



Original Research

Utility of international store-and-forward teledermatopathology among a cohort of mostly female patients at a tertiary referral center in Afghanistan[☆]

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ABSTRACT

Background: The variety and complexity of dermatologic diseases in Afghanistan and the associated diagnostic resource constraints have not been previously studied. Moreover, the utility of store-and-forward teledermatopathology in this resource-limited setting has not been investigated.

Methods: A retrospective analysis was conducted of 150 store-and-forward teledermatopathology cases that were composed of a clinical history, clinical images, and histologic images that were sent from an academic teaching hospital in Kabul to a dermatology-trained dermatopathologist at Emory University in the United States between November 2013 and June 2017. For each case, the histologic impression of the Emory dermatopathologist was compared with that of the Kabul-based general pathologist and the clinical differential diagnosis and histologic impression of the Kabul-based dermatologist.

Results: Eighty-one of the cases that were analyzed were from female patients. The diagnosis after telepathology consultation differed from the first entity in the clinical differential diagnosis in 34.7% of cases. The telepathology consultation refined the Afghan general pathologist's histologic impression 45.5% of the time and the Kabul-based dermatologist's histologic impression 24.3% of the time. A clinically significant difference in care was made in 19.3% of cases for which an analysis could take place between the histologic impressions of the Emory dermatopathologist and U.S.-trained dermatologist. The most common resource constraints that limited a definitive diagnosis were the inability to perform infectious stains and cultures to identify specific pathogens (19.3% of cases) and immunofluorescence studies to confirm autoimmune bullous disease (6.7% of cases).

Conclusions: These results highlight the important diagnostic role that teledermatopathology can serve in resource-limited settings such as in Afghanistan.

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Introduction

Medical literature on dermatologic diseases in Afghanistan consist primarily of articles that describe the epidemiology, clinical features, and treatments of cutaneous leishmaniasis in Afghans and foreign military personnel as well as articles that document other skin diseases among foreign military personnel in Afghanistan. Additionally, little is known about the resource constraints faced by dermatologists in Afghanistan and the role of teledermatology and telepathology in

this context (Driver et al., 2012; Faulde et al., 2008; Jebran et al., 2014; Reithinger et al., 2004; Safi et al., 2012; Shair, 1978a, 1978b; Shaw, 1967; Van Thiel et al., 2010).

The Department of Dermatology at Emory University has an ongoing collaboration with the Department of Dermatology at an academic teaching hospital in Kabul, Afghanistan. A dermatology-trained dermatopathologist at Emory University receives cases in teleconsultation from a U.S.-trained dermatologist who is based at the teaching hospital. These cases consist of clinical and histologic images as well as detailed clinical histories that are sent in email form. This study sought to investigate how store-and-forward (SAF) static teledermatopathology impacts diagnostic outcomes and patient management in this resource-limited setting.

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Materials and methods

A retrospective analysis was conducted of teledermatopathology cases that were referred from the teaching hospital in Afghanistan to a dermatology-trained dermatopathologist at Emory University between November 2013 and June 2017. The Emory institutional review board deemed this study exempt.

The Department of Dermatology at the teaching hospital in Afghanistan performs a limited number of biopsies per month due to cost and these are generally reserved for difficult cases that cannot be diagnosed and/or treated on the basis of clinical findings alone. When a biopsy is performed at the teaching hospital, the tissue is processed at a local pathology laboratory and the sections are interpreted by a general pathologist (who does not have dermatopathology fellowship training) at this facility.

The general pathologist examines hematoxylin-eosin stained slides and determines the fields and magnifications to be imaged. Static images are captured with a microscope-mounted digital camera (Spot insight QE, Model #4.2, Serial # 222135, 2 megapixel, Diagnostic Instruments, Inc., Sterling Heights, MI). The general pathologist then sends these images along with his histologic impression of the images to the dermatologist who performed the biopsy. The photographs were in JPEG format and most with a resolution of 1600 x 1200 pixel and ranging in size from 200 kb to 500 kb.

The emails that were sent from the Kabul-based dermatologist to Emory University for a given case contained a detailed clinical history and clinical differential diagnosis as well as attachments with the associated clinical and histologic images. None of the histologic photographs were compressed before email transmission. In addition, the emails contained the Afghan general pathologist's histologic impression as well as that of the dermatologist. The Emory University dermatopathologist, who is board certified in dermatology and actively sees patients at The Emory Clinic in addition to reviewing slides, then reviews the history and clinical and histologic photographs and provides a histologic impression on the basis of this information. The histologic impressions from the dermatologist and dermatopathologist result from a correlation of the clinical history and photographs with histologic findings.

An Excel spreadsheet was compiled that included the following information for each of the 150 cases: patient age, sex, clinical history, pre-consultation clinical differential diagnosis, pre-consultation histologic impression from the general pathologist, pre-consultation histologic impression from the dermatologist, histologic impression from the Emory University dermatopathologist, general category of final diagnosis, specific final diagnosis, and resource constraints that limited the ability to assign a specific diagnosis.

For each case, the histologic impression of the Emory University dermatopathologist was compared with the first entity in the clinical differential diagnosis. The former was also compared with the histologic impressions of the general pathologist and dermatologist in Kabul. A binary system for diagnostic concordance was utilized in each of these three comparisons and the dermatopathologist's impression was treated as the golden standard. The term "histologic impression" describes the histologic diagnosis and/or description provided by an individual reviewer.

In cases for which a definitive histologic diagnosis could not be made by the Emory University dermatopathologist, the histologic descriptions between the individuals were compared instead. An individual's histologic impression was considered refined if the dermatopathologist arrived at a different diagnosis or provided a substantially different histologic description. This discordance may or may not have made a clinically meaningful difference in care. Reasons for the inability to render a specific diagnosis by the Emory University dermatopathologist included resource constraints (e.g., lack of infectious histochemical stains, lack of access to immunohistochemical

stains) as well as other facts such as the intrinsic difficulty of pathology of inflammatory skin disease.

In cases for which the dermatopathologist's histologic impression refined that of the dermatologist, an attempt was made to determine whether the collaboration affected the clinical management of the patient. If, for example, the two individuals made different diagnoses on a case but both diagnoses were benign neoplasms that did not require further intervention, then the collaboration was deemed not to have affected the clinical management of that case.

A clinically meaningful difference was also not made if, for example, both individuals diagnosed distinct eczematous dermatoses for which the treatments were the same (e.g., topical corticosteroid medications). However, if one individual felt the disorder was papulosquamous and the other eczematous, then this difference of interpretation would correspond to a clinically significant difference in care because although the initial treatment management might be topical corticosteroid medications, more aggressive interventions diverge for these entities.

Results

In total, 150 cases were included in the analysis including 81 female and 69 male patients. Average patient age at the time of presentation was 39.3 years with a range of 9 months to 85 years. The average duration of symptoms prior to presentation was 4.1 years. The diagnostic categories into which the diseases fell are shown in Table 1.

The diagnosis after telepathology consultation differed from the first entity in the clinical differential diagnosis 34.7% of the time. Telepathology consultation refined the Afghan general pathologist's histologic impression 45.5% of the time and the U.S.-trained dermatologist's histologic impression 24.3% of the time. For the 34 cases for which teleconsultation refined the dermatologist's histologic impression, this discordance altered the clinical management of the patient in 27 of those cases. The results of these analyses are summarized in Table 2. (Note: in the second column of Table 2, the number of analyzable cases for each of the three comparisons falls short of the 150 total cases due to some instances where the clinical differential diagnosis, Afghan pathologist's histologic impression, or U.S.-trained dermatologist's histologic impression was not provided for a given case, for example if one of the parties was on leave.)

The most common resource constraints that limited a definitive diagnosis were the inability to perform infectious histochemical stains and cultures to identify specific pathogens (n = 29; 19.3% of cases) and immunofluorescence studies to confirm autoimmune

Table 1
Diagnostic categories of cases

Diagnostic Category	No. of cases (% of total cases)
Malignant neoplasms	43 (28.7)
Infectious diseases	32 (21.3)
Rheumatologic dermatoses	11 (7.3)
Autoimmune bullous diseases	10 (6.7)
Papulosquamous diseases	8 (5.3)
Genodermatoses	8 (5.3)
Other	6 (4.0)
Eczematous dermatoses	5 (3.3)
Lichenoid dermatoses	5 (3.3)
Benign neoplasms	5 (3.3)
Non-infectious granulomatous diseases	4 (2.7)
Unknown	3 (2.0)
Neutrophilic dermatoses	3 (2.0)
Adnexal disorders	2 (1.3)
Alopecias	2 (1.3)
Deposition disorders	1 (0.7)
Panniculitides	1 (0.7)
Vasculitides	1 (0.7)

Table 2
Effect of teleconsultation on pre-consultation diagnoses

	No. of Analyzable Cases	No. of Cases in which Teleconsultation Refined the Entities in Column 1 (% of Analyzable Cases)
First entity in clinical differential diagnosis	147	51 (34.7)
Afghan pathologist's histologic impression	123	56 (45.5)
U.S.-trained dermatologist's histologic impression	140	34 (24.3)

bullous disease (n = 10; 6.7% of cases). The results of these analyses are summarized in Table 3.

Discussion

Teledermatopathology provides the opportunity to expand access to care to underserved populations in remote areas as well as in developing countries. Teledermatopathology can be divided into SAF and real-time applications.

One example of SAF teledermatopathology is digital, whole-slide imaging (WSI) whereby a virtual slide system digitizes glass slides into high resolution images and the consulting pathologist can use relevant software to view any field at any magnification. Although WSI offers the advantage of a digital image of the entire glass slide, this is impractical in many developing countries because of the prohibitive cost that is associated with the acquisition of the necessary equipment, software, and storage capacity for large digital image files (Gimbel et al., 2012; Shahriari et al., 2017). Moreover, laboratories such as the one involved with the current study may be limited by internet bandwidth and daily limits on the size of transferable data.

Another technology that enables digital, whole-slide review is robotic telepathology whereby the operator controls the microscope from a remote location for synchronous consultation of slides. The consulting pathologist has full remote control of the microscope, which enables him or her to examine the entire slide digitally with control over slide movement and magnification (Gimbel et al., 2012). Studies have demonstrated high rates of diagnostic concordance between standard light microscopy and virtual microscopy (i.e., virtual, whole-slide telepathology; Al Habeeb et al., 2012; Leinweber et al., 2006; Piccolo et al., 2002; Riedl et al., 2012).

In contrast to WSI and robotic telepathology, static image telepathology is an SAF modality that involves the transfer of individually captured digital images of select fields of histologic slides. These images are transmitted over the internet to be viewed by remotely located consulting pathologists. In the current study, static image teledermatopathology was the only modality available.

Few studies have evaluated the accuracy or utility of teledermatopathology in resource-limited settings. Gimbel et al. (2012) described their experience with an asynchronous static-

image teledermatopathology program to provide a second opinion consultation to pathologists who were affiliated with a regional network of four hospitals in East Africa. This group demonstrated that the diagnostic accuracy between static image and glass slide diagnoses made by two dermatopathologists at the Massachusetts General Hospital was high (91%), which suggests that sampling bias is not a major limiting factor in static image telepathology. Moreover, their interobserver concordance was high (Gimbel et al., 2012).

Even fewer studies have examined the impact of teledermatopathology on the care of patients in resource-limited settings. Micheletti et al. (2014) summarized their experience with nearly 300 cases seen via the robotic telepathology system in Gabarone, Botswana and attempted to gauge its impact on the care of patients with dermatologic conditions in that country. In this study, teledermatopathology consultation made a substantive contribution to clinical management in 234 of 291 cases (80.4%; Micheletti et al., 2014).

To our knowledge, the current study is the first report to catalog the variety and complexity of dermatologic diseases among Afghans who seek care at an academic teaching hospital that require skin biopsy tissue for diagnostic evaluation. These results demonstrate the utility of static image SAF teledermatopathology in a low-resource setting as a clinically significant difference in care was made in 27 of 140 cases (19.3%) for which an analysis could take place between the histologic impressions of the Emory University dermatopathologist and U.S.-trained dermatologist. Of note, the histologic impressions of the dermatologist and dermatopathologist resulted from the correlation of the clinical history and clinical photographs with histologic findings, which highlights the importance of clinicopathologic correlation in this setting.

The purpose of this collaboration extends beyond rendering an accurate diagnosis to providing a continuing educational experience for the referring pathologist and dermatologist through continuous feedback with regard to image acquisition, field selection, and histologic interpretation. Indeed, the faculty and residents at all levels at both the Department of Dermatology at Emory University and the Department of Dermatology at the academic teaching hospital in Kabul benefit from the educational value of this ongoing collaboration.

The current study has some important limitations. This was a retrospective study of a relatively small number of cases. The nature of the diseases that were referred to a tertiary center and in Afghanistan in general may be different than in other resource-limited settings, which limits the generalizability of these findings.

In some cases, diagnostic certainty was limited by the resolutions of the images. The current study utilized static SAF teledermatopathology that involved the single-field transmission of subjectively preselected and captured areas of microscopic slides. Therefore, the submitted image may not have included the relevant histopathology that was required to render an accurate diagnosis. In contrast, virtual slide and robotic dynamic systems have the advantage of decreasing sampling errors and increasing diagnostic accuracy but are much more costly and therefore not feasible in most resource-limited settings (Massone et al., 2008).

There was limited capacity for follow up on these cases to determine the short- or long-term effects on patient outcomes. Given that only one dermatopathologist was involved in this collaboration, this study did not account for interobserver differences among dermatopathologists. In the current study, the dermatopathologist's histologic impression was treated as the golden standard because he had more specialized training in dermatopathology than the dermatologist or general pathologist. Therefore, the utility of teledermatopathology to this team in Kabul may be different than the utility of teledermatopathology to teams in other international locales or rural areas in the United States depending on the levels of expertise of the individuals involved. The dermatologist's histologic impression is believed to have been less frequently revised than

Table 3
Most common diagnostic resource constraints

	No. of Cases in which Ability to Make Specific Diagnosis was Limited Due to Entity in Column 1 (% of total)
Inability to perform infectious stains and cultures	29 (19.3)
Inability to perform immunofluorescence studies	10 (6.7)
Inability to perform immunohistochemical stains	7 (4.7)

that of the general pathologist due in part to the former having participated in a formal dermatopathology curriculum throughout 3 years of dermatology residency in the United States. This formal training was supplemented by continued informal study of dermatopathology after completion of the residency training.

The subset of cases that were involved in this study was composed of the most challenging cases that presented to the tertiary care facility. Due to the financial and resource constraints at the facility, only these challenging cases were biopsied from month to month. All cases that were biopsied were sent for teleconsultation. The most practical indication for teledermatopathology in this resource limited setting is for the challenging cases that cannot be diagnosed and treated on clinical findings alone.

Finally, at the academic teaching hospital in Kabul as well as many other healthcare facilities in the developing world, there is no access to fungal or mycobacterial cultures, immunofluorescence studies, or immunohistochemical stains. Therefore, the ability to definitively diagnose specific infectious, immunobullous, and malignant neoplasms is limited. These deficits represent a possible future target for healthcare infrastructure initiatives in this and other regions of the world.

Conclusions

These results demonstrate that static image SAF teledermatopathology in resource-limited settings improves the diagnostic outcomes in a clinically significant way. Static SAF teledermatopathology has great potential to allow access to subspecialist expertise in underserved areas.

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