1-20-2020

Remote Access for Whole Slide Imaging: Resident Group Experience

Ifeoma Onwubiko

Rand Abou Shaar

J. M. Tuthill

Ashish Mishra

3. Varghese F, Bukhari AB, Malhotra R, De A. IHC profiler: An open source plugin for the quantitative evaluation and automated scoring of immunohistochemistry images of human tissue samples. PLoS One 2014;9:e96801.
4. Aeffner F, Wilson K, Martin NT, Black JC, Hendriks CLL, Bolon B, *et al.* The gold standard paradox in digital image analysis: Manual versus automated scoring as ground truth. Arch Pathol Lab Med 2017;141:1267-75.
5. Taylor CR, Levenson RM. Quantification of immunohistochemistry – issues concerning methods, utility and semiquantitative assessment II. Histopathology 2006;49:411-24.
6. Bankhead P, Fernández JA, McArt DG, Boyle DP, Li G, Loughrey MB, *et al.* Integrated tumor identification and automated scoring minimizes pathologist involvement and provides new insights to key biomarkers in breast cancer. Lab Invest 2018;98:15-26.
7. Meyerholz DK, Beck AP. Principles and approaches for reproducible scoring of tissue stains in research. Lab Invest 2018;98:844-55.
8. Bankhead P, Loughrey MB, Fernández JA, Dombrowski Y, McArt DG, Dunne PD, *et al.* QuPath: Open source software for digital pathology image analysis. Sci Rep 2017;7:16878.

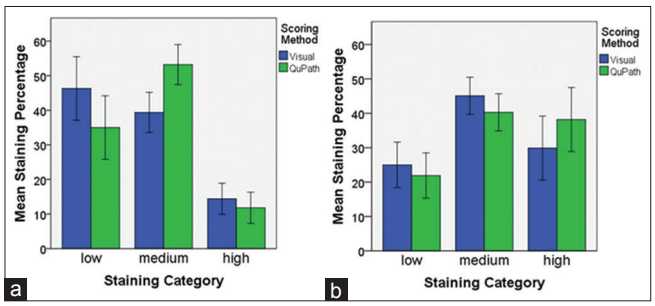

Figure 1: Comparison of staining mean (±SE) between visual scoring and QuPath by staining category. (a) VSM analysis. Comparison of scoring methods between low, medium, and high intensity staining produced *P*-values of 0.383, 0.079, and 0.689, respectively. (b) EVT analysis. Comparison of scoring methods between low, medium, and high intensity staining produced *P*-values of 0.446, 0.345, and 0.288, respectively

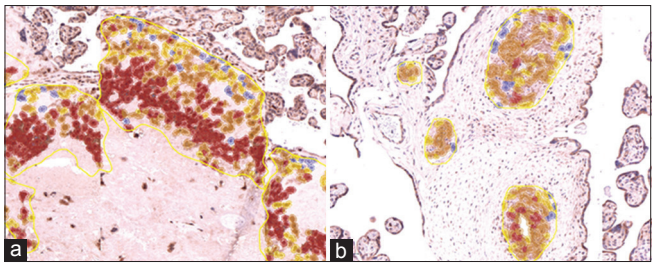

Figure 2: Representative images of QuPath analysis of GPR18 in placental tissue using object tool. Cell segmentation with intensity expression into: Negative (blue), low (yellow), medium (orange), and high (red). (a) EVT analysis (b) VSM analysis

Remote Access for Whole Slide Imaging: Resident Group Experience

Ifeoma Ndidi Onwubiko[1], Rand Abou Shaar[1], Ashish Mishra[1], J. Mark Tuthill[1]

[1]Department of Pathology and Laboratory Medicine, Henry Ford Hospital Health System, Detroit, Michigan, USA. E-mail: ionwubi1@hfhs.org

Background: The introduction of digital pathology slides produced from scanning conventional glass slides also referred to as Whole Slide Imaging (WSI) in the late 1990s has gradually gained more acceptance by pathologists. Most modern WSI instruments are capable of producing high-resolution digital slides within minutes. WSI compared to static digital images are preferred for diagnostic, educational, research purposes providing an opportunity to expand user tools including digital annotation, rapid navigation, magnification, viewing and analysis. At Henry Ford Health System, residents in the department of Pathology and Laboratory Medicine have successfully utilized WSI in tumor board preparation, multidisciplinary team meeting presentations, unknown conferences, Performance Improvement Program (PIP) presentation, gross conferences, frozen section, autopsy conferences, digital gross conferences and research projects. Despite its extensive usage, residents performed all WSI functions with the hospital, increasing residents' duty hours. In this study, we proposed providing remote access to WSI to all residents by providing VPN enabled secure remote access to WSI. **Methods:** We surveyed all residents (n=14) [Table 1] at the Department of Pathology and Laboratory Medicine, Henry Ford Hospital prior to granting VPN enabled remote access to WSI. **Results:** Analysis of data collated revealed 100% resident use of WSI digital pathology in daily work flow. 100% of the residents indicated that remote access to WSI is perceived to improve their time management with digital pathology slide review. All 14 residents used WSI for several functions including: unknown teaching slides (79%, n=11), tumor boards presentations (64%, n=9), research projects (43%, n=6), picture taking (57%, n=8) and for other educational purposes not specified (43%, n=6) [Figure 1]. 57% expressed frustration with making extra-trips to hospital for slide review [Figure 2]. 79% of the residents spent additional time to review slides after duty hours out of which to 21% of the residents spent more than two hour per weekend visit review [Figure 2]. **Conclusion:** We anticipate that providing residents remote access to WSI will reduce after duty hours spent on work related activities, resident frustration and improve time management and wellbeing. The overall usage of the system is projected to significantly reduce resident on site work hour. The typically highest usage of the system was for unknown educational slides.

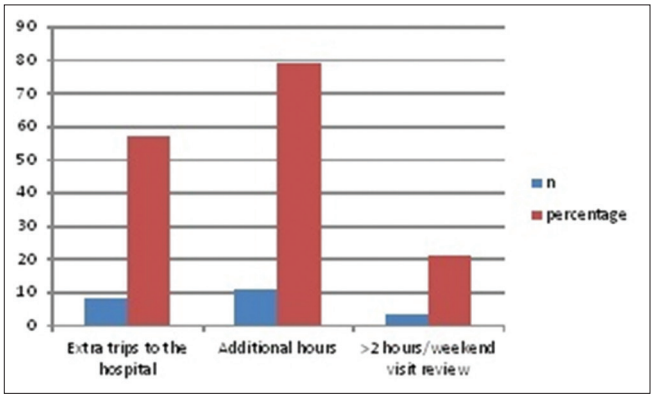

Figure 1: Dissatisfaction from slide review outside regular duty hours. Reference Onwubiko. 2019

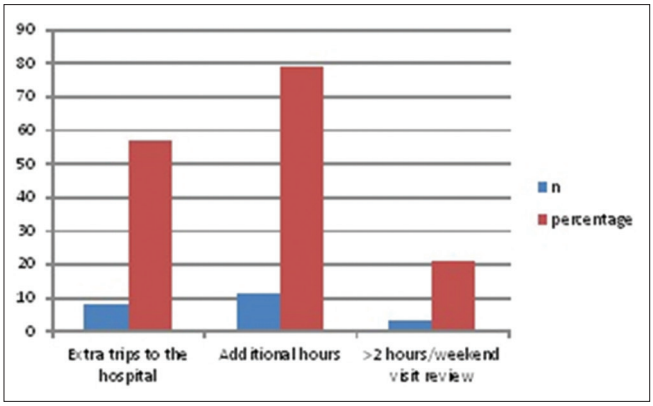

Figure 2: Dissatisfaction from slide review outside regular duty hours. Reference Onwubiko. 2019

Table 1: Resident composite by year of training

Year of training	n
First	4
Second	2
Third	4
Fourth	4

Reference: Onwubiko. 2019

Performance Assessment of Various Digital Pathology Whole Slide Imaging Systems in Real-Time Clinical Setting

Sathyanarayanan Rajaganesan[1], Rajiv Kumar[1], Vidya Rao[1], Trupti Pai[1], Neha Mittal[1], Ayushi Shahay[1], Santosh Menon[1], Sangeeta Desai[1]

[1]Department of Pathology, Tata Memorial Centre, Mumbai, Maharashtra, India.
E-mail: sathyanmkl@gmail.com

Introduction: Increasing interest in the validation of available digital-pathology systems (DPSs), before adopting in clinical setting is observed recently. However, limited information on comparative performance-assessment of these DPSs is available. In order to make the suitable decisions and judicious investments related to appropriate hardware and software implementation, it would be prudent to undertake a comprehensive evaluation of the various whole slide imaging (WSI) platforms. **Aims and Objective:** 1) To perform the real-time comparative evaluation of various DPSs to assess their technical performances 2) To evaluate the compatibility of DPSs to handle different type of pathology specimen i.e., Biopsy, Resection specimen, Frozen, IHC & Cytology 3) To evaluate the diagnostic accuracy, inter-observer and intra-observer concordance 4)To identify which technologies (software and hardware) were associated with the effective use of digital imaging. **Materials and Methods:** We performed a comprehensive real-time comparative evaluation of 4 different DPSs (Anonymized as DPS:1,2, 3 & 4) using a total 240 cases (604 glass slides) comprising of 60 cases in each specimen categories (i.e. Biopsy, Resection specimen, Frozen & Cytology) and assessed by 7 pathologists (Two specialist and Five general). Cases of four organ systems i.e. Breast, Thoracic, Gastrointestinal tract (GIT) and Genito-urinary tract (GUT) were included in this evaluation. Each platform was evaluated after a minimum wash-off period of 2 weeks. **Results:** A total 2376 digital images were generated using 4 DPSs (excluding 40 failed scans) and a total of 15,575 image reads [(OM and WSI) were evaluated and subsequent results were recorded as: 1. Onsite technical evaluation of digital scanner's capability: The technical specifications onsite evaluation was performed as follows: a) Slide Scanning Performance: The first time successful scanning rate for all specimen types except cytology followed the sequence (Maximum to minimum): Scanner 1> Scanner 4> Scanner 2> Scanner 3. Besides scanner 1, all other scanners had difficulty in handling of the cytology slides especially scanner 2(41% failure rate). b) Scanning time: The mean scanning time per slide followed this sequence (minimum to maximum): Scanner4> Scanner1 > Scanner 2> Scanner 3 c) Storage space: Overall digital image output from the scanner 3 occupied least space, across all specimen type, followed by scanner 2 > scanner 1> scanner 4. Interestingly, among the specimen type, cytology slides took more time to scan and for storage as opposed to the H&E and IHC slides. Further, the mean time to scan and for storage for IHC slides was significantly less when compared to the corresponding H&E slides. 2. Diagnostic accuracy for WSI versus OM: Overall diagnostic accuracy when compared with reference standard for OM and WSI was 95.44% and 93.32% respectively. The discordance rate for OM was 4.56% (including 2.48% minor and 2.08% major discordances) and for WSI was 6.68(including 4.28% minor and 2.4% major discordances). Both inter as well as intra observer agreement between WSI and OM for primary diagnosis of biopsy, resection and frozen specimen was substantial to near perfect agreement. WSI was inferior to OM for the primary diagnosis of cytology specimens. Diagnostic assessment time required for OM was less as opposed to WSI across all specimen types. Assessment of digital image quality and level of confidence: a) The overall image quality was best in scanner1. No statistically significant correlation between the number of discrepancies and image quality of particular scanner could be established. b) Colour Variation in WSI: The scanner 1 and 2 were almost consistent in reproducing the original colour of the glass slides c) Digital artifacts: Mean digital image artifacts rate was 6.8% (163/2376 digital images) across all the scanners. Maximum number of digital artifacts were noted in scanner 2(n=77) followed by scanner 3(n=36). Common artifacts were out of focus images (either focal or diffuse); observed in H& E slides on scanner 4 and 3 and stitching errors; in cytology/H&E slides on scanner 2. d)Image viewer software: Most of the pathologists preferred viewing software of scanner 1 and scanner 2, as the pattern of case arrangement and display resembled like routine OM