Guidance for remote reporting of digital pathology slides during periods of exceptional service pressure

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The Digital Pathology Committee of the Royal College of Pathologists
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1. Purpose of this guidance

This guidance document outlines the recommendations of the Royal College of Pathologists' Digital Pathology Committee regarding temporary remote reporting of digital slides in times of clinical and service necessity.

The General Medical Council has issued the following guidance (https://www.gmc-uk.org/news/newsarchive/supporting-doctors-in-the-event-of-a-covid19-epidemic-in-the-uk):

> *If Covid-19 becomes an established significant epidemic in the UK, NHS and HSC services in primary and secondary care and public health across all four nations will be put under extreme pressure. This pressure will inevitably be exacerbated by staff shortages due to sickness or caring responsibilities. It will be a challenge for our profession. We are confident doctors will respond rapidly and professionally and want to assure colleagues that we recognise this will require temporary changes to practice, and that regulators and others will take this into account.*
> *A significant epidemic will require healthcare professionals to be flexible in what they do. It may entail working in unfamiliar circumstances or surroundings, or working in clinical areas outside of their usual practice for the benefit of patients and the population as a whole. This can be stressful and you may have concerns about both the professional practicalities and implications of working in such circumstances.*

It is intended as a practical guide to support the safe use of digital pathology until further evidence and practical evaluation is undertaken. It does not replace existing guidance on training, validation and reporting of digital cases in the department under normal circumstances.

The key messages are:
- Existing College Guidance affirms that it is safe to use digital pathology with appropriate experience, risk assessment and risk reduction
- Validation is a self directed learning process by which pathologists learn how to diagnose digitally, based on comparison with the glass slides
- Pathologists who have fully validated already will be confident in working remotely, possibly on lower specification equipment, and be very comfortable with assessing risk and making decisions on digital, sometimes in suboptimal conditions
- Pathologists who have limited or no validation, or who have not used digital pathology before will find that they can confidently report some or many cases digitally, **without undertaking a formal 1-**

2 month validation comparing glass and digital. but should be aware of the risks and mitigate this risk where possible

- In exceptional circumstances they may decide to report cases digitally, using a risk mitigation approach – this does not remove the need for validation or quality assurance once normal services are being provided

2. Background

Adoption of digital pathology for clinical use is novel, with only a handful of departments across the UK currently using digital pathology for primary diagnosis.

In all pathology diagnosis, there is a need to maintain clinical standards and patient safety, and patients deserve the highest standards of diagnosis in all situations.

In some circumstances, the pathologists may need to make diagnoses in a less ideal setting, such as with reduced clinical information or using different equipment. Many pathologists are familiar with using microscopes at home which are not as highly specified as those at work. Evaluating and balancing risks is a routine part of a pathologist's job – deciding when to get a second opinion or order further work from the lab, for example.

These same practical principles of risk assessment and risk reduction can be applied to remote use of digital pathology.

A combination of departmental policy and standard operating procedures provide a method for the safe introduction of digital pathology. This includes a few key principles including basing decisions on the evidence available in the literature, a risk assessment of digital reporting, training in using the system, validation with the glass slide to develop confidence in reporting (and provide evidence of this), and risk reduction strategies.

This general approach is detailed in the RCPath guidance for digital pathology implementation.[1] In some departments, digital pathology reporting is further standardized through the use of uniform workstations including (at some sites) "medical grade displays". This approach was developed based on several years of work and now underpins the national guidance in the UK and Sweden.

"Validation" to practice with digital pathology is a learning process which typically takes a number of weeks or months using the technology, and comparing with glass slides, to complete.

More work is also needed to develop a formal process for remote reporting, including the development of validation processes for remote reporting, and establishing the minimum specifications for the workstation and display required. Some of this needs to be addressed by a program of work to examine home working; some may require basic research to answer. When working remotely, few pathology departments have provided "home workstations" of similar specification to those used on site, which may be a short-term impediment to full remote digital reporting. In other specialities, provision of home workstations to enable flexible or off site review of radiology images is accepted practice.

However, it is recognised that there are occasions on which remote reporting of cases may be necessary for clinical or practical reasons. Worldwide, several pathologists report successful use of workstations of various

specifications, both on-site and remotely. Access to digital images during urgent or unusual circumstances offers significant clinical value – e.g. maintaining a service or providing an urgent second opinion.

The Committee recognises that – while the evidence and experience is still accumulating - with appropriate precautions and risk assessment/ risk reduction it is possible to use the technology to facilitate these clinical or practical needs.

The existing Royal College of Guidelines for digital pathology and guidelines on working remotely also provide some guidance in this area.

Finally, in the exceptional circumstances presented by the COVID-19 pandemic, NHSX has given guidance on information governance for the (https://www.nhsx.nhs.uk/key-information-and-tools/informationgovernance-guidance) and the GMC guidance on supporting doctors in the event of a COVID-19 epidemic (https://www.gmc-uk.org/news/news-archive/supporting-doctors-in-the-event-of-a-covid19-epidemic-inthe-uk)

3. Principle and method

Where there is demonstrable clinical and service necessity, and the agreement of the Clinical Lead has been obtained, consultant pathologists may elect to report digital slides remotely.

They will need to ensure they have read any local SOPs or guidance available and be familiar with the Royal College Guidelines on Digital pathology and this guidance document.

The pathologist will need to access the departmental slide archive/ image management software using secure remote access (e.g. a virtual private network (VPN)). The pathologist will need to be able to contact the office and laboratory directly by phone or email as appropriate, as well as the requesting clinician.

The pathologist will need to assess the risk of making a digital diagnosis on a case by case basis and should exercise caution based on their assessment of risk. They may consider a remote diagnosis to be a preliminary or interim diagnosis, deferring definitive reporting until they have access to digital or glass slides on site.

Pathologists should be aware that the technical specifications of the display (including luminance, and resolution and contrast ratio) of the display can affects the quality of the image, and ease of use. More challenging diagnoses can be difficult on lower specification displays. The environment should also be considered, with the positioning and degree of natural light impacting image assessment.

The scope of remote/ home digital reporting should be clearly defined, with particular differentiation made between primary diagnosis, secondary review/MDT review and immunohistochemistry/auxiliary test review, which bear different levels of risk.

A risk evaluation should be performed to determine the types of case suitable for remote reporting, and those that should be reviewed again on site, reported on site, or deferred to glass.

The pathologist may consider lowering their threshold for requesting second/consensus opinion from colleagues, who may be working in the department, or remotely.

Depending on their risk assessment of a case, the pathologist may wish to convey this risk to the requesting clinician, either verbally, or within the report. For example:

"This diagnosis was made on a non-clinical system at a remote site, to expedite giving a rapid opinion, but this diagnosis is provisional and will be confirmed on second review on site"

The need for remote reporting of digital slides should be reviewed on a regular basis with the clinical lead.

Workflows and systems appropriate to the laboratory in question need to be established such that pathologists are aware of which cases are awaiting reporting and which are urgent for example. In addition, a mechanism for enabling the pathologist to be able to view the request form where appropriate, e.g. for authorisation need to be established.

4. Risk assessment and risk reduction
4.1 Equipment
4.1.1. Displays
Digital primary diagnosis at hospitals are usually completed using workstations on a fast network connection, and high quality displays - sometimes "medical grade" - which are high contrast, high resolution and bright displays, which are calibrated and quality controlled.

It is not known what the minimum specification of display screens should be for digital pathology, or how remote/home IT systems should be quality assessed for this purpose. Further research is needed in this area.

Home computers and laptops may have to have lower resolution, less contrast, and less consistent illumination than departmental digital pathology screens, and pathologists may find their ability to assess certain pathological features is compromised (examples are illustrated below). This particularly applies to older machines. This lower capability of certain displays is sometimes – but not always - readily apparent to the pathologist without side-by-side comparison of some images.

Paradoxically some modern consumer grade displays and portable/ mobile displays on high end laptops, tablets and phones have very high specifications and may be as good as if not better than some medical grade displays, although they may not have the same level of quality control and calibration as a medical grade display.

For reference, typical specifications for the medical grade displays used at Leeds, and a "consumer off the shelf" display evaluated in recent research are shown below, for reference (4). Please note that similar specifications do not mean equivalence of the displays in terms of diagnostic accuracy – this will require further validation and/or experimental work to establish. Similarly, for long term use some process for calibration and QA of displays is necessary.

	Medical grade (e.g. at Leeds Teaching Hospitals NHS Trust)	Consumer grade (highest preference score of nonmedical grade displays in testing [4])	Consumer grade more suited to home working due to lower resolution and physical size
Size (diagonal)	31 inches	32 inches	24 – 27 inches
Resolution	6 Megapixels	8 Megapixels	3-4 Megapixels
Contrast ratio	1500:1	1000:1	1000:1
Luminance (max)	1000 cd/m2	350 cd/m2	300 cd/m2
Luminance (setting)	400 cd/ m2	300 cd/m2	300 cd/m2
Colour calibration	Automatic Full colour calibration (sRGB <20%)	Regular calibration should be considered	Regular calibration should be considered
Example	Jusha C61	Philips BDM3275UP	e.g. Dell Ultrasharp U2719D
Comment	High end calibrated medical grade display	Consumer grade display which got highest scores in testing [4]	Typical consumer grade display practical and affordable for remote use

Pathologists should be aware that reporting on a home computer or laptop with a lower specification display may represent a higher risk than reporting using the departmental digital pathology system and display.

Further guidance on home reporting and recommended minimum specifications can be found in appendix B, which includes a link to access to a point of use QA tool for pathology. The tool tests colour accuracy, not diagnostic accuracy, and may be a useful indicator of the suitability of a particular screen for digital pathology diagnostics, but more work is needed to establish this.

Image: A Point of Use QA for pathology (POUQA) [5] See appendix B for the link. The image above is for illustrative purposes only – the live link should be used to test displays

4.1.2. Human interface devices and software

Pathologists should be aware that the software and "human computer interaction devices" (i.e. mouse/ trackball) used remotely may be different from the software used on site, and this may present a challenge in navigating digital slides (e.g. screening a whole slide for rare objects such as lymphovascular invasion)

4.1.3. Network connection

A digital pathology system comprises several elements from the image stored on the digital pathology storage system, through the network connection, to the user workstation and display.

In hospitals, network connections are typically 100 Mbit/sec to 1000 Mbit/sec. This network capacity can support multiple users on high resolution (6-8 Megapixel) displays.

Remote connections can be much slower, especially if running over an encrypted "virtual private network" for security. Hospitals may have limited bandwidth on their remote access connections, so may choose not to prioritise digital pathology as a service.

At the remote site or home environment, additional barriers to the connection speed could include the performance of the internal wireless network, reducing the overall speed of the connection.

If the overall connection speed is too slow, making the use of remote digital pathology difficult for anything but a small number of cases – some sites may prefer to ship glass slides to the home site.

In the experience of the committee, a typical home broadband connection of 15-20 Mbits/ second in the UK is acceptable with a lower resolution display (e.g. 2-4 megapixels); a higher resolution screen may suffer from lower performance as the connection to the digital pathology server in the hospital is insufficient to stream a higher resolution image, leading to a slower viewing experience or increased "pixellation".

4.2 Validation and training

The Royal College of Pathologists' supports the use of digital slides to make primary diagnosis and recommends a period of training and validation.[1] Digital primary diagnosis has been individually validated by a number of pathologists at many sites worldwide.

Generally, following a completed validation procedure, pathologists feel that 1-2% of digital cases require a secondary safety check on glass. Those that have not completed a validation procedure and have less experience of digital diagnosis may find more cases for which they are not confident to provide a definitive diagnosis.

Areas of diagnostic difficulty common to all specialties include, but are not limited to:
-   Assessment of dysplasia
-   Detection of metastasis and micrometastasis
-   Identification and assessment of mitotic figures
-   Identification and classification of granulocytes, particularly eosinophils -   Fine nuclear detail

A detailed list of areas of diagnostic difficulty arranged by topography can be found in appendix A, and more information on validation can be found in the relevant SOP, and a Leeds paper on the subject. [2]

Remote reporting of digital slides represents a higher level of risk for pathologists who have not completed and signed off a full validation procedure using the on-site system. This is because those pathologists who are "fully digital" in the department will likely be better placed to assess the risk of an individual case, based on their greater experience of comparing digital and microscope images, both during and after their validation.
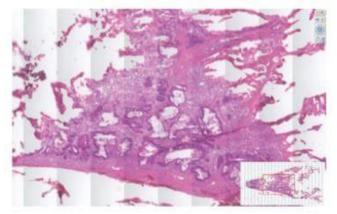
4.3 Digital slide quality

Digital slides produced in the laboratory are subject to quality control steps, but occasionally suboptimal slides are issued to e-Slide Manager. This may be especially true with frozen sections or hand-stained sections, which may be thicker and harder to scan.
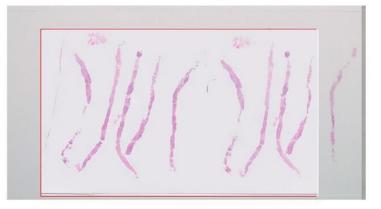
Glass slide artefacts including bubbles and tissue folds will be replicated on the digital slide, but in addition, digital slides may have focal areas which are out of focus and may exhibit striping artefact (see image below). Other artefacts include missing tissue (i.e. not all of the tissue on the slide is in the field of view on the digital image). This can affects pale slides such as those that are mainly adipose tissue more than other types of slides, but could affect other slides such as biopsies where tissue pieces are accidentally left out of the scan area. Pathologists need to be aware of this and have strategies to mitigate.

The pathologist will need to exercise professional judgement as to whether slide quality precludes diagnosis or initial assessment of a slide. They will need to contact the laboratory to arrange re-scanning of affected slides as appropriate.

Remote reporting of suboptimal digital slides represents a higher level of risk.

Example of a digital slide with prominent striping artefact. (Note the vertical stripes cutting through the tissue image.

Example of a digital slide in which not all the tissue has been scanned, but the "overview image" shows the missing area

4.4 Reporting environment

Environmental factors can impact upon your performance at the digital microscope [6]. Bright ambient lighting can negatively impact on ability to use digital slides, especially if the display being used is less bright. Natural light sources are potentially more impactful than most artificial light sources particularly on bright days. Positioning of the display in front of a window (so the user is looking at the screen and out of the window simultaneously), can inhibit performance more than other positions. A suitable blind or curtain can reduce ambient light and increase the relative luminance and contrast of the display.

Prolonged use of display monitors can result in fatigue, and remote reporting pathologists should exercise their judgement in when to take "screen breaks".

Pathologists reporting digitally remotely should consider the effects of ambient lighting and take regular screen breaks to avoid fatigue.

5. Conclusions

During periods of service need and clinical necessity, pathologists may request, or be requested, to work remotely. Digital slide reporting may help expedite assessment of urgent cases and help maintain pathology services.

If a pathologist wishes to provide diagnoses remotely using digital slides, they will need to assess the level of risk of doing so on a case by case basis, considering the factors outlined in this document. The scope of cases and scenarios suitable for remote reporting should be discussed beforehand, and the pathologist should use the following risk mitigating strategies where appropriate:

- Deferral to glass slides
- Referral for a second opinion
- Request for rescanning of suboptimal slides
- Informing requesting clinician of the relative risk of the assessment

As with on-site digital reporting, ongoing quality assurance of the process is recommended, for example by recording any discordances noted between the remote diagnosis and the subsequent final diagnosis.

References

1. Royal College of Pathologists. Best practice recommendations for implementing digital pathology. 2018. [Internet] Available from: https://www.rcpath.org/uploads/assets/f465d1b3-797b-4297b7fedc00b4d77e51/Best-practice-recommendations-for-implementing-digital-pathology.pdf

2. Williams BJ, Treanor D. Practical guide to training and validation for primary diagnosis with digital pathology. *J Clin Pathol* 2019. http://dx.doi.org/10.1136/jclinpath-2019-206319

3. Royal College of Pathologists guidelines on working from home, 3rd edition, April 2014 (https://www.rcpath.org/profession/guidelines/specialty-specific-publications.html)

4. Display Evaluation for Primary Diagnosis using Digital Pathology. Emily L Clarke , Craig Munnings, Bethany Williams , David Brettle, Darren Treanor *In press – link to follow*

5. Point of use quality assurance (POUQA) for digital pathology display evaluation. Available at http://www.virtualpathology.leeds.ac.uk/research/systems/pouqa/pathology/

6. Development and Evaluation of a Novel Point-of-Use Quality Assurance Tool for Digital Pathology Emily L. Clarke, David Brettle, Alexander Sykes, Alexander Wright, Anna Boden; Darren Treanor. https://doi.org/10.5858/arpa.2018-0210-OA

7. NHSX Information Governance Guidance (https://www.nhsx.nhs.uk/key-information-and-tools/informationgovernance-guidance)

8. GMC guidance on supporting doctors in the event of a COVID-19 epidemic https://www.gmc-uk.org/news/news-archive/supporting-doctors-in-the-event-of-a-covid19-epidemic-inthe-uk

Appendix A Areas of digital diagnostic difficulty, by topography

Histopathology subspecialty	Potential pitfalls
General	Identification and grading of dysplasia
	Identification of lymph node metastasis and micrometastasis
	Identification and quantification of mitotic figures
	Identification of granulation tissue
	Identification of micro-organisms
Breast	Identification and grading of nuclear atypia
	Identifying microinvasion and lymphovascular space invasion
	Identification of lobular carcinoma
	Grading invasive cancers (mitotic count component)
	Identification of weddelite calcification
	Identification of sentinel lymph node metastasis/micrometastasis
Skin and soft tissue	Identification and grading of squamous dysplasia
	Micro-organism detection
	Granulomatous inflammation
	Melanocytic lesions
	Granulocyte identification and classification
	Identification of sentinel node metastasis
	Identification of amyloid
	Identification of lymphoproliferative disease/malignancy
Endocrine	Identification of granulomata
	Identification of lymph node metastasis
	Identification of amyloid in medullary carcinoma of the thyroid
	Classification of thyroid neoplasms- identification of cellular papillary features
	Identification of mitoses and atypical mitoses
Genitourinary	Identification and grading of urothelial dysplasia
	Identification of micro-organisms
	Identification of granulomatous inflammation
	Identification and classification of inflammatory cells (especially granulocytes)
	Identification of amyloid
	Identification of lymphoproliferative disease/malignancy
	Grading renal carcinoma (nuclear features)

Gastro-intestinal	Identification and grading of oesophageal dysplasia
	Identification of focal activity in inflammatory bowel disease
	Identification of eosinophils in oesophageal biopsies
	Identification of granulomata
	Identification of micro-organisms – particularly Helicobacter pylori
Gynaecological	Identifying and grading cervical dysplasia
	Identifying metastasis/micrometastasis
	Assessing endometrial atypia
	Identifying mitotic figures (particularly in soft tissue uterine lesions
	Identifying mucin
Head and neck	Identification and grading of squamous dysplasia
	Identification of micro-organisms including fungal forms
	Identification of granulomata
	Identification and typing of inflammatory cells
Hepatobiliary/pancreatic	Interpretation of liver special stains
	Identification of dysplastic epithelium (particularly gall bladder)
	Identification and typing of inflammatory cells
	Identification of granulomata
Neuropathology	Identification and assessment of mitotic figures
	Identification of necrosis
	Identification of eosinophilic granular bodies
	Assessment of nuclear features
Cardiothoracic	Identification of dysplasia/malignancy in small biopsy specimens
	Identification of micro-organisms including mycobacteria
	Identification of granulomatous inflammation
	Identification of micrometastasis in EBUS specimens

Appendix B: Suggested display requirements for remote reporting of digital pathology

In the absence of sufficient experimental work to evaluate the minimum specifications for digital pathology displays, we recommend the following display specifications as a minimum, based on a pragmatic approach and results of initial testing from [4]

Display requirements

- Maximum luminance (brightness) of 350 cd/m^2 or greater.
- Resolution 3 Megapixels or greater (a typical microscope is an equivalent of 10 Megapixels, approximately)
- A size of 24 inches or more for a desktop display provides most comfortable experience

Display adjustment

- Ideally use display curve gamma 2.2
- If you can change the colour space and are using a web browser to view images select sRGB
- Adjust contrast and brightness using the monitor on-screen display so you can simultaneously see both the 5% black and 5% white squares
- Select brightness to a comfortable level whilst still being able to see the 5% squares
- Avoid reflections from windows/lamps, angle the screen to avoid these, preferably view in dimmed lighting conditions.

Display quality assurance

- Check you can see all four letters on the point of use QA tool provided by NPIC (http://www.virtualpathology.leeds.ac.uk/research/systems/pouqa) this should be checked regularly – e.g. every few weeks, or for each reporting session if the viewing environment has changed

  If you are unable to cannot pass the POUQA test:
  - Recheck the display adjustment.
  - If possible try another display.
  - Consider altering the environmental lighting (e.g. draw the blinds)
  - If urgent proceed with reporting but be aware you might miss some features and you can use the software brightness and contrast controls to see into areas of concern. (On a LCD display try moving your head to the sides to increase contrast)

- Use a commercial screen wipe to clean the display regularly

  (If you have no commercial screen wipes get three **soft** paper towels. Moisten one towel (you should not be able to easily squeeze out any drops of water) and put on a very small drop of washing up liquid, wrap this in another towel and clean the display in circular patterns, buff off with the third towel)