reporting service can be broadly divided into four categories: improvements in patient safety, improvements in diagnostic workflow, improvements in workforce factors, and improvements in over-all service quality.

The flexibility and agility of digital pathology systems allows for a number of improvements to the diagnostic workflow, including the ability to manipulate workload allocations by pushing and pulling of cases to respond to fluctuations in workload or case mix in a department. Rapid case tracking, archiving and retrieval, and faster case transfer times between the laboratory and primary pathologist, and the pathologist and internal or external second opinion pathologists should streamline turnaround times and diagnostic pathways. Given the strategic context outlined above, improvements in workforce factors are some of the key benefits service managers seek to capitalise on in a digital deployment. The innate flexibility of the digital diagnosis offers the potential for diverse and appealing patterns of work, freeing the diagnostician from geographical and temporal constraints on where and when they work. Digital reporting can enable optimisation of the workforce, supporting those that work less than full time to maximise the hours they can offer, and providing an incentive for those considering retirement to continue to offer their services on more flexible terms. Working arrangements more conducive to "work - life balance" are likely to appeal to the next generation of pathologists, and drive recruitment of medical graduates into the specialty.

Improvements in service quality are likely to follow from the myriad workflow and

workforce improvements already outlined. Improved information sharing and collaboration, in particular streamlined double reporting and rapid access to second opinion can lead to better quality diagnosis, and accuracy and convenience of the recording of cancer staging parameters could drive up the quality and reproducibility of cancer dataset reporting.

Finally, we should consider patient safety, surely the cornerstone of clinical decision making. Use of an integrated digital pathology system offers obvious advantages, with paperless transmission of digital slides directly to the pathologist lessening the possibility of a misidentification or transposition error at multiple points in the diagnostic workflow.

Furthermore, digital slides offer a readily portable, instantaneously transmissible diagnostic image which is not subject to the physical limitations frailties and risks of glass slides and their transport.

The benefits of a histopathology laboratory digitisation can be felt at multiple levels – from the patient who stands to benefit from patient safety improvements and faster time to diagnosis, to the pathologist who can benefit from a streamlined workflow, the institution which can reap efficiency savings. And the broader regional network which can benefit from pooling of reporting expertise and capacity.

So why aren't we all digital pathologists already? There are 3 major challenges which stand as barriers to widespread adoption.

1. Significant investment is needed to develop digital pathology networks.
2. IT networks that support digital pathology will have to

have sufficient capacity and storage to accommodate large files containing digital images and be robust enough to ensure the patient confidentiality is protected.

3. Pathologists are medical professionals, who may have 10, 20 or 30 years' experience with the light microscope. The switch to digital pathology requires them to modify their practice and become familiar with the subtle differences between digital images and light microscopy. Pathologists need opportunities to engage with digital reporting, train in the use of microscope software, and modify their reporting practice, without compromising patient safety.

The Royal College of Pathologists has a newly appointed lead for digital pathology, Dr Darren Treanor, and has developed a strategy and guideline for digital pathology adoption in the UK,<sup>4,5</sup> which hopes to address some of these barriers to adoption, and encourage best standards in digital reporting. The College recognises the need for digital pathology and its potential utility in benefiting patients, and supports the safe adoption of the technology in the NHS. It has recently published detailed guidelines for pathologists seeking to use digital pathology to make diagnoses, including practical steps for "validation" to ensure that patient safety is maintained. In addition to replacing the light microscope with the digital microscope, use of digital images in routine diagnostics opens the door for the development and use of augmented intelligence/ computer assisted diagnosis, which could free the pathologist from some of the more onerous and repetitive tasks (e.g. counting and quantifying

parameters) and allow them to concentrate on the more intellectual facets of complex pathological interpretation.

In conclusion, digital pathology offers the flexibility to redesign and improve pathology diagnostic services in the NHS.

- Digital pathology benefits patients by improving safety, streamlining access to expert opinion and dual reporting.
- It improves the workflow and connectivity of laboratories and increases flexibility and efficiency of the workforce.
- Investment is needed in infrastructure, including IT systems, staffing and training.
- The NHS is positioned to lead the world in patient safety focused, evidence based clinical digital pathology deployment.

#### References:

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## LEEDS TEACHING HOSPITALS NHS AND DIGITAL PATHOLOGY

We are the most long established digital pathology project in Europe, with a proven track record in delivering quality digital pathology research and innovations – including our free access website, <http://www.virtualpathology.leeds.ac.uk/>, where public and professionals alike can access our digital slide library, educational and research materials.

Leeds Teaching Hospitals NHS Trust has a collaborative partnership with Leica Biosystems for a 100% digital pathology clinical deployment. Our experienced digital pathology research team is capturing data on the benefits of clinical digitisation, developing deployment tools and protocols to aid the transition of over departments to digital practice. As part of this partnership, we have already digitized our breast and neuropathology diagnostic services, and this year we will continue to roll out digital pathology sub-specialty by sub-specialty, and start using digital slides for our multidisciplinary team and cancer review meetings.

We currently scan 30% of our slide output for primary digital diagnosis – which represent the entirety of our breast and neuropathology workload. Cases are viewed by our pathologists on custom workstations with high resolution, medical grade monitors.

At Leeds, we are passionate about evidence based practice, and want to ensure that the benefits of digital pathology are harnessed without compromising patient safety, or our own professional standards. In line with this, we are the first team to systematically analyse the evidence base, to investigate the patient safety implications, and to design the world's first evidence based training and validation protocol to help pathologists transition to digital reporting.



Dr Millican Slater, consultant pathologist at Leeds Teaching Hospitals NHS Trust, at her digital pathology workstation.

We hold regular free workshops in Leeds, where we offer advice and hands on experience of digital reporting. These attract attendees from Europe and the United States, and we are invited to travel the world to share our knowledge and experience.

In our work we have demonstrated, that when given access to a quality training and self-validation programme, our pathologists are able to make 99% of their diagnoses on the digital microscope, meaning that in our department, the light microscope will soon be for emergency use only.<sup>6</sup>

To find out more about our project, refer to our website, or contact Dr Bethany Williams [Bethany.williams2@nhs.net](mailto:Bethany.williams2@nhs.net)