Building Capacity in Laboratory Medicine in Africa by Increasing Physician Involvement

A Laboratory Medicine Course for Clinicians

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ABSTRACT

Objectives: To describe a 4-day laboratory medicine course for clinicians given at Addis Ababa University, Ethiopia, designed to improve the use of laboratory-based diagnoses.

Methods: Each day was dedicated to one of the following topics: hematology, blood bank/transfusion medicine and coagulation, chemistry, and microbiology. The course included lectures, case-based learning, laboratory tours, and interactive computer case-based homework. The same 12-question knowledge quiz was given before and after the course.

Results: Twenty-eight participants took the quiz before and 21 after completing the course. The average score was 5.28 (range, 2-10) for the initial quiz and 8.09 (range, 4-11) for the second quiz (P = .0001). Two of 12 and 8 of 12 questions were answered correctly by more than 60% of trainees on the initial and second quiz, respectively.

Conclusions: Knowledge and awareness of the role of the laboratory increased after participation in the course. Understanding of laboratory medicine principles by clinicians will likely improve use of laboratory services and build capacity in Africa.

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Upon completion of this activity you will be able to:
• recognize the limits of nonlaboratory (syndromic)-based diagnosis.
• assess the gaps in knowledge clinicians in Africa have regarding principles of laboratory medicine.
• present a curriculum on laboratory medicine for clinicians in Africa.

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Questions appear on p 461. Exam is located at www.ascp.org/ajcpCME.
on syndromic diagnosis and a strong tendency to ignore test results in favor of clinical intuition. This pattern of low trust in laboratory results among sub-Saharan African clinicians leads to treatment decisions based on clinical judgment, regardless of tests results. One way to counter this lack of trust and improve engagement is to educate clinicians about the clinical laboratory.

In the United States, the Academy of Clinical Laboratory Physicians and Scientists (ACLPS) published a proposed curriculum delineating what medical students should know about laboratory medicine. By defining a knowledge base in laboratory services, the authors lay the foundation for a better understanding of the role of clinical laboratories and expectations regarding quality of results, turnaround time, and reporting of critical values and reference ranges. Using the foundations of the ACLPS curriculum and modeled on a problem case-based approach that has been used for medical students at Emory University School of Medicine, a 14-contact-hour short course on clinical laboratory principles was designed for physicians at Addis Ababa University under the framework of the Medical Education Partnership Initiative, which seeks to increase the numbers and quality of physicians and health professionals trained and retained in sub-Saharan Africa.

The objectives of this course included bringing awareness of the function of the clinical laboratory, showcasing the ACLPS laboratory medicine foundations, and engaging physicians in a dialogue with the laboratory. In addition, courses that highlight the role of a clinical pathologist are imperative to attract medical students to the profession. In this article, we describe the course and its implementation and evaluation.

Materials and Methods

The 14-contact-hour course was divided into 4 half-days (3.5 hours per day). The topics taught included hematology, blood bank/transfusion medicine, microbiology, chemistry, urinalysis, and coagulation. Each day started with 1.5 to 2 hours of lectures, followed by 1.5 hours of case-based learning solved in groups, and ended with a discussion of the cases (0.5 hours). The trainees were divided into three groups that included all the clinical specialties that participated in the course, and every day one group had a guided tour of the clinical laboratory at Black Lion Hospital as part of the curriculum.

Lectures

The four faculty clinical pathologists toured the Black Lion Hospital Clinical Laboratory the day before the course started so that their lectures were tailored to

<p>| Table II Topics for Lectures and Cases for Case-Based Learning |
| --- | --- |</p>
<table>
<thead>
<tr>
<th>Area</th>
<th>Description of Lecture Topic and Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hematology</td>
<td>Lecture Different methods for obtaining complete blood cell count results and their impact on interpretation</td>
</tr>
<tr>
<td>Chemistry</td>
<td>Lecture Scope of laboratory testing (type of specimens, number of tests)</td>
</tr>
<tr>
<td>Microbiology</td>
<td>Lecture Principles of microbiology as several separate disciplines</td>
</tr>
<tr>
<td>Blood bank/transfusion medicine and coagulation</td>
<td>Lecture Whole blood collection and processing</td>
</tr>
</tbody>
</table>

Cases for case-based learning

1. Lymphocytosis (64-year-old woman with fatigue and lymphocytosis)
2. Microangiopathic anemia in an HIV-positive patient
3. Malaria

1. Diabetic ketoacidosis in a pregnant patient (25-year-old pregnant woman with shortness of breath and dizziness)
2. Paraproteinemia
3. Abnormal urinalysis

1. Cryptococcal meningitis in an HIV-positive patient (22-year-old man with persistent headaches and fatigue)
2. Tuberculosis in an HIV-positive patient
3. Sepsis

1. Anemia in patient with colon cancer (50-year-old man with lightheadedness, fatigue, and shortness of breath)
2. Patient with sickle cell anemia with alloantibodies
3. Hemophilia

HIV, human immunodeficiency virus.

* Interactive homework case (http://path.emory.edu/EPeP/; in the section Laboratory Principles for Clinicians, use EPeP as username and password).
locally available test menus. The chemistry and hematology lectures presented the general clinical laboratory foundations from the aforementioned ACLPS curriculum. Selected laboratory principles delineated in the ACLPS curriculum specific to the different areas were integrated in all lectures given by the clinical pathology faculty. In addition, there were two local invited speakers. The first was a representative from the African Society for Laboratory Medicine who described the activities and plans of this organization that are dedicated to strengthening clinical laboratory capacity throughout Africa. A second invited speaker from the Central Blood Bank in Ethiopia gave a lecture on the history and future plans of the Ethiopian National Blood Transfusion Service. Last, one infectious disease clinician from the United States gave a presentation on how he uses laboratory results in clinical care. Table 2 presents the topics addressed in the lectures based on the different areas.

### Case-Based Learning and Discussion

We prepared 12 cases for case-based learning and discussion, three for each day of the course. Table 1 lists the topic of each case. These clinical cases included questions that highlighted laboratory principles covered during the lectures. Printed versions of the cases were brought to the classroom so that the trainees could take notes as they were answering the questions and could be used as future reference. One faculty member was a facilitator for each group of trainees. Trainees were encouraged to use multiple sources to solve the questions in the cases. These included textbooks on laboratory medicine, blood bank/transfusion medicine, coagulation, and hematology that were brought by the faculty, as well as Internet resources. After the groups had finished answering the questions, they each had to give a brief oral presentation to the rest of the class summarizing their case, the discussion that had occurred while solving the case questions, and a list of three to five brief points (“pearls”) that they had learned about laboratory medicine from their case.

Participants were given a USB drive at the beginning of the course with course materials including the 12 cases prepared for case-based learning, four interactive learning modules, and reference reading materials. Trainees were asked each day to do an interactive computer-based case that was present in the USB drive as homework to affirm the concepts learned during the day. The interactive cases were based on one of the three cases that had been discussed during that day’s session (see Table 1).

On the first day, we performed an assessment of attitudes regarding laboratory services as well as a 12-question knowledge quiz regarding laboratory medicine Table 2. A total of 28 trainees completed the quiz and attitude assessment. Eighteen trainees completed and returned these documents on the first day, and 10 more trainees did this on the second day. At the conclusion of the course, the same knowledge quiz that had been given at the beginning of the course was administered, with 21 trainees completing it. To define if the differences in scores were statistically significant between the knowledge quiz before and after, an unpaired two-tailed t test using the online QuickCalcs t test calculator (GraphPad Software, La Jolla, CA) was performed.
Results

Of the 28 participants who completed the assessment before the course, there were 21 residents, three faculty members, and four individuals who work in the laboratory. All participants were from Addis Ababa University, except for one resident who was from Jimma University. The clinical specialties represented included anatomic pathology, internal medicine, surgery, dermatology, obstetrics, and anesthesiology. Most participants (61%) came to the course because their supervisor suggested it, while 38% stated that they were interested in the topic.

The class mean score in the precourse knowledge quiz was 5.28 (range, 2-10), with only two of 12 questions being answered correctly by more than 60% of the participants. The topics of the questions answered correctly included reference ranges and diagnostic sensitivity and specificity. The class mean score on the same knowledge quiz done at the conclusion of the course was 8.09 (range, 4-11). Eight questions were answered correctly by more than 60% of participants. In addition to the previously correctly answered questions, the gains were present in all areas (blood blank/transfusion medicine, hematology, chemistry, and microbiology). Figure 1 graphs the number of correct answers before and after the training. The improvement in knowledge based on the two tests was statistically significant ($P = .0001$).

All 24 participants who did not work in the laboratory stated that they had had interactions with the laboratory since most had come to retrieve results or for obtaining blood products for their patients. Two participants said they had come to the laboratory because they had unexpected results on their patients, and one said that he or she wanted to know about reference ranges. Likert scale results regarding interactions and trust in the laboratory and use of results are presented in Table 3. Of note, although no participant rated the interaction and trust in the laboratory as least valuable, most responses were neutral. Regarding use of laboratory results, most responses were either neutral or slightly above neutral. Of the participants, 57% sent laboratory tests to the hospital laboratory, 14% to outside laboratories, and 29% to either. Reasons to send the specimens to the hospital laboratory included low cost, accessibility, and ease for the patient and clinician; those sending specimens to outside laboratories cited unavailability of tests and lack of trust in results obtained at the hospital laboratory. When asked what they did when they thought there was a laboratory error, 50% of participants said they repeated the test in an outside laboratory, 29% said they would repeat the test in the hospital laboratory, and 33% said that they would communicate with the laboratory. When asked about barriers between the laboratory and clinicians, participants cited poor communication and isolation from each other (32%), personal differences such as lack of understanding of what each group does (32%), lack of time (21%), and lack of tests needed (10%).

The assessment of attitudes performed after the course was filled out by 11 participants who came to the entire course, nine who came on 3 days, and one who came on 1 day. Nineteen participants said they had changed their attitude toward the laboratory as they had learned and appreciated what the laboratory does to render results and the importance of communication between clinicians and the laboratory. All participants said that the course would be used in their daily work: 39% stated that the increased knowledge would make them more aware of the different issues that occur in the laboratory, 33% stated that they would communicate with the laboratory when they have problems, 22% said that the course will help them with interpretation and utilization of tests, and 11% commented that they now have a positive attitude toward the laboratory. Likert scale self-assessment of the different topics learned is presented in Table 4. Of interest, for the majority of topics, the participants felt very comfortable with the knowledge they had learned and appreciated what the laboratory does to render results and the importance of communication between clinicians and the laboratory.

Figure 1 Knowledge assessments. The x-axis shows the number of correct answers and the y-axis shows the number of trainees with the correct answers. In blue are the results from the knowledge quiz performed before the course and in red those of the quiz done after the course.

Table 3

<table>
<thead>
<tr>
<th>Attitude</th>
<th>Scale, No. (%)$^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interaction with laboratory personnel</td>
<td>0 6 (25) 9 (38) 4 (17) 5 (21)</td>
</tr>
<tr>
<td>Trust in hospital laboratory results</td>
<td>0 7 (29) 9 (38) 7 (29) 1 (4)</td>
</tr>
<tr>
<td>Results used for diagnosis</td>
<td>0 0 6 (26) 10 (43) 7 (30)</td>
</tr>
<tr>
<td>Results used as prognostic indicators</td>
<td>1 (5) 1 (5) 7 (32) 9 (41) 4 (18)</td>
</tr>
<tr>
<td>Results used to follow up patients</td>
<td>1 (5) 1 (5) 7 (32) 9 (41) 4 (18)</td>
</tr>
<tr>
<td>Results used to treat patients</td>
<td>0 2 (10) 7 (33) 8 (38) 4 (19)</td>
</tr>
</tbody>
</table>

$^a$ Scale ranges from 1 (least valuable or used) to 5 (most valuable or used).
Table 4
Likert Scale Regarding Self-Assessment of Topics Learned During the Course

<table>
<thead>
<tr>
<th>Self-Assessment</th>
<th>Scale, No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal values (reference ranges)</td>
<td>0  3 (15)  17 (85)</td>
</tr>
<tr>
<td>Sensitivity and specificity</td>
<td>0  4 (20)  16 (80)</td>
</tr>
<tr>
<td>False-positive and false-negative results</td>
<td>0  1 (5)  19 (95)</td>
</tr>
<tr>
<td>Variability of results depending on method</td>
<td>0  3 (15)  17 (85)</td>
</tr>
<tr>
<td>Interferences</td>
<td>3 (15)  6 (30)  11 (55)</td>
</tr>
<tr>
<td>Preparation of patient and specimens</td>
<td>0  1 (5)  19 (95)</td>
</tr>
<tr>
<td>Result interpretation using different methods</td>
<td>0  6 (30)  14 (70)</td>
</tr>
<tr>
<td>Laboratory quality control measures</td>
<td>2 (10)  4 (20)  14 (70)</td>
</tr>
<tr>
<td>Critical values</td>
<td>1 (5)  4 (20)  15 (75)</td>
</tr>
<tr>
<td>Interaction with laboratory professionals</td>
<td>1 (5)  0  19 (95)</td>
</tr>
<tr>
<td>Turnaround time</td>
<td>2 (11)  4 (21)  13 (68)</td>
</tr>
<tr>
<td>Use of the tests discussed</td>
<td>0  3 (15)  17 (85)</td>
</tr>
<tr>
<td>Interpretation of point of care</td>
<td>1 (5)  4 (20)  15 (75)</td>
</tr>
</tbody>
</table>

* Scale ranges from 1 (not comfortable) to 3 (very comfortable).

Discussion

Knowledge regarding the foundations of laboratory medicine was improved using a 14–contact-hour course delivered using lectures, case-based learning, case discussions, and interactive cases as demonstrated by the knowledge quizzes. Participants had good base knowledge regarding normal ranges and diagnostic sensitivity and specificity prior to the course, while gains in knowledge were observed in laboratory principles specific to all areas. In the evaluation performed after the course, participants commented they had changed their attitude toward the laboratory as they gained knowledge of what happens in the laboratory. In addition, all participants stated they would incorporate what was learned in their daily practice. Although the quiz and assessment can measure only a small amount of knowledge acquired recently and an initial intent to change behavior, the participant engagement observed leads us to believe there will likely be a change in attitude toward the laboratory. Probably the most important gain that came through in the evaluation performed after completion of the course was the realization by participants that more communication with laboratory personnel is necessary when issues arise so as to improve patient care and laboratory services. A study of physicians’ and nurses’ satisfaction with laboratory services in Gondar, Ethiopia, stresses the need for communication between clinicians and laboratorians for quality improvement and interventions. Ultimately, having physicians who understand laboratory medicine principles will likely promote evidence-based medicine with modern laboratories and evolve into having a subspecialty in clinical pathology, either as a standalone subspecialty or integrated with anatomic pathology in Ethiopia.

It was not surprising that trainees liked case-based learning and discussions best. Case-based learning is structured so that trainees explore clinically relevant topics using open-ended questions with well-defined goals. In our course, the cases were structured targeting the laboratory tests available to them in the hospital and exploring the principles behind them. Many medical schools have transitioned to case-based curricula as they have shown to increase student enthusiasm for learning, enhance performance on tests, and improve attendance to class. Case-based learning in postgraduate training has been used as a way to expose residents to clinical scenarios they do not encounter frequently. In particular, case-based curriculum is currently used to teach clinical microbiology in a multidisciplinary approach where faculty, residents, fellows, and students of different specialties meet during microbiology rounds. To our knowledge, this is the first publication of a short course that uses a case-based curriculum highlighting general laboratory principles to clinicians in the postgraduate setting.

The homework interactive cases did not receive as high a rating as the case-based learning and discussions. A 5-year review of Duke University’s web-based informatics education also showed that students consistently rated their person-to-person, on-campus portion of the training as their favorite, although this seems to contrast with the fact that some of the trainees suggested more online material and videos for the course. Computer-based training has become very popular because it expands education.
programs that can be delivered to people in many locations worldwide and can breach time restrictions.\textsuperscript{25,26} Popular formats include lectures and videos placed on websites, virtual patients or interactive exercises, tutorials, synchronous and asynchronous forums, and other formats\textsuperscript{27,28}; however, creating e-learning material that is of good quality and is useful for trainees takes time.\textsuperscript{24,29} We created four interactive cases for the course that were not only given to trainees in USB drives but can also be accessed through the web (http://path.emory.edu/EPeP/; in the section Laboratory Principles for Clinicians, use EPeP as username and password). In these cases, there is immediate feedback after a trainee answers the multiple-choice questions. Each module is designed to highlight laboratory principles in a case-based format and should take between 15 and 20 minutes to complete.

Based on the assessment performed before the course, interactions of participants with the laboratory are frequent in the Black Lion Hospital. Most participants had gone to the laboratory to find out results on their patients. In the United States, this rarely occurs since physicians (including medical students, residents, and fellows) have access to laboratory results via electronic medical records without having direct interaction with the laboratory. Another reason for participants to go to the laboratory included retrieval of blood products. In the United States, this may happen, although nurses and technicians are frequently sent on these tasks. Thus, it is not surprising that for participants in this course, touring the laboratory was not a highlight of the program as it is in the United States when we take medical students to tour the clinical laboratories.\textsuperscript{12} Nonetheless, it is imperative that physicians visit the laboratories where tests on their patients are performed so that they realize the type of instrumentation available and that laboratory technologists know their trade, which are two laboratory facets that may not be evident by going to the laboratory to pick up results or retrieve blood products.

In our initial survey, we found that more than half of the participants send their laboratory work to the hospital laboratory since this is convenient for them and the patient and the work is affordable. However, some basic tests may not be available in the hospital laboratory because there are no reagents or the instrument is down due to lack of maintenance, so trainees said they send samples to other laboratories. It is well known that higher volume of testing allows for better quality since it requires dedicated trained personnel and supports staff competency.\textsuperscript{1} Thus, physicians should advocate to hospital administration the need to have a clinical hospital laboratory with competent staff, regular procurement of reagents, and proper instrument maintenance rather than having clinicians send specimens to outside laboratories.

In conclusion, we delivered a course that highlighted laboratory principles to clinicians using multiple formats, of which case-based learning and case discussions were the ones most accepted by the trainees. The 14–contact-hour course enabled trainees to perform better on a knowledge quiz. We believe that courses like this bring awareness to what is performed in the laboratory, improve use of laboratory services, make clinicians advocates for laboratory services, and ultimately improve patient care.

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References


