Global Pathology Training in Residency and Fellowship
A Mutually Beneficial Intervention

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• Context.—Most cancers occur in lower and middle income countries, where pathologists are scarce. Despite this, few pathology training programs offer global health electives, and trainees are not exposed to challenges associated with practicing in resource-restricted settings.

  Objective.—To implement a global health elective model aimed at exposing trainees to global health while alleviating overburdened pathologists in resource-restricted settings.

  Design.—For 1 year, trainees at 2 US institutions reviewed cases shipped weekly from a pathology lab serving Trinidad and Tobago and Guyana. Turnaround time, specimen type, and trainee and clinician satisfaction were assessed.

There is a need for anatomic pathology in lower- and middle-income countries (LMICs). One-third of cancers can be prevented and another third cured if diagnosed early and accurately, and treated appropriately.³ Cancer mortality is high in LMICs because of poor health care infrastructure, including lack of highly trained health care professionals, like surgical pathologists. This often results in a lack of accurate diagnoses and proper care.²,³ Because of resource restriction, it is not uncommon for health care providers in LMICs to be forced to forego standard pathologic tissue diagnosis in certain patients and treat disease empirically.⁴ This can lead to unnecessary or harmful therapy and, paradoxically, increased health care costs.

A large proportion of graduate medical training programs in the United States address health care in LMICs by offering a global health travel elective or more formal global health education tracks for trainees. Training programs that offer such electives are often ranked higher in the graduating pool of medical students, because newly minted physicians are keenly aware of global health disparities and the need for both training and intervention in resource-restricted settings.⁵ Global health education in anatomic pathology is, however, scarce. This may be because of the relative novelty of the field of global oncology or the unfounded perception that pathology development is nearly impossible in these settings.⁶

Anatomic pathology residency training has evolved with the advent of immunohistochemical and molecular assays; as such, morphology-only based diagnoses may not be emphasized in the typical US training program. Furthermore, given the prevalence of cancer screening programs in the United States and low rates of infectious diseases, pathology trainees are also not widely exposed to advanced carcinomas or infection-associated malignancies.⁷ Rather, their training is generally focused on practice in resource-rich settings. Unlike other medical specialties, anatomic pathology residents—even in their third year of training—must remain dependent on the attending pathologist to finalize a case, never experiencing true “ownership” of the diagnosis until becoming an attending pathologist.⁸ This lack of exposure to independent practice may lead to difficulties as an attending pathologist.

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Results.—Trainees reviewed an average of 16 cases per week. Average turnaround time was 6 days. There was no significant difference between the turnaround time for the US trainees and the pathologist based in the lab in Trinidad. Trainees and clinicians reported a high level of satisfaction, and the collaboration was fruitful, resulting in the publication of a case report.

Conclusions.—We demonstrate that collaboration between US trainees and laboratories in resource-restricted settings, in the form of a global health elective, is mutually beneficial.

These gaps in anatomic pathology training in the United States may be filled by developing a model that exposes senior trainees to clinical cases from low-resource countries and affording them the opportunity for independent review. Such a model can also fill the gaps in diagnostic services in LMICs. Slides can be shipped to the pathologist, or telepathology can be used if the lab is equipped with Internet access, slide scanners, and/or cameras. We exploit this feature of pathology and present a pilot study of a model of a global pathology elective that is beneficial to both US pathology trainees and a resource-restricted site. The site was a lab located in San Juan, Trinidad, that received samples from Trinidad and Tobago (a country in which 20% of the population lives below the poverty line, despite its designation as a World Health Organization high income country) and Guyana (a World Health Organization-designated low-income country).

MATERIALS AND METHODS

Collaboration Site

We collaborated with Nexgen Pathology (NGP), a private anatomic pathology laboratory based in San Juan, Trinidad and Tobago, that also serves patients in Guyana. The combined population of these 2 countries is 2.1 million. With 7 pathologists serving this region, the pathologist to patient ratio is 1:300 000; the typical ratio should be 1:20 000.9 In these countries, the average turnaround time for case finalization can range from 2 weeks to 2 months (Wesley Greaves, MD, oral personal communication, February 2016). A significant portion of pathology services in these countries are performed in association with nongovernmental organizations or by private laboratories, not unlike LMICs. The lab director and only attending pathologist at the collaboration site is a US-trained anatomic and clinical pathology (AP/CP) board-certified hematopathologist and works as an attending pathologist at a local public general hospital. He maintains his certification with the American Board of Pathology, is a regular attendant at United States and Canadian Academy of Pathology conferences, and is actively engaged in education in pathology in both the United States and the Caribbean. There is a wide spectrum of surgical pathology and cytology cases at the lab, including gynecologic, gastrointestinal, and urologic specimens, originating from both private and public medical institutions with an annual volume of up to 3500 surgical specimens per year. Hematoxylin-eosin as well as selected special stains are performed manually at the laboratory, and immunohistochemistry is limited. There is also limited capacity for telepathology, with 1 microscope and no trained personnel to take images reliably.

Fellows

Our collaborators were 2 AP/CP board-certified, US-based pathology fellows with Trinidadian parentage; they were also known to the local pathologist. One of the fellows visited Trinidad and Tobago on a month-long elective to implement telepathology in Trinidad. Although the implementation was unsuccessful because of technical barriers, the idea of a more sustainable collaboration by way of shipping cases was born. Both fellows subsequently secured faculty positions at tertiary academic centers in the United States.

Collaborative Model

Hematoxylin-eosin slides were processed at NGP. All hematoxylin-eosin and rush biopsies were triaged to the in-house pathologist (American board-certified in hematopathology), and the remainder was split among the participating fellows and the in-country pathologist. Local rotating medical graduates (house officers) at the laboratory in Trinidad would preview slides and proffer a diagnostic interpretation before shipment for their own education. Slides were batched and shipped to fellows once weekly from June 2016 to June 2017. Cost of shipment averaged $80.00 per

week. If immunohistochemical stains were needed, this would be discussed with the in-house pathologist because patients are required to pay for these additional stains. Once approved by the local pathologist, some would be performed at NGP (estrogen receptor [ER], progesterone receptor [PR], HER2, thyroid transcription factor [TTF-1], cytokeratin 7, cytokeratin 20) and then shipped to the fellow or, if urgent, reviewed by the in-house pathologist. Occasionally, some cases would be sent to Cleveland Clinic Laboratories (Cleveland, Ohio) virtual immunohistochemistry services for immunohistochemical stains, and the result would be reviewed digitally by the fellow. NGP does not use electronic medical records or digital laboratory information systems, so reports were generated via Dropbox Business (Dropbox Inc) for sign-out. Although there is no Health Insurance Portability and Accountability Act (HIPAA) equivalent in Trinidad, special care was taken to adhere to HIPAA via Dropbox using the best practice guidelines provided by the Web site, including 2-step verification and regular access reviews. The local house officers would pre-type these reports with a provisional diagnosis, and this would then be sent to the fellows for review via Dropbox. The in-country pathologist reviewed all cases sent to the fellows for quality assurance purposes in the first month of the collaboration. Any malignant cases or cases flagged by the fellows would also be reviewed by the in-house pathologist via telepathology (microscopic images were sent via email to the local pathologist). Additionally, faculty at each fellow’s institution would offer opinions on particularly difficult cases. Malpractice insurance was covered by NGP. The trainees were considered consultants to the in-house pathologist, who received approval from the medical board of Trinidad and Tobago for the fellows to review cases.

Statistics

A Student t test was performed using Microsoft Excel to compare the overall turnaround times (date of specimen receipt to date of report issuance) between the fellows and the in-country pathologist.

RESULTS

Pathology Cases and Turnaround Times

The median number of cases shipped to the fellows per week was 16 per fellow (range, 7–22; Figure 1). These cases were predominantly biopsies and resections from the gastrointestinal, gynecologic, and genitourinary tracts, and most (1063 of the 1223 cases [87%]) were benign (Table). The median number of cases shipped to the fellows per week was 16 per fellow (range, 7–22; Figure 1). These cases were predominantly biopsies and resections from the gastrointestinal, gynecologic, and genitourinary tracts, and most (1063 of the 1223 cases [87%]) were benign (Table). The mean turnaround time was 6 days for the in-country pathologist and 5 days for the fellows. In fact, the turnaround time from the date of shipment was 3 days for the fellows, significantly less than the turnaround time of the in-country pathologist (P < .001).

Pathology Trainee Experience

The fellows revealed a high level of satisfaction with the elective. They felt independent but well supported and reported that it was good preparation for their future as attending pathologists. In addition, the resource restriction forced them to be more judicious and thoughtful in their use of immunohistochemistry.

Local (Trinidad and Tobago and Guyana) Clinicians

We received feedback from 2 clinicians who also found the collaboration beneficial. They reported that the experi-
ence was educational for them. In some cases, they were unaware of updated diagnostic criteria or certain diagnostic entities. Communication between the local clinicians and the fellows was challenging, but the in-country pathologist routinely acted as a channel of communication for any case-related issues.

**Interesting Examples**

During the year of collaboration, the fellows encountered many interesting cases. There were very few infectious cases evaluated and far more entities associated with noncommunicable diseases. An example of a neoplastic entity encountered included an osteoblastic osteosarcoma. The sample showed fragments of a hypercellular malignant neoplasm with scattered multinucleated cells and malignant bone deposition (Figure 3). The fellow’s differential diagnosis included osteoblastic osteosarcoma. Because of her limited experience and the relative rarity of those lesions, she asked for review by a soft tissue pathology expert at her home institution who confirmed her initial diagnosis. Rare nonneoplastic examples included gastrointestinal amyloidosis. Tubal gut biopsy samples sent to 1 fellow showed an amorphous eosinophilic infiltrate in the lamina propria consistent with amyloidosis, which was confirmed with a Congo red stain (Figure 4). This is a rare finding even in the subspecialty of gastrointestinal pathology, and was recently published as a case report by Goetz et al.¹⁰ in the *West Indian Medical Journal*.

**DISCUSSION**

We present a model of a global pathology elective that addresses both the current gaps in anatomic pathology training in the United States and the scarcity of pathologists in resource-restricted communities. We demonstrate that shipping slides to the US-based trainees greatly eased the burden of an otherwise overextended pathologist in a resource-restricted setting without negatively affecting report turnaround time. In addition, we show that pathology trainees were exposed to interesting cases and felt more comfortable practicing independently. Although this intervention was performed on a relatively small scale,
we believe that this model can be used and expanded by most residency and fellowship programs.

The spectrum of disease has changed in LMICs. Both the incidence and prevalence of infectious disease have waned. With the increased longevity of these populations, the incidence of noncommunicable diseases, particularly malignancies, has increased. In 2012, for example, 60% of new cancer cases occurred in lower-income countries. Perceived barriers to cancer control in these regions include poor health infrastructure and lack of access to health care (including structured screening programs). In the United States and United Kingdom, the ratio of pathologists to patients is 1 to 20 000. Many LMICs, however, either have no local pathologist or have 1 pathologist serving more than 50 times as many patients as those in higher-income countries.

Despite the fact that more than 70% of medical decisions are based on results from either an anatomic or a clinical pathology laboratory, there is very little emphasis on the global health literature on pathology capacity-building in LMICs. In our study, we engaged with local pathologists, house officers, and clinicians while at the same time exposing US-based pathology trainees to a practical global health experience. Exchanges similar to this will foster research, motivate pathologists, and ultimately improve patient care in LMICs.

Pathology residency training in the United States can be improved. Given the prevalence of cancer screening programs in the United States, pathology trainees rarely see infection-associated malignancies (eg, cervical carcinoma) or advanced malignancies. Given their access to a wide range of immunohistochemical stains and molecular genetics studies, trainees may use ancillary studies as a crutch in their approach to difficult cases rather than first relying on histomorphologic features. In addition, anatomic pathology is a unique specialty in which there remains heavy dependence on the attending pathologist to complete cases; trainees rarely independently finalize their own cases. Lastly, other medical graduate training programs recognize the need for global health education, yet pathology remains far behind the curve. The model presented in this study addresses these limitations of current pathology residency training. Fellows were forced to rely on morphology and be judicious with their use of immunohistochemical stains as they were faced with the actual cost to the patient for this type of ancillary testing. They were also effectively independent practitioners even though there was suitable supervision by the in-country pathologist. Another substantial benefit of this model was that, unlike other medical specialties, the trainees remained at their home institution and did not incur the expense of travel or lodging while actively participating in a global health elective. This is a timely advantage given the travel restrictions in the midst of this year’s COVID pandemic. Apart from the exposure to interesting cases, experience as independent practitioners, and limited expense, there was also remarkable academic productivity during and after the conclusion of this project. This small foray into global pathology has already led to published global health care research. One fellow was a senior author on a case report on gastrointestinal amyloidosis in Trinidad and is involved in numerous other projects with the lab, whereas the other is currently involved in lab optimization in resource-restricted settings. Most studies on global health oncology do not include pathologists in their intervention, perhaps because it is not thought of or perhaps because pathologists feel ill equipped to participate. This model provides some impetus for such participation.

There are some limitations to this model. The pathologist at our collaborator site initially reviewed all slides assigned to the fellows prior to shipment, which added to his daily workload. However, because of his commitment to the project, he persisted in the evaluation for the first month. We will admit that finding an already overburdened collaborator willing to perform such a review may be one of the largest hurdles in setting up such a collaboration. Our fellows were already diplomats of the American Board of Pathology prior to beginning this pilot study. Therefore, in effect, they were capable of signing out cases independently, regardless of supervision. When implementing this model, we would suggest restricting participation to already boarded senior residents/fellows unless a faculty member is heavily involved in case co-review. In addition, our fellows acted as consultants to the laboratory, an arrangement facilitated by the in-house pathologist. In the future, however, the fellows can obtain medical licenses from the country because this is often a seamless and inexpensive process. The lab at our collaborator site was already able to process tissue and make hematoxylin-eosin microscopic slides. This model will not work unless such a system is already in place at the collaborating institution. The cost of shipment of the slides was factored into the overall cost of testing. Because cases were batched and shipped in bulk, shipping costs for individual patients were significantly reduced. Even though it is low cost, the model requires some monetary investment for shipment of slides on the part of the in-country lab. Although whole slide imaging could be considered in lieu of shipping for other sites, slide scanners along with the appropriate software were prohibitively expensive for the laboratory in San Juan and may be.
for similarly sized laboratories in other countries of interest. Communication between the laboratory in the originating country and the fellows can be enhanced by taking photographs of larger specimens with a cassette/block key. This was not done during this project given that there were few large resection specimens, but it should be employed for future similar collaborations. Lastly, participation by the fellows was voluntary and not part of a formal global health rotation; they worked extra time on weekends and nights as part of the project. One possible alternative to year-long involvement is a monthly rotation for interested trainees, which could be paired with a lighter rotation so that the participating trainees are not overburdened themselves. There would be significant differences from the model described, including more invested faculty for trainee supervision and cosigning of cases and less of a long-term relationship with the site of interest. Given that the time commitment is so low, however (maximum 3 hours per week), supplementation of a month-long rotation with global health education sessions and collaborations with other international sites may be considered.

In summary, we present a simple and low-cost collaborative model that is beneficial to both patient care in resource-restricted countries and US pathology trainees. Similarly structured global pathology electives can be beneficial because they can enhance trainee education, increase opportunities for research, and improve quality of care in resource-restricted settings. It is incumbent upon us

Figure 3. Hematoxylin-eosin–stained slides showed fragments of a hypercellular malignant-appearing neoplasm at low power (A) with malignant bone deposition seen at higher power (B) consistent with a diagnosis of osteoblastic osteosarcoma, high grade (original magnifications ×40 [A] and ×400 [B]).

Figure 4. A, High-power magnification of this ileum biopsy shows an amorphous eosinophilic infiltrate within the lamina propria on hematoxylin-eosin stain. B, A Congo red stain showed the typical apple-green birefringence on polarized light, consistent with a diagnosis of gastrointestinal amyloidosis (original magnification ×400 [A and B]).
as physicians and physician-educators to expose trainees to the challenges of health care in resource-restricted settings, not only outside the United States but also within it. Doing this will engender awareness, empathy, and, perhaps most importantly, action toward improved health care outcomes for patients in these settings.

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