A static-image telepathology system for dermatopathology consultation in East Africa: The Massachusetts General Hospital Experience

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Background: The histologic diagnosis of skin lesions in the developing world is complicated by the shortage of pathologists with subspecialty training in dermatopathology, limited access to ancillary diagnostic testing, and costly referrals for expert glass slide consultation in challenging cases.

Objective: In this study we evaluate the feasibility of a static-image telepathology platform in Africa for performing accurate dermatopathology consultations.

Methods: A static-image telepathology platform using the iPath server was utilized by referring pathologists in 4 African hospitals. Diagnostic interpretations were provided by Massachusetts General Hospital dermatopathologists at no cost. The diagnostic accuracy and interobserver correlation was evaluated.

Results: The static histopathologic images were diagnostic in 22 of 29 (76%) cases. Diagnostic accuracy between static image and glass slide diagnosis in 22 cases was 91%, ranging from 86% to 95% according to years of dermatopathology subspecialty expertise. Comparison with the glass slides showed that the telepathology diagnosis was limited by inappropriate field selection in only one case. Interobserver concordance between two pathologists was high (K = 0.86) suggesting that this platform is easy to use with minimal training of both referring and consulting pathologists.

Limitations: Concordance between conventional microscopy and static image telepathology was performed in 22 of 29 cases for which glass slides were received. Interobserver concordance was performed for two pathologists.

Conclusion: Static-image telepathology is a feasible means of rendering diagnoses on dermatopathology cases and is a cost-effective technology for obtaining much-needed second opinions in resource-poor settings. (J Am Acad Dermatol 2011.12.036.)

Key words: cost-effective; dermatopathology consultation; resource-poor setting; static-image; telepathology.

INTRODUCTION
The histologic diagnosis of skin lesions in the developing world is complicated by several factors, including shortage of pathologists, lack of subspecialty dermatopathology training, limited access to ancillary diagnostic testing such as immunophenotypic and molecular diagnostic testing, and prohibitive costs associated with ancillary studies.
and shipping glass slides to referral centers for consultation. Limited access to local subspecialty-trained dermatopathologists and other subspecialists for consultation poses further constraints to pathologists dealing with challenging skin cases, and the cost and time associated with sending glass slides to referral centers for expert opinion is often too expensive for routine use.

Telepathology, or pathologic diagnosis based on examination of digital images of histologic slides viewed from a remote location, holds promise as an efficient, cost-effective means of providing subspecialized pathology consultation over large distances. Telepathology technology has evolved from static-image based systems to whole slide scanning. Static image telepathology involves the transfer of individually captured digital images of histologic slides. These images are then transmitted via the Internet for viewing by consulting pathologists, who can be thousands of miles away from the referring pathologist. This technology is relatively simple and requires a microscope, microscope-based digital camera, personal computer, and Internet connection accessible by the referring and consulting pathologists. This set-up requires a one-time fee to acquire the necessary equipment and does not incur a cost to the referring physicians for each consultation, making it accessible to physicians in resource-poor settings. It also eliminates the cost and time associated with shipping glass slides to a referral institution, making it an attractive alternative to more cost-prohibitive, traditional methods of sending cases for second opinion.

Several technologies exist that enable whole-slide digital review via telepathology. Robotic telepathology systems allow the operator to control the microscope from a remote location in real-time for synchronous consultation of slides. This technology allows consulting pathologists full control of the microscope, enabling them to examine the entire slide digitally with control over slide movement and magnification. Robotic telepathology offers the advantage of whole-slide examination over static-image telepathology, but requires more costly equipment and greater technical training of the pathologist in a resource-challenged setting because of the lack of funding and/or training available for technical support personnel. Whole slide scanning generates digital images of entire slides and produces a digital replica of the slide in which the consulting pathologist can view any field at any magnification via a computer. Compared with static-image telepathology, whole slide imaging technology offers the advantage of consultants having access to the entire slide and the ability to manipulate the field of view and magnification themselves. A major disadvantage of whole slide imaging is the enormous cost associated with acquiring and maintaining the equipment and the large amount of data transmitted via the Internet that is required for its use.

Many studies have previously validated the performance of static-image and virtual whole slide telepathology compared with traditional microscopy for general and subspecialty surgical pathology and frozen section specimens. In addition, concordance between light microscopy and static-image telepathology has been extensively documented for a variety of dermatopathology entities. However, only a few studies have evaluated the feasibility and utility of teledermatopathology consultation for hospitals and pathologists located in resource-poor settings. We describe our experience with using an asynchronous static-image telepathology program to provide second-opinion consultation at no cost to pathologists affiliated with a regional network of 4 hospitals in East Africa, with particular focus on dermatopathology consultations. The two countries within the hospital network (Kenya and Tanzania) have a combined population of approximately 80 million inhabitants served by a total of only 40 pathologists (ie, 1 pathologist for every 2 million inhabitants). Because of the absence of pathology fellowship training programs in the region, patients have limited access to subspecialty pathology consultation in areas such as dermatopathology, cytopathology, and hematopathology, as well as most other subspecialties within surgical pathology. In addition, immunohistochemistry, a diagnostic test considered routine in North America and Europe, is available in only a minority of laboratories and the
staining panel offered is relatively limited. Our study illustrates an important need for dermatopathology subspecialty consultation in resource-poor settings that may be effectively addressed by telepathology systems such as the one we describe, from the standpoint of both diagnostic accuracy and cost. The benefits of this exchange to both the referring and consulting physicians are discussed. We also explore potential limitations of static-image telepathology in rendering dermatopathologic diagnoses.

METHODS

The study design was reviewed and approved by the Massachusetts General Hospital Institutional Review Board (protocol #P001815) and classified as an evaluation for service formally exempt from review by the Aga Khan University Hospital Research Committee. Referring pathologists trained in image acquisition selected cases requiring second-opinion consultation after examination of original hematoxylin-eosin (H&E)-stained slides prepared in their local histology laboratories and determined the fields and magnifications to be photographed (Fig 1, A). Static images were captured by microscope-mounted digital cameras (Olympus Q-color 3, 3.2 Megapixels, Olympus America Inc, Center Valley, Pennsylvania; http://www.olympusmicro.com/brochures/pdfs/qcolor3.pdf or SPOT Insight, 2 Megapixels, SPOT Imaging Solutions, Diagnostic Instruments, Inc, Sterling Heights, Michigan; http://www.spotimaging.com/downloads/public/pdf/IN1820.pdf) and uploaded to the iPath (http://telemed.ipath.ch/rahp/) or subsequently, the iPath-2 (http://ipath.aku.edu/rahp/) telepathology servers. The iPath Web sites are open-source teledmedicine platforms that allow referring pathologists to upload histologic images, as well as associated clinical information, clinical photographs, and radiology images (Fig 1, B).11,12 The iPath system can be set up to send users an e-mail alert each time a new case is posted or a new comment is added to a case. The uploaded clinical information, available clinical photographs, and histologic H&E images were reviewed by a triage pathologist at the Massachusetts General Hospital (MGH), who then referred the case to subspecialists within the pathology department depending on the type of case posted, including two Board-certified dermatopathologists.

Following review of the information provided for each case, pathologists at MGH rendered a diagnosis that was uploaded to the iPath Web site for viewing by the referring pathologist. For responses to cases in which a definitive diagnosis was possible, consulting pathologists were asked to include an educational component, such as discussion of the differential diagnosis or diagnostic pearls and pitfalls, references from the published literature, and/or treatment recommendations if applicable. In cases for which definitive diagnosis was not possible, discussion of entities in the differential diagnosis, along with recommendations for further diagnostic work-up, were provided. In nondiagnostic cases, additional clinical information or images (ie, if suboptimal quality or representative fields not appropriately selected) could be requested.

In order to evaluate diagnostic accuracy between static-image and conventional microscopy for dermatopathology cases, glass slides were reviewed by the same dermatopathologists who previously rendered an opinion based on digital images. Concordance was performed for all cases in which the glass slides were subsequently received. The consulting dermatopathologists were blinded as to the original diagnoses rendered using static-image telepathology and reviewed the glass slides after a period of 5 to 32 months, allowing for an appropriate “wash-out” time between digital and conventional microscopic evaluation. The level of diagnostic accuracy between digital and glass slide microscopic (intraobserver agreement) was determined using the precision of estimate and 95% confidence interval (CI).13 The level of concordance (interobserver agreement) for each case was determined using the kappa statistic (K).14

RESULTS

Since the telepathology program was established 3 years ago, 29 dermatopathology cases have been submitted for second-opinion consultation. Dermatopathology represents the most common surgical pathology subspecialty in which second-opinion teleconsultation has been sought (29/109 cases, 26.6%). The dermatopathology cases were posted by 5 pathologists, based at 4 different hospitals in Kenya and Tanzania. The majority of the cases (24/29, 82%) originated from two centers, one located in Kisumu in the Western Province of Kenya (12/29, 41%) and the other in Dar es Salaam, the largest city in Tanzania (12/29, 41%).

The cases submitted were divided into neoplastic (N = 10/29, 35%) and inflammatory (18/29, 62%)

Abbreviations used:
CI: confidence interval
H&E: hematoxylin-eosin (stain)
K: kappa (statistic)
MGH: Massachusetts General Hospital
TAT: turn-around time
categories, with one combined neoplastic/infectious case (N = 1/29, 3%) (Table I). The average number of images submitted per case was 11 (range of 4 to 23 images). Twenty-one of 29 cases (72%) submitted included H&E images only, and 8 of 29 (28%) cases included both H&E and digital clinical photographs (Fig 2). The average turn-around time (TAT) from date of referral to date of diagnosis rendered was 7 days. A sample clinical image and static histopathology image received for consultation (Table I, case 5) is shown in Fig 3 (A and B).

The static histopathologic images were diagnostic in 22 of 29 cases (76%) (Fig 4). Seven of these were neoplastic cases and 15 were inflammatory diseases. Glass slides were subsequently received for review in 18 of the 22 cases determined to be adequate for diagnosis based on the static images alone. For the remaining 7 cases, lack of clinical information, poor quality of images, or unavailability of immunohistochemical studies rendered 5 cases (17%) partially diagnostic and 2 cases (7%) nondiagnostic. In 1 of 2 nondiagnostic and 5 of 5 partially diagnostic cases, an educational component was provided in the response, including a discussion of the differential diagnosis, request for more tissue for histologic evaluation, additional studies such as immunohistochemistry, or need for additional clinical information. Glass slides were subsequently received for review in 2 of 5 partially diagnostic cases and 2 of 2 nondiagnostic cases.

The kappa coefficient for interobserver agreement for two pathologists was 0.86, which corresponds to “almost perfect agreement” for the diagnoses in 22 cases in which glass slides were available for review (glass slides were not received for 7 additional cases for which teledermatopathology consultation had previously been provided).  
14 The overall diagnostic accuracy between the static telepathology and glass slide diagnosis was 91% (95% CI: 88-94). Of note, diagnostic accuracy ranged from 86% to 95% for two pathologists and correlated to years of experience in dermatopathology, with the more experienced dermatopathologist exhibiting the higher diagnostic accuracy.
<table>
<thead>
<tr>
<th>Case</th>
<th>TAT (days)</th>
<th>No. of images</th>
<th>Age (y)</th>
<th>Gender</th>
<th>History</th>
<th>Cutaneous site</th>
<th>Final diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>10</td>
<td>U</td>
<td>U</td>
<td>Small mole, pruritus × 1 month. Gross findings: fragment of brown-black skin measuring 2×2×1.5 cm</td>
<td>L side of abdomen</td>
<td>Pigmented irritated seborrheic keratosis</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>5</td>
<td>30</td>
<td>F</td>
<td>Chronic hyperpigmented recurrent skin lesions on anterior and posterior chest wall, with pruritus and lichenification</td>
<td>Trunk</td>
<td>Chronic eczematous dermatitis</td>
</tr>
<tr>
<td>3</td>
<td>14</td>
<td>12</td>
<td>11</td>
<td>M</td>
<td>Papular, nonpruritic, nonscaly scalp lesions. Had prior biopsy of same site reported as nonspecific inflammatory dermatitis. Fungal stains negative.</td>
<td>Scalp</td>
<td>Lichen planopilaris</td>
</tr>
<tr>
<td>4</td>
<td>24</td>
<td>6</td>
<td>2</td>
<td>F</td>
<td>Mass</td>
<td>R thigh</td>
<td>Myoepithelioma vs hamartoma w/myoepithelial features</td>
</tr>
<tr>
<td>5</td>
<td>21</td>
<td>21</td>
<td>34</td>
<td>M</td>
<td>HIV positive, numerous lesions on bilateral hands and legs × 3 months, painful, itchy, burning</td>
<td>Extremity</td>
<td>Kaposi sarcoma</td>
</tr>
<tr>
<td>6</td>
<td>7</td>
<td>11</td>
<td>45</td>
<td>M</td>
<td>HIV negative</td>
<td>Lower extremity</td>
<td>Fibrohistiocytic tumor vs vascular tumor (eg, solid Kaposi sarcoma vs angiosarcoma)</td>
</tr>
<tr>
<td>7</td>
<td>25</td>
<td>21</td>
<td>55</td>
<td>M</td>
<td>HIV status not known</td>
<td>Lower extremity</td>
<td>Mild chronic eczema</td>
</tr>
<tr>
<td>8*</td>
<td>3</td>
<td>8</td>
<td>38</td>
<td>M</td>
<td>HIV+ on HAART. Recent CD4 count: 376. Macular hyperpigmented, lichenified lesions on lower limbs and feet</td>
<td>Lower extremity</td>
<td>Kaposi sarcoma w/concurrent molluscum contagiosum</td>
</tr>
<tr>
<td>9</td>
<td>5</td>
<td>7</td>
<td>19</td>
<td>M</td>
<td>Large recurrent ulcerated scalp lesion</td>
<td>Scalp</td>
<td>Epithelioid tumor, nature uncertain</td>
</tr>
<tr>
<td>10</td>
<td>3</td>
<td>7</td>
<td>26</td>
<td>M</td>
<td>Cyst</td>
<td>Finger</td>
<td>Papillary eccrine adenoma</td>
</tr>
<tr>
<td>11</td>
<td>1</td>
<td>10</td>
<td>38</td>
<td>M</td>
<td>Gross findings: skin ellipse 3 × 2.2 × 1.5 cm w/a rough slightly raised surface about 1.7 cm in diameter. Cut surface showed a white thickened dermis.</td>
<td>Upper arm</td>
<td>Atypical granular cell tumor</td>
</tr>
<tr>
<td>12</td>
<td>0</td>
<td>8</td>
<td>0.4</td>
<td>F</td>
<td>Lesion × 3 mo. Gross findings: ulcerated skin ellipse measuring 2.3 × 0.9 cm excised to a depth of 0.7 cm. Cut surface firm and yellow.</td>
<td>Scalp</td>
<td>Juvenile xanthogranuloma</td>
</tr>
<tr>
<td>13</td>
<td>5</td>
<td>14</td>
<td>9</td>
<td>M</td>
<td>Anterior mid-suprapubic skin/subcutaneous mass. Gross findings: 2.5 × 1.3 × 1.2 cm skin ellipse w/a central elevated lesion measuring 1 cm. Cut section of lesion is solid, gray-white.</td>
<td>Suprapubic subcutaneous mass</td>
<td>Langerhans cell histiocytosis (histiocytosis X)</td>
</tr>
<tr>
<td>14</td>
<td>1</td>
<td>18</td>
<td>60</td>
<td>F</td>
<td>Hypopigmented patch × 6 years. No ulceration. Associated w/pruritus and pain.</td>
<td>Perianal skin</td>
<td>Lichenoid and perivasculary lymphohistiocytic infiltrate w/numerous admixed plasma cells and overlying lichen simplex chronicus</td>
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<table>
<thead>
<tr>
<th>Case</th>
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<th>Final diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>8</td>
<td>Adult M</td>
<td>19</td>
<td>Clinical diagnosis: phimosis w/ nodular “leucplastic” prepuce.</td>
<td>Penile foreskin, prepuce</td>
<td>Spongiosis, atrophy, prominent vessels, and numerous plasma cells. Histopathologic differential diagnosis includes (1) Zoon’s balanitis (balanitis xerotica obliterans); (2) lichen planus—like eruption (could be related to a drug); (3) secondary syphilis (serology recommended); (4) lupus; (5) cannot exclude cutaneous T-cell lymphoma.</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>8</td>
<td>Adult M</td>
<td>22</td>
<td>Immunocompromised patient, on anti-retrovirals, w/ multiple hyperpigmented lesions on body</td>
<td>L hand, dorsum</td>
<td>Eosinophil-rich intraepidermal vesiculobullous disease. Differential diagnosis: (1) dermatitis (contactant, id reaction, arthropod bite, allergic). Of these, favor arthropod bite and allergic/id reaction because of the depth of infiltrate; (2) bullous pemphigoid (need clinical correlation; (3) pemphigus vegetans (need clinical correlation). Typically, (2) and (3) above would require direct immunofluorescence studies for confirmation.</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>4</td>
<td>Adult F</td>
<td>10</td>
<td>Extensive scaly eruptions over nose, gluteal region, and arms for past 3 months. Rule out psoriasis.</td>
<td>Site unspecified</td>
<td>Superficial capillary plexus abuts the epidermis and there are scattered apoptotic keratinocytes. If the lesions represent treated psoriasis (favored), this would be the only residuum. The differential diagnosis includes a mild eczematous dermatitis, possibly id reaction, on the basis of slight spongiosis, perivascular lymphocytic infiltrate, and parakeratosis.</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>9</td>
<td>Adult F</td>
<td>21</td>
<td>Hyperpigmented nodular lesions on leg below knee and another lesion on nape of neck since 2004, on and off. They started as papular lesions, gradually developing into this. She has used several medicines including local steroids (details not known).</td>
<td>Leg</td>
<td>Hypertrophic lichen planus vs prurigo nodule w/ postinflammatory hyperpigmentation.</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>9</td>
<td>Adult F</td>
<td>23</td>
<td>Symmetrical skin lesion on lateral aspects of both feet. Not itchy or painful, no drug or insect bite history; lesions present since 2003, gradually increasing in size</td>
<td>Lower extremity</td>
<td>Lichen simplex chronicus</td>
<td></td>
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DISCUSSION

Static-image telepathology is a feasible means of rendering diagnoses on dermatopathology cases and is a cost-effective technology for obtaining much-needed second opinions in resource-poor settings. Herein, we show that: (1) a relatively large number of surgical pathology cases submitted for teleconsultation were dermatopathology cases; (2) the diagnostic accuracy between static image and glass slide diagnosis was high (91%), suggesting that sampling bias...
is not a major limiting factor in static image telepathology; and (3) the interobserver concordance was high (K = 0.86), suggesting that this platform is easy to use with minimal training of both referring and consulting pathologists.

Our interobserver concordance rate between two pathologists is similar to that of previous reports examining the use of telepathology in dermatopathology. The two cases for which there was diagnostic discordance between two pathologists were rare and challenging histopathologic diagnoses. Specifically, these were: (1) acrokeratosis verruciformis of Hopf, an uncommonly encountered genodermatosis and (2) a case of lichen planopilaris with subtle histopathologic findings. Of note, a third instance of telepathology and glass slide discordance was a case of toxic epidermal necrolysis for which the diagnostic field was not included among the static telepathology images and only appreciated on glass slide examination (Fig 5, A). Notably, the diagnostic field was a separate small fragment of tissue on the glass slide (Fig 5, B and C). Our reported diagnostic accuracy is comparable to that reported for telecytology, in which percent agreement with consensus diagnoses on glass slides varied from a mean of 78% (range: 71%-83%) for junior pathologists (n=3, mean: 2 years of experience) to 86% (range: 82%-93%) for senior and/or subspecialized pathologists (n = 3, mean: 22 years of experience).16 In addition to years of experience in performing glass slide diagnoses, an individual consultant’s comfort level with performing diagnostic interpretations based on digital images may also affect diagnostic accuracy.17

The level of diagnostic accuracy in our teledermatopathology study is similar to that of previous reports by others in frozen-section specimens (85% to 99%),18-20 cytopathology specimens (80.9% to 94%),21,22 and subspecialized surgical pathology settings, including pulmonary pathology (99%).23,24 Berman, Elgart, and Burdick24 showed an 80% concordance rate using static-image telepathology compared with 99% concordance using conventional...
glass-slide microscopy. Piccolo et al6 also showed similar results in their study of concordance between telepathology diagnosis and conventional microscopy diagnosis of 20 randomly selected, previously diagnosed dermatopathology cases. They reported 78% accuracy for static-image-based telepathology diagnosis compared with 85% for diagnoses based on conventional microscopy. They noted that store-and-forward static image telepathology is particularly useful in small biopsies, where sampling bias and field selection may not be as significantly problematic as in larger specimens.

Nonetheless, several studies have identified factors that potentially limit definitive diagnosis based on static-image telepathology, which can be considered technical or diagnostic in nature.1,2,4,6,8,9,25,26 Technical factors include field selection error, inadequate photographic sampling, and poor image quality. In our study, field selection error was identified as the major contributing factor in the initial misdiagnosis of the toxic epidermal necrolysis case (Table I, case 26), in which the diagnostic area was not present in static telepathology images submitted for review. Poor image quality was an additional technical factor impeding diagnosis of a telepathology case encountered in our experience (Table I, case 29). In this case, the nature of the epithelial proliferation, while favored to represent seborrheic keratosis, could not be determined with certainty on the basis of the static-telepathology images alone. This may have been due to the use of a lower resolution camera at this site (2 megapixels) compared with the remaining 3 sites (3.2 megapixels). However, on the basis of previous reports which have established a minimum resolution of 1.9 megapixels27 and the frequent use of 1.3 megapixel resolution for static teledermatopathology image acquisition systems,27,28 the poor image quality in this case may have been due to photographic technique. These technical deficiencies can be mitigated by feedback from the consulting pathologists to the referring pathologists. Diagnostic factors include areas in which diagnostic criteria are contentious (eg. grading dysplastic nevi), or lesions in which subtle cytologic or architectural features must be assessed to arrive at a diagnosis (eg. inflammatory conditions).2

Many of the technical factors that have been identified as limitations of static-image telepathology are mitigated by robotic and whole-slide imaging telepathology systems, which enable the consulting pathologist to view a digital image of an entire slide with full control over field selection and magnification. For this reason, whole-slide imaging technology has been favored over static-image telepathology. While this technology offers the advantage of providing a digital image of the entire glass slide, whole-slide imaging technology is impractical in developing countries because of the prohibitive cost associated with acquiring the necessary equipment (ranging from approximately $25,000-$250,000), software, and storage capacity for large digital image files.29 Within the regional network of hospitals with which we collaborated, 4 different pathology laboratories could be linked to each other and to our department using a static imaging system installed at each remote site; this was accomplished at a fraction of the cost of 4 whole slide scanners. In his discussion of

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\text{Fig 5. A. Nondiagnostic static image submitted for telepathology consultation with accompanying clinical history of blisters eruption on extremities and trunk. B. Low-power view of glass slide reveals fragment of detached diagnostic tissue at periphery of slide. C. Higher power view of detached fragment upon which diagnosis of toxic epidermal necrolysis is made.}
\]
telepathology in the developing world, Hitchcock identified that the infrastructure in developing countries should dictate which technology is utilized, as no consultation can be sustained if the equipment cannot be maintained. Overall, whole-slide imaging technology is currently not feasible in resource-poor settings compared with static image telepathology, which is more cost effective, requires less technical training and maintenance, and can be reliably supported by available Internet and software resources if adequate training is provided to referring pathologists and if subspecialty-trained pathologists apply appropriate clinical pathologic correlations when interpreting the images.

Owing to digitization, telepathology can improve the integration of clinical information in diagnosis through clinical-pathologic correlation and thereby improve diagnostic accuracy. In this study, the static telepathology images were diagnostic in 76% of cases (N = 22/29) overall. While clinical history was provided to some degree for all cases (see Table 1), only 8 of 29 cases included both H&E images and a digital clinical photograph (see Fig 2). Of these, the static telepathology image was diagnostic in 7 cases and partially diagnostic in one case. Of the remaining cases for which only H&E images were provided, the static telepathology image was diagnostic in 15 cases, partially diagnostic in 4 cases and nondiagnostic in 2 cases. Thus the proportion of cases for which the static image telepathology was diagnostic was 7 of 8 (88%) for those that included a digital clinical photograph and 15 of 21 (71%) for those without a digital clinical photograph. This suggests that the inclusion of a digital clinical photograph and clinical history, while not always absolutely necessary, may enhance the rate of accurate teledermatopathology diagnosis and mirrors the importance of performing clinicopathologic correlation in rendering glass slide diagnoses for dermatopathology cases.

The mean turn-around time for telepathology consultation in this study was 7 days. This is in the context of a clinical timeline wherein return appointments are scheduled no less than 2 to 3 weeks, and often much longer, from the time of the initial biopsy because of the shortage of dermatology-trained specialists. Although the patients were informed of any delays in diagnosis related to referral for consultation, the turn-around time did not affect patient care in this setting. The turn-around time exceeding 2 weeks for the 3 cases in this study was not related to the telepathology system, but was due to independent review by two pathologists and the time constraints of the individual pathologists (eg, extended travel to an area with no Internet access and time away from work for other reasons). While this often resulted in a turn-around time greater than could theoretically be achieved by telepathology (eg, on the order of minutes, such as for frozen-sections), this was still significantly better than the turn-around time (and cost) associated with traditional glass slide consultation.

Furthermore, the purpose of this teledermatopathology collaboration with physicians in East Africa extends beyond rendering an accurate diagnosis in as little time as possible; it includes providing continuing education to referring pathologists and this platform optimizes the opportunity for dialogue between referring and consulting pathologists. In our experience, static-image telepathology using the iPath platform provides a unique educational experience for both the referring and consulting pathologists, by allowing not only for consultation on difficult and interesting dermatopathology cases, but also providing continuing education to general pathologists in East Africa who lack formal subspecialist training. Additional educational information and/or clinical recommendations were provided in the responses for 13 of 29 cases including references cited, discussion of the differential diagnosis, treatment suggestions, need for additional clinical history, and further studies such as immunofluorescence or immunohistochemical stains. Therefore this technology builds capacity among local pathologists in resource-poor settings in terms of field selection, image acquisition, diagnostic approach to dermatopathology cases, and recognition and awareness of specific dermatopathological entities. Additionally, the referred cases provide a unique opportunity for MGH pathology residents to view dermatopathology cases that are uncommon in our hospital’s setting or that represent dermatopathological entities, including Kaposi sarcoma and eruptive collagenoma. In this way, the educational value of the consultation is bimodal: the referring pathologists receive expert opinion and consultation and the consulting institution has an opportunity to review interesting cases that provide additional educational material for its pathology trainees.

In summary, remote viewing of dermatopathology cases using static-image telepathology can be used successfully to refer challenging cases for second opinion, particularly in resource-poor settings, to share interesting cases among pathologists separated by vast distances, and to provide continuing education to general pathologists. In addition, this technology eliminates the time and cost associated with sending glass slides for consultation. Overall, static store-and-forward telepathology serves as an efficient, cost-effective means for providing diagnostic support and continuing education to pathologists practicing in resource-poor settings.
The utility of this technology is maximized when clinicopathologic correlation is combined with histologic examination of digital images. The potential limitations of using static-image telepathology may be diminished by ensuring the referring physicians have adequate training in use of the equipment and by giving them continuous feedback regarding image acquisition, field selection, and the importance of providing clinicopathologic information and expert surgical pathology interpretations.

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REFERENCES

tol 2003;139:357-40.