Providing Laboratory Medicine Training in a Low-Resource Setting

Lessons Learned From a Recent Experience in Sierra Leone

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ABSTRACT

Objectives: We developed and participated in a 1-week laboratory medicine training presented from June 3, 2019, to June 7, 2019.

Methods: The training was a combination of daily morning lectures and case presentations as well as afternoon practical sessions in the clinical laboratory. The content was selected over months by local organizers and the visiting faculty and further modified on site to reflect local needs.

Results: Participants identified practice changes that could be realized in the short term but most faced significant barriers to implementation in the absence of structured and long-term follow-up.

Conclusions: In this report, we review insights learned from our experience and reflect on strategies for realistic, meaningful, and relevant contributions in the setting of laboratory medicine-oriented short-term programs.

Key Points

- Short-term laboratory medicine training in low-resource settings should be customized to meet local needs.
- Sustainability of practice changes may not be ensured without long-term follow-up.
- Plans for long-term follow-up should be addressed during the pretraining phase to ensure successful implementation.

Reliable clinical laboratory services delivering timely and accurate test results are essential components of health care delivery; however, they remain difficult to achieve in many low- and middle-income countries (LMICs), particularly in sub-Saharan Africa.¹⁻³ In 2018, *The Lancet* dedicated a series to the status of pathology and laboratory medicine (PALM) services in LMICs that highlighted gaps in the provision of quality services, proposed potential solutions, and issued a call to action for stakeholders.⁴⁻⁶ One barrier to PALM services identified by the series was insufficient human resources due to the scarcity of trained pathologists in LMICs,⁴ and proposed solutions included task shifting and short-term visitor programs.^{5,7} In fact, capacity-building programs that include short trainings, site visits, and supervision have been implemented to varying degrees of success in many LMICs.⁸⁻¹²

In this report, we describe a recent experience in developing and implementing a 1-week laboratory

medicine training at Koidu Government Hospital (KGH) in Sierra Leone from June 3, 2019, to June 7, 2019. On-the-ground logistics were coordinated by the nongovernmental organization, Partners In Health (PIH) Sierra Leone, in collaboration with the Sierra Leone Ministry of Health and Sanitation (MoHS). Participants included laboratory supervisors and laboratory technicians from rural and town settings across Sierra Leone and Liberia. The teaching facilitators were three US-based clinical pathologists (R.H., C.W.S., and Q.E.) specialized in transfusion medicine, clinical microbiology, and clinical chemistry.

Background and Context

Sierra Leone is a country in West Africa with an estimated population of 7.8 million.¹³ It has a fragile health care system that was recently ravaged by the Ebola epidemic between 2014 and 2016. Communicable, maternal, neonatal, and nutritional diseases continue to account for the majority of deaths and disability-adjusted life years, but noncommunicable diseases have been on the rise with an approximate 34% change between 2007 and 2017.^{13,14} To address this disease burden, basic diagnostic services at least need to be accessible and reliable.

Sierra Leone has a national medical laboratory strategic plan that includes the strengthening of laboratory organizational structures, the provision of regulation, and the development of a qualified laboratory workforce among its top objectives.

While clinical laboratories are required to apply for licensure, there is no clear process for accreditation. A minority of laboratories participate in external quality assurance programs or have internal quality control programs. Importantly, the management structure of the clinical laboratory is not clearly established or reflective of the educational or training background of the laboratory workforce. Currently, several institutions for higher learning contribute to the laboratory workforce. Notably, the College of Medicine and Allied Health Sciences offers degree programs in biologic sciences or medical technology whose graduates are expected to be laboratory technologists or scientists. The Milton Margai College of Education and Technology Eastern Polytechnic in Kenema offers certificate programs whose graduates are expected to be laboratory technicians. As of late 2015, however, nearly half the laboratory workers had a certificate or lower as their highest level of qualification, and almost a third had a secondary-level education or lower.¹⁵ In essence, a significant proportion of the laboratory workforce gains inadequate knowledge and skills on the

ground and could benefit from short-term training and/or refresher courses.

Predeparture and On-Site Planning of Curriculum

The training comprised daily morning lectures and clinical case presentations that covered topics in general laboratory practice, transfusion medicine, clinical microbiology, clinical chemistry, and hematology (Table 1) followed by afternoon practical sessions in the clinical laboratory at KGH. Local organizers and the visiting faculty invested significant effort in planning and developing the content, which was contextualized toward local needs. The visiting faculty who were trained as clinical pathologists communicated via conference calls and email with the local organizers represented by a medical doctor and laboratory manager from PIH based at KGH and the KGH government-appointed laboratory manager. The local organizers (C.K., M.B., and S.K.) had intimate knowledge of the conditions at the KGH laboratory, and in collaboration with the MoHS they arranged for representatives from other clinical laboratories in the country and one laboratory in Liberia to participate in the training. Over several months, the visiting faculty and the local organizers pared down the content from a broad range of topics in laboratory medicine to those serving the most pressing contextual health care needs. The visiting faculty nonetheless arrived with

Table 1
Topics During Morning Didactic Sessions

Discipline	Topic
Transfusion medicine	<ul style="list-style-type: none"> • Pretransfusion Testing and Crossmatching • ABO Blood Typing and Discrepancies • Clinically Significant Blood Groups • Whole Blood and Blood Products • Transfusion Reactions • Quality Assurance and Safety in Blood Transfusion
Clinical microbiology	<ul style="list-style-type: none"> • Blood Donor Recruitment and Screening • Laboratory Diagnosis of Malaria • The Gram Stain Part 1 • The Gram Stain Part 2 • Update on the Laboratory Diagnosis of Schistosomiasis
Clinical chemistry	<ul style="list-style-type: none"> • Body Fluid Analysis • Principles of Laboratory Specimen Collection, Processing and Transport • Preanalytical Variation • Establishing and Monitoring a Quality Control Program • Point-of-Care Testing • Clinical Chemistry Case Studies
Hematology	<ul style="list-style-type: none"> • Blood Smears

more lectures than those listed in Table 1 in anticipation of on-site changes. As the background of planned participants changed during the predeparture planning from primarily a physician to a technician audience, the educational emphasis shifted from laboratory medicine theory to actual laboratory practice.

Despite these preparatory steps, the content was further modified during the actual training sessions as the host laboratories' capacities and needs were further elucidated and laboratory issues were viewed on site. This was partly accomplished by soliciting the participants daily for the didactic topics of their choice from the preplanned list. In some cases, particularly clinical microbiology, the participants requested lectures that were on hand but not included in the designed course content. Furthermore, lectures were originally designed to be 30 to 45 minutes in duration, but some ran close to 2 hours when no time restrictions were placed on questions and answers. Lectures representing standard US laboratory medicine curriculum such as method validation or alloantibody identification became less relevant because they were not routinely performed by the participating laboratories. Similarly, lectures on statistical quality control (QC) did not address the particular needs of the participants who either did not have QC programs or relied on device controls as opposed to liquid QC material. On the other hand, presentations addressing practical topics such as phlebotomy practices and sources of preanalytical errors as well as protocols for Gram stains were enthusiastically received by the participants, who demonstrated high levels of engagement.

Afternoon practical sessions were particularly valued because they were driven by local laboratory technicians and focused on their routine practices and troubleshooting issues. In one session, blood gas and basic chemistry testing on the same specimen yielded significantly different results on a point-of-care device (i-STAT; Abbott Point-of-Care) and a benchtop photometer (Humalyzer Primus; HUMAN). Participants identified preanalytical factors such as the phlebotomy technique and choice of tube as the major contributors to these differences. In another session, thin and thick malarial smears were prepared and reviewed, and critical modifications to the thick-smear protocol were tested and implemented.

Perspectives of Local Participants

At the end of the training, participants provided written evaluations and were awarded certificates of attendance. Two main themes emerged from these

evaluations: (1) participants expressed interest in a longer training program and for it to be repeated across different laboratories in Sierra Leone for wider dissemination, and (2) they appreciated the flexibility in course content that allowed them to choose topics of lecture and discussion on site. As part of the formal evaluation, the facilitators and participants dedicated the morning half of the last day to the review of practice changes, timeline for implementation, and questions or topics for follow-up.

Several practice changes that could be implemented in the immediate or short term were identified during the brainstorming session (Table 2). Some of these changes, such as phlebotomy best practices, were highlighted during the lectures, while others, such as appropriate handling of i-STAT cartridges, came from observations or interactions during the practical sessions. Participants and facilitators further identified long-term practice changes (Table 3) that would require adequate infrastructure before they could be implemented. For example, functional supply chains, accessible technical support, and quality management systems are a prerequisite for

Table 2
Practice Changes to Be Implemented Immediately or in the Short Term

Discipline	Area of Practice Change
Phlebotomy	<ul style="list-style-type: none"> • Tourniquet application <1 minute • No skin tapping or fist clenching
Transfusion medicine	<ul style="list-style-type: none"> • No warming of blood units necessary prior to transfusion • Single cooler per patient for blood products
Clinical microbiology	<ul style="list-style-type: none"> • Modification of Giemsa staining protocol
Clinical chemistry	<ul style="list-style-type: none"> • Appropriate handling and storage of i-STAT cartridges

Table 3
Practice Changes to Be Implemented in the Medium to Long Term

Discipline	Area of Practice Change
General laboratory practice	<ul style="list-style-type: none"> • Creation and maintenance of laboratory manual
Transfusion medicine	<ul style="list-style-type: none"> • Maintenance of inventory for blood product coolers • Establishment of transfusion reaction forms • Establishment of protocols for the transfusion of O-positive blood (trauma blood) • Establishment of cross-matching for whole-blood transfusion
Clinical microbiology	<ul style="list-style-type: none"> • Training for thin and thick smear preparations
Clinical chemistry/hematology	<ul style="list-style-type: none"> • Establishment of criteria for benchtop device vs point-of-care testing for the same analytes • Method comparison for analytes available on both benchtop and point-of-care devices

instituting blood cross-matching and performing instrument validation.

Participants alluded to challenges of sustainable implementation of long-term and short-term practice changes that have been previously described as barriers to PALM access.⁴ These included lack of human resources and inconsistent managerial oversight across the different laboratories, inadequate knowledge and training of quality control procedures, and unreliable funding for equipment, consumables, and maintenance.

Challenges and Insights

Short-Term Visitor Programs

Given the short-term nature of the training, the faculty were prepared to deliver a wide array of high-yield topics in transfusion medicine, clinical microbiology, and clinical chemistry. We found that participants preferred a focus on fewer but more in-depth didactics and discussions of practical applications of laboratory medicine principles such as phlebotomy practices, sources of preanalytical errors, and optimization of available testing protocols. Although we covered less material than originally planned, the training stimulated lively discussions and sharing of knowledge between facilitators and participants and, more significantly, among participants deriving from and serving different rural areas.

The modification of the content both pretraining and on-site highlights the issue with short-term visitor programs such as ours that are a common model in global health and have been associated with unintended outcomes.⁵ Nonsustainability is particularly problematic in the case of a single or intermittent visit. This issue needs to be carefully addressed or at least acknowledged with transparency. For that reason, it might be prudent to design short-term programs with the understanding that follow-up may not occur or will be delayed. Such programs would focus on local needs that could be addressed on site or for which follow-up is within the means and capacity of the participating hosts. For example, it is reasonable to expect that modifications of blood smear staining protocols or phlebotomy best practices are more likely to be implemented following a 1-week training course. On the other hand, appropriate handling of blood products and creating and maintaining a laboratory procedure manual are examples of practice changes that require follow-up and, for some, repeat visits. These discussions could take the form of virtual pretraining, which would help with content design and enhance the value of on-site training. A pretraining site visit is another option to identify some

of the local needs but may be outside the allocated budget while virtual pretraining is essentially free. In any case, sustained communication between facilitators and hosts and a high degree of flexibility and willingness to modify course content during both the preparatory stages and on-site delivery are critical.

Improving Laboratory Medicine in Low-Resource Settings

The training was conducted by physicians trained in clinical pathology and subspecialized in the areas of transfusion medicine, clinical microbiology, and clinical chemistry. The learners were laboratory staff and supervisors from KGH and other health care facilities in Sierra Leone and Harper, Liberia. The participants reported struggling with both receiving recognition for and appreciating their own contribution to patient care given the broken cycle of trust between the laboratory and clinicians.¹⁶ We emphasized the role of pathologists and laboratory scientists in health care delivery by including clinical case studies in the lectures and during the ensuing discussions that virtually brought the patient to the laboratory. The validation of the participants' experiences was further underscored by confirming that the misrepresentation or lack of understanding of the role of laboratorians is often present even in high-income countries with advanced health care systems.¹⁷⁻¹⁹

Other training workshops have reported changes in the attitude of clinicians toward the laboratory as they gained knowledge of its operating principles.¹² In a study of physicians' and nurses' satisfaction with the clinical laboratory, participants underscored the need for better communication between clinicians and laboratorians for improved service.²⁰ On the other side of the equation, it is essential that laboratory personnel feel empowered about their work and appreciate how they contribute to patient care across all phases of testing.

Long-Term Follow-up

Plans for long-term follow-up included quarterly virtual meetings as a way to support the suggested practice changes after the training with the possibility of repeat visits to other sites as well. Time and budget considerations were unsurprisingly key constraints, but it was also challenging to schedule the virtual follow-up sessions on top of daily clinical, teaching, and administrative duties. Furthermore, virtual meetings were not an option for many participants outside KGH with whom communication posttraining was difficult. Importantly, technical resources for providing input or feedback on blood smear or parasite smear interpretations such as microscope cameras were lacking.

One current model of long-term follow-up that could be implemented is the telementoring approach fostered by Project ECHO²¹ that includes periodic (eg, weekly, monthly) 1-hour sessions, including brief didactics (typically less than 10 minutes), followed by case or problem presentations and discussions with participants. A number of communication programs (eg, Skype and Zoom) are now widely used following the COVID-19 pandemic and provide a readily available format. This approach to real-time problem solving allows the site participants to bring actual challenges to the mentors, develop ideas for future in-person workshops, and create sustained connectivity between the teams. Such online programs use free or low-cost software and are driven by the desire to professionally develop both mentors and mentees.

Loh et al²² have proposed that a continuous partnership between a single visiting organization and multiple hosts in the local community is the model most likely to have enduring impact. While definitive studies are lacking, there is compelling evidence that mentored laboratories show improvement in quality.^{8,10,23} Overall, this suggests that long-term follow-up is crucial for maintaining impact; however, there is equal emphasis on the need for extensive time commitment²⁴⁻²⁶ as well as the significant challenges in maintaining follow-up even in well-structured programs.^{11,23} Several factors appear to be essential for success, including clearly articulated goals in alignment with national plans, sufficient commitment on both sides, and well-defined methods of assessing progress.¹⁰ For training courses such as we describe, discussion of the nature and the frequency of follow-up if desired should probably occur during the initial stages of course development.

Conclusions

In summary, we developed and participated in a 1-week laboratory medicine training for laboratory supervisors and technicians comprising both lecture-based learning and practical sessions at KGH in Sierra Leone. The training was well received by the participants and culminated in compilation of a list of proposed practice changes over the short and long term. For sustainability, these changes require a structured approach to continued follow-up and formal assessment that should be clearly delineated by the visiting partners in partnership with the local hosts.

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