

Laboratory Equipment Training to Improve Quality of Laboratory Services and Patient Care

Success Story

I-TECH Ethiopia
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Proper management of the equipment in the laboratory is necessary to ensure accurate, reliable, and timely testing. —ISO 15189 (SLIPTA)

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ACRONYMS AND ABBREVIATIONS

ART	Antiretroviral Therapy
EHRIG	Ethiopian Hospital Reform Implementation Guidelines
EPHI	Ethiopian Public Health Institute
FMHACA	Food, Medicine and Health Care Administration and Control Agency
FMOH	Federal Ministry of Health
I-TECH	International Training and Education Center for Health
QMS	Quality-Management System(s)
QMSE	Quality-Management System Essentials
SLIPTA	Stepwise Laboratory (Quality) Improvement Process Towards Accreditation
SLMTA	Strengthening Laboratory Management Towards Accreditation

INTRODUCTION

Laboratory test results play a key role in 60–70 percent of all clinical diagnostic decisions. Clinicians also use lab tests to monitor disease over time, identify changes in patient health conditions before symptoms occur, diagnose illness, plan treatment and evaluate how well treatment is working. Therefore, well-maintained biomedical equipment is essential to any functioning health system (1).

In Ethiopia, nonfunctioning lab equipment, a lack of training in equipment operation and maintenance, and lack of equipment maintenance programs present major challenges that impede delivery of health care service at both regional and national levels—including at facilities supported by the International Training and Education Center for Health (I-TECH)

In response, the Federal Ministry of Health (FMOH) launched the Ethiopian Hospital Reform Implementation Guidelines (EHRIG) (2) in 2010. The guidelines focus on selected health management functions, including management of medical equipment. Through its laboratory support program, I-TECH Ethiopia worked with laboratories in the Afar, Amhara and Tigray regions to implement the guidelines.

I-TECH, in partnership with FMOH and the Regional Health Bureaus (RHBs), has helped to strengthen Ethiopia’s national laboratory system by building up lab technician skills, improving diagnostic services, providing essential equipment, training lab technicians in preventative maintenance, and generally helping the labs to improve their quality of service and achieve international accreditation. I-TECH has also promoted the restoration of non-functioning lab equipment to functional status in I-TECH-supported labs, thereby increasing their ability to deliver essential services.

The initiative has proven to be cost-effective. Its focus on training laboratory technicians in the safe use and preventative maintenance of equipment has reduced instrument downtime and workflow interruptions. This has helped to shorten turnaround times required for lab results, and improve the quality of lab services, providing significant benefits for the populations the labs serve.

OBJECTIVE

Provide targeted support to improve the ability of laboratory technicians to efficiently manage equipment in order to provide reliable, efficient and high-quality lab services.

IMPLEMENTATION

Equipment management and preventive maintenance training

Specific training on key automated and semi-automated laboratory equipment was provided by trained I-TECH laboratory team members, using the standard national curriculum for equipment management training developed by FMOH/EPI. The training targeted lab techs and managers/supervisors at I-TECH supported health centers, hospitals and regional referral labs. The training included both theoretical (classroom) and hands-on components.

Theoretical Training

Theoretical training was provided in the form of classroom lectures. The training consisted of 13 standard modules that included the preanalytical, analytical and postanalytical phases of specimen management, quality control and maintenance, and recording and reporting of results.



Training of laboratory technicians at Adwa Hospital, in Northern Ethiopia, on preventive maintenance of ART monitoring equipment (hematology analyzer, in this case.)

Hands-On Training

Hands-on training was provided on-site. The key pieces of equipment used for training were computerized, sophisticated machines used for monitoring HIV/AIDS patients, including flow

cytometry instruments (for CD4 blood counts), hematology analyzers (for red cell, white cell, and platelet counts), blood chemistry analyzers and semi-automated equipment (microscopes, centrifuges and photometers).

Training included techniques used for monitoring and operating equipment, performing inspections, testing, fault-finding and troubleshooting, and servicing equipment to manufacturer specifications and standards.

Critical procedures in preventive maintenance, validation and qualification of the equipment were also covered.

Preventive Maintenance Training

Training covered maintenance performed to extend equipment lifespans and prevent failure. It was usually scheduled at specific intervals, and included specific tasks, such as lubrication, cleaning (e.g., filters) or replacing parts that are expected to wear, or which have finite lifespans (e.g., tubing).



Training of lab techs on preventive maintenance of ART monitoring equipment (CD4 counter.)

On-Site Equipment Maintenance (Repair)

As a first step, non-functioning laboratory equipment at 17 I-TECH-supported labs was logged into inventory. Each piece of equipment was then categorized and prioritized according to function and to where it was most needed.

Once this was done, all non-functional equipment listed in the inventory, ranging from relatively simple (manual) devices to fully automated equipment, was categorized and

prioritized according to function and importance in patient testing. I-TECH and facility leaders performed this task, calling in outside service providers to perform repairs on-site, saving the labs the time, effort and expense of performing repairs themselves.

Evaluating Equipment Management

Improvement in laboratory equipment management following the training workshops was confirmed by exit audits, using SLIPTA checklist-based scoring. The equipment management indicators on the SLIPTA checklist make up the third critical indicator (Equipment Record Maintenance) of the Equipment section of the checklist, which has a maximum value of 30 points.



The classroom session of the equipment management training workshop.

Sample Turnaround Time

Turnaround time is the total elapsed time from when a test is ordered to when the results are verified and released. Shorter turnaround times indicate improvement in delivering timely service. Improvements in turnaround times were recorded for both ART monitoring (CD4, chemistry, and hematology analysis) and tuberculosis sputum smear microscopy tests.

Evaluation of Overall Quality Improvement

Overall improvements in quality were measured and confirmed through a series of evaluations using the standard SLIPTA checklist and scoring system.

RESULTS

Since 2007, I-TECH has worked in collaboration with the RHBs, regional laboratories and the EPHI to provide specific training on lab equipment, certifying more than 300 lab techs in preventive maintenance.

This training has resulted in less unexpected equipment downtime, improved performance vis-a-vis standard requirements, less need for major repairs, less waste of reagent and control materials, less time spent repeating procedures and fewer delays in obtaining test results.

Turnaround time is used as a means of verifying improvements in the quality of laboratory services. Improvements in turnaround times were recorded for both ART monitoring and tuberculosis sputum smear microscopy tests (Table 1).

Table 1. Average laboratory turnaround times before and after training in equipment management (including preventative maintenance).

Laboratory tests	Turnaround Time	
	Before Training	After Training
CD4, chemistry, and hematology analysis ¹	12–24 hrs	4 hrs
Tuberculosis sputum smear microscopy	2 hrs	45 min

¹. ART monitoring equipment

Training had a positive impact on delivery of services, and contributed to overall improvement in laboratory quality-management systems, as measured using the SLIPTA checklist and scoring system (Table 2). Labs participating in the second cohort of the national SLMTA program were chosen for purposes of comparing the impact of equipment training on the Quality-Management System Essentials (QMSE) *Equipment* indicator, as well as on overall quality.

Table 2. The impact of equipment training on the QMSE Equipment indicator and overall quality.

I-TECH-Supported Hospital Laboratories	SLIPTA Checklist Score			
	Before Training (30 points max.)	After Training (30 points max.)	Star Scores	
			Baseline Audit	Exit Audit
Dupti	14	22	0	2
Dessie	12	20	0	2
F/Hiwot	06	16	0	0
Maychew	18	28	0	3
Mekelle	10	25	0	2

A total of 73 pieces of laboratory equipment at 17 I-TECH-supported labs were successfully restored to functioning status and returned to service between February and March 2012, increasing the amount of equipment available to the labs (Table 3); most are in use at expanded point-of-care testing sites.

Returning previously retired equipment to service helped improve relationships among laboratories and those requesting tests, as it helped to ensure continuity of lab services.

Table 3. Laboratory equipment repaired and returned to service in I-TECH-supported labs in Amhara, Tigray and Afar, February and March 2012.

Type of Equipment	Pieces of Equipment			
	Amhara	Tigray	Afar	Total
Microscopes	20	10	08	38
Centrifuges	21	06	08	35
Totals	41	16	16	73



Returning microscopes to service improves TB-sputum smear microscopy, the “gold-standard” method for detection of malaria parasites in blood.

More importantly, the training enabled trainees to communicate effectively with clinical personnel about medical equipment and safety issues, train other users in the operation and proper care of equipment, perform preventive maintenance and minor repairs in a cost-effective and timely fashion, and help establish safe environments for patients and staff.

The I-TECH initiative in restoring retired equipment enabled our laboratory to put more equipment [into] service than we had [previously], and this created patient satisfaction since we can provide the required service [in a timely fashion]. We need to maintain I-TECH’s initiative. —Referral hospital laboratory manager

CHALLENGES

We found the following challenges to efficient laboratory operation:

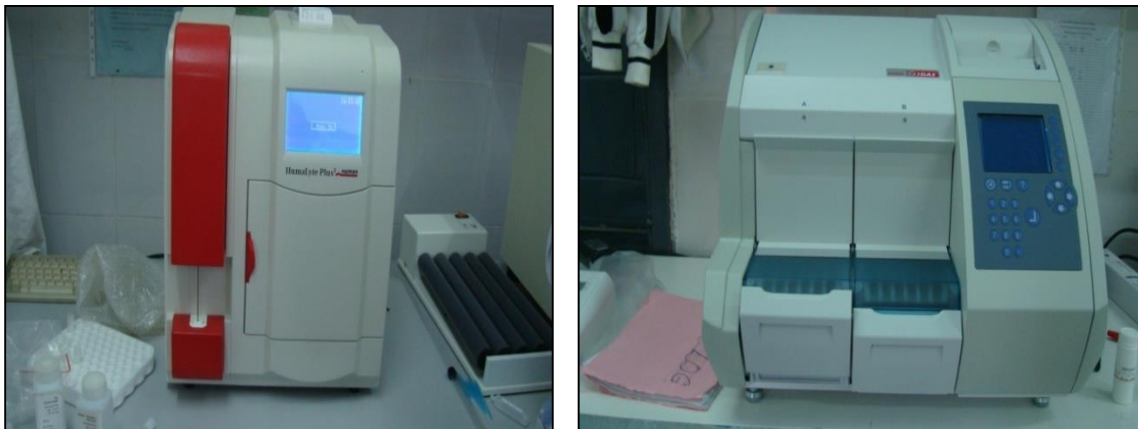
- High turnover of trained laboratory professionals. This presented the most serious challenge, contributing to significant interruptions in laboratory services. High turnover continues to undermine the ability of labs to perform their work efficiently.
- It is not common for trained laboratory staff to pass along their expertise with specific diagnostic equipment to their colleagues. The typical expectation is that training will be conducted by outside personnel.
- Lack of access to necessary spare parts or reagents (e.g., equipment calibration materials).
- Shortage of manpower. Some laboratories are understaffed, making it difficult for them to provide the on-job training.

We suffer with lack of appropriate maintenance programs [in the laboratory], and also lack of staff with [the] technical capability to manage, train, operate and provide effective equipment maintenance support. —District hospital laboratory manager

LESSONS LEARNED

Management of laboratory equipment is a core function that contributes significantly to the success of any lab. In order to ensure that equipment functions well, the users of that equipment must be properly trained.

Uninterrupted laboratory test services can be best achieved when the equipment is functional. This can be achieved by providing adequate training and mentorship to lab technicians in the operation, maintenance (especially preventive maintenance) and troubleshooting of lab equipment.



Some of the automated laboratory diagnostic equipment provided by I-TECH.

Having laboratory staff with the basic knowledge of the principal lab equipment necessary to perform preventive maintenance ensures reliable results, safe working environments and longer equipment lifespans.

In general, maintenance is cost-effective. That is, performing regular equipment maintenance is less expensive than performing extensive repairs or having to replace that equipment.

Running internal controls is critical to ensuring proper function of equipment and reagents.

It is critical that the staff who use the equipment should be trained in its calibration and everyday preventive maintenance.

Developing the human resources necessary to operate an effective maintenance program is critical.

It is critical that our key equipment is functional. This can be achieved only through training like [that] I-TECH is providing, and also sustaining our equipment management program. —Regional referral laboratory manager

CONCLUSIONS AND RECOMMENDATIONS

Equipment management is an essential component of a laboratory quality-management system. Proper management of lab equipment is necessary to ensure accurate and reliable results.

Proper training in equipment use and maintenance limits instrument downtime and workflow interruptions, and reduces turnaround times.

In low-income countries like Ethiopia, most medical equipment is imported. Unfortunately, much of this equipment is out of service. This, in turn, impairs the ability of health care facilities to provide quality services. It is therefore critical to train laboratory staff in basic preventive maintenance and repair.

I-TECH has provided advanced lab equipment (such as blood coagulation, hormone, chemistry and electrolyte analyzers) that requires proper training and management to ensure it is used correctly and maintained properly.

I-TECH, in collaboration with the Bahir Dar Regional Referral Laboratory, recently conducted inventories of lab equipment in selected labs in the Amhara region. Nearly 40 percent of the equipment inventoried was out of service, mostly due to lack of simple maintenance. In fact, the majority of problems noted during the inventory were either relatively easy to fix, caused by user error, and/or resulted from lack of preventive maintenance.

The primary responsibility for the care and maintenance of laboratory equipment rests with its users, i.e., lab techs. Therefore, labs should establish and maintain equipment management programs. Such programs should include proper training of staff, ensuring that all users are trained in operation and preventive maintenance of equipment, monitoring the use of that equipment (including routine review of equipment records), updating maintenance procedures as needed and ensuring that all procedures are followed.

All users should understand how their equipment works, what its limitations are, and what it can and cannot do. Accordingly, users should be trained to perform preventative maintenance tasks on a regular basis. Training is not an activity that happens only once; it is required at various times throughout the laboratory professional's career.

Users should not be expected to start work without having received appropriate training on the equipment they will be using. This includes all laboratory equipment, from automated and semi-automated devices to auto-pipettes. Since new makes and models of equipment are constantly becoming available, lab techs need to update their skills continually. It is especially important to provide training to staff who are new to their posts.



A multi-headed (ten-headed) microscopes provided by I-TECH to regional referral and University hospital laboratories (first microscopes of its kind in the country) helping to enhance trainings on microscopy (Left). The BahirDar regional referral laboratory professionals on training (Right).

An inventory process must be introduced if the laboratory does not have an existing system for keeping track of equipment. The lab should keep a log of all equipment in its inventory; the log should be updated with information on new equipment, and should document when aging equipment is retired. Moreover, the establishment of an effective inventory program enables the lab to respond quickly and efficiently to increasing demand for the functional lab equipment that is available. Lab managers should specifically assign responsibility for keeping track of equipment to trained lab techs.

In conclusion, all laboratories should have well-organized equipment management programs that include proper training conducted on a regular basis. These programs should address equipment selection, preventive maintenance, and procedures for troubleshooting and repair. Only by doing so will patients and health care providers have access to the medical equipment essential to providing accurate diagnoses, effective treatment and/or appropriate rehabilitation.

The status of our key equipment in this laboratory is by far better than it was before. Thanks to the training provided by I-TECH, we have [almost no] equipment out of [service] and our staff are well trained enough to handle the operation and the required management, including day-to-day preventive maintenance. —Referral hospital laboratory manager

REFERENCES

1. World Health Organization. *Medical Equipment Maintenance Program Overview*. Geneva: World Health Organization; 2012.
2. Ethiopian Hospital Reform Implementation Guidelines (EHRIG), *Medical Equipment Management*, FMOH, May 2011, Chapter 9, pp. 1-30.
3. Master Plan for the Public Health Laboratory System in Ethiopia (2009–2013); Federal Ministry of Health (FMOH)/Ethiopian Health and Nutrition Research Institute (EHNRI), January 2009.