

MEDICAL LABORATORY SUPPORT IN A FIELD MEDICAL UNIT DURING EARTHQUAKE RELIEF ACTIVITIES

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ABSTRACT

Managing a clinical laboratory in peace time presents many challenges including supplies, instrument downtimes and personal issues. We observe the same and many more at an exaggerated scale while working in a field medical laboratory in an austere environment. Lab staff and pathologist have not only to carry out routine duty of performing lab investigations but many other tasks assigned to them in the field. Some of the requirements for a good laboratory service in the field include motivated staff, supplies including proper equipment and reagents along with their backups, power supply, adequate space, storage facilities, communication skills and a good administration. It is a unique experience. The purpose of this study is to present workload distribution along with some observations and impressions regarding medical laboratory support during earthquake disaster in Central Java, Indonesia and suggest measures for improvement of lab services in the field.

Key words: Field medical laboratory, field hospital, earthquake, relief activities, equipment, reagent kits, tests

INTRODUCTION

An earthquake of magnitude 6.2 on the Richter scale rocked Yogyakarta and Central Java Provinces, Indonesia on 27 May 2006. (Fig. 1) It played havoc with the lives of the local population; the effects were augmented by an eruption of a volcano Mount Merpai located in Central Java¹. (Table 1)

On Friday Jun 2, 2006 Pak Army Medical Mission contingent along with a 75-bed field hospital left Rawalpindi in a PAF C-130 aircraft to conduct rescue and relief operations in the earthquake hit areas for three weeks duration. This field hospital was commanded by a Lieutenant Colonel and comprised of 14 specialists, two lady doctors, five general duty medical officers (GDMOs), 47 paramedics and two nurses along with 10 tons of medicines. The medical team was capable of treating 300 outdoor patients per day including surgery along with provision of routine lab investigations. The field hospital was equipped with a mobile surgical unit capable of undertaking 25 major surgical operations in a day

We reached Solo city by the evening of June 3, 2006 and proceeded to our camping place in a remote and

badly affected area near village Tirtomarto, District Chewas, Central Java, Indonesia. We decided to set up our Field Hospital in a big grassy ground near a damaged school building. The field hospital consisted of a series of tents arranged in U-shaped pattern in one half of the ground along with living area for doctors and paramedical staff in the other half. Each tent was dedicated to a specific function: an out patient department (OPD), a waiting area for patients, a Dental unit, a medical ward, a surgical ward, an operation theatre (OT), a recovery room, an ITC, an orthopedic unit, an X-ray unit, ultrasound, and a Field Laboratory along with mess area, and a tent for commanding officer (CO) office cum briefing cum recreational area for officers. (Fig. 2) The hospital was entrusted with the job of making all efforts to help the earthquake victims in the friendly country. It remained deployed in Indonesia for one month and 15 days and carried out relief work which received wide applause.

MATERIALS AND METHODS

This study was conducted in a field medical laboratory at Pakistan Army Medical Mission Hospital during

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earthquake relief activities in June-July 2006 in Kalatan District Chewas, Central Java, Indonesia.

Laboratory Composition

The hospital inventory was finalized and the medical and paramedical staff joined the contingent in CMH Rawalpindi on a very short notice. There was very short time to thoroughly check the lab items provided. There were two lists of supplies. A list of equipment and reagents provided by medical directorate and the other included a dry chemistry analyzer, a small centrifuge and some reagent kits donated by CMH Abbottabad which were categorized, on inspection, as backup items. The lab equipment is listed in Table 2.

There was no time to reorient every thing. It was assumed that, with a few exceptions, we would fairly be

Area affected	500 sq km
Population affected	3.2 million
Deaths	6725
Injured	45,201
Houses damaged	610,551
Health facilities destroyed	46
Health facilities damaged	89

TABLE 1: KEY IMPACTS OF EARTHQUAKE

S. No.	Nomenclature	No.
1.	Chemistry analyzer (Metrolab 1600)	01
2.	Reflotron and pipettes (backup)	01
3.	Microscopes, binocular	02
4.	Microscope Bulbs	10
5.	Water Baths electric (37 C ⁰)	02
6.	Timer/Stop watch	01 (each)
7.	Sahli Hemometer complete	02
8.	HB, WBC, RBC Pipettes	30
9.	Westergren ESR Tubes	90
10.	Test Tubes small	03 (only)
11.	Test Tube Racks	02
12.	Centrifuges Table Top	02
13.	Distiller (Still) electric	01
14.	Micro Pipettes 5,10,50,100,1000 ul	01(each)
15.	Autoclave	01
16.	Needle cutter	01
17.	Tourniquets	02
18.	Disposal Syringes 3 cc, 5 cc	500(each)
19.	Glass Slides with Cover Slips Pkts	08 (each)
20.	Lancet Prickers, Pkt of 200	02

TABLE 2: EQUIPMENT PROVIDED TO THE FIELD LAB

Tests	Number
Blood glucose (F)	73
Blood glucose (R)	329
Blood Urea	210
Serum Creatinine	166
Serum Bilirubin	214
ALT	214
ALP	214
Total Protein	3
Blood Cholesterol	15
Blood CP	413 (1239 procedures)
Blood Hbs	157
TLC, DLC	5 (10 procedures)
MP	4
Platelets	14
Blood groupings	13
Rh	13
Blood donations	1
Peripheral blood film examinations	9
Bleeding Time	11
HBsAg	188
Anti-HCV	188
HIV	146
Urine RE	434
BS, BP	4 (8 procedures)
Body fluids	2
Sputum for AFB: ZN	4
Stains	
Urethral pus swabs	1
Stool RE	1
Total tests	3046 tests (3881 procedures)

TABLE 3: LAB TESTS PERFORMED IN THE FIELD LAB

able to provide necessary support to our clinical colleagues for three weeks duration according to our initial plan.

Lab staff included a pathologist (principal author) and two senior lab technicians along with a part time sanitary worker. Later a local interpreter joined us after hospital was deployed in the field.

The patients and lab tests

The patients who were advised various lab tests by out patient department reported at the lab for specimen submission. Samples from the admitted cases were brought to the lab by a porter. The field laboratory



Fig. 1: Post earthquake devastation, Central Java, Indonesia

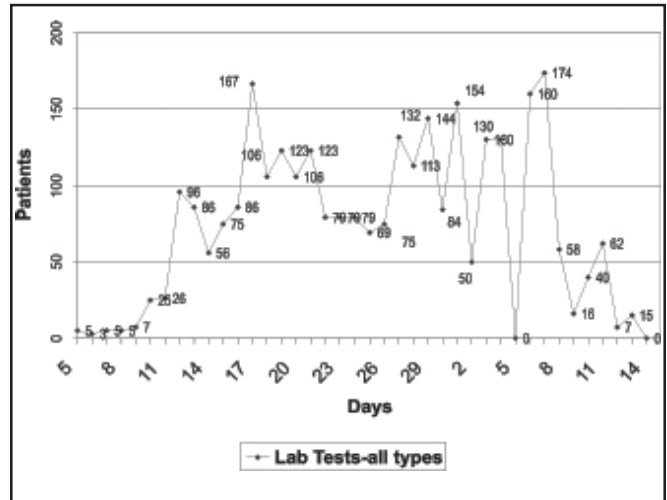


Fig. 4: Lab workload – 5th June –14th July 2006



Fig. 2: A general view of Pak Medical Mission field Hospital



Fig. 5: Patients attending lab



Fig. 3: Laboratory activity



Fig. 6: Lab layout



Fig. 7: A typical test procedure steps

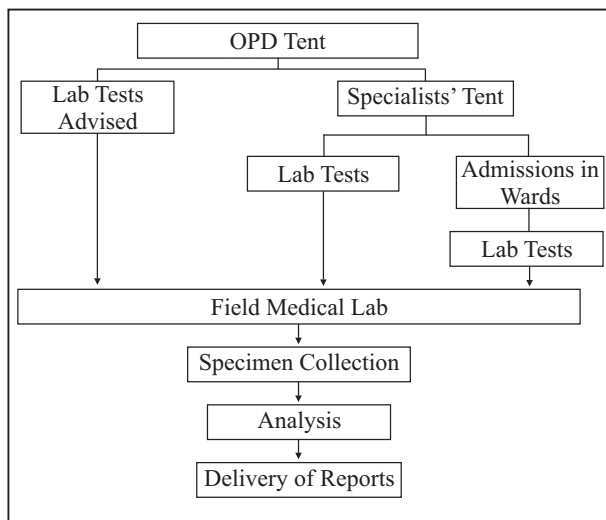


Fig. 8: Pattern of work flow



Fig. 9: Means of communication



Fig. 10: Visiting delegates

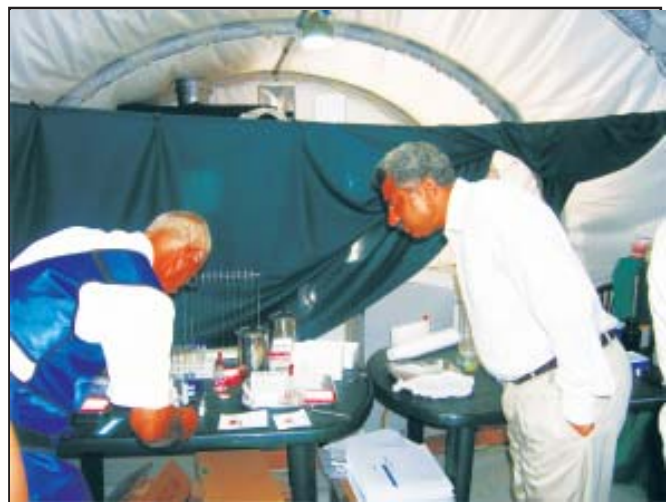


Fig. 11: Cuban Field Medical Hospital Lab

had to provide support in routine hematology, chemistry, serology, blood banking and clinical pathology tests.

RESULTS

The laboratory became operational on June 5, 2006, two days after arrival in the country (Fig. 3). A total of 30,757 patients received treatment at the field hospital between June 5 and July 15, 2006. A total of 2956 patients of all ages ranging from new born to above 90 years were referred for laboratory examinations (9.2%), 3046 lab requests submitted, and 3881 individual procedures were performed (Fig. 4, Table 3).

Out of 434 urine REs performed, 39 showed pus cells (UTI), 16 showed RBCs (microscopic hematuria) and 20 patients had pus cells and hematuria both. In 54 cases albumin and in 11 cases glucose was found present ($\geq +$) while BS BP and ketone bodies were detected in one specimen each.

No case of malaria was seen in the peripheral blood films in this tropical part of the world. On peripheral blood film examinations hypochromia and microcytosis was seen in 2 cases while 2 patients had chronic myeloid leukemia (CML) and one had aplastic anemia.

Out of 214 LFTs performed, a rise in both serum bilirubin and ALT was found in 3 cases while isolated ALT rise was seen in 17. Seven patients had impaired RFTs.

Out of 128 individuals 4 were positive for HBsAg, while none was positive for Anti-HCV. A 35 years old female was identified as having HIV test positive using device method and was referred to a tertiary care hospital in Jakarta for confirmation and registration.

Lab staff has to do many other jobs assigned to them in the field.² Our lab technicians participated during initial deployment and later in all daily activities. In the initial 3 weeks lab was open from 0730 h in the morning till 2200 h in the night. In the last three weeks lab staff was available on call after 1800h. Most of the time was spent in the lab, however, the pathologist (principal author) also used to receive visitors, took them around in the camp, visited out reach camps, pasted posters and banners in and around the camp premises, was part of local purchase committee and gave innumerable suggestions to the command.

DISCUSSION

In a field lab, staff and pathologist have not only to carry out lab investigations but many other tasks assigned to them. The requirements for a good laboratory service in the field include motivated staff, supplies, backups, adequate space, storage facilities, communication skills and a good administration. This experience not only provides an insight into the nature of medical facilities and laboratory support in an earthquake affected area of Indonesia but also highlights weaknesses inherent in our system and a potential for improvement.

For most of the things we had backup support available like a dry chemistry analyzer served as a backup instrument for the semi-automated chemistry analyzer. Similarly there were two microscopes, two water baths, spare pipettes and two Neubaur chambers. We did not have a dedicated freezer or a proper blood bank.

The manual of our chemistry analyzer was missing at the time of departure. However it posed no problem as we were familiar with the daily maintenance and programming of this instrument. Such important items

should not be missing while leaving for an unfamiliar and remote area from where it is really difficult to contact the suppliers and vendors back at home.

Field hospitals are supposed to provide medical cover to the patients during acute phase of disaster till the local medical infrastructure is functional again. We had reagent kits available for performing glucose profile, liver function tests and renal function tests, cholesterol, sera for blood grouping, Rh and cross match, Leishman stain for blood complete picture (CP), malarial parasite (MP) and peripheral blood films for morphology, and stains for routine microscopic examination of fluids, sputum and swabs. Strips were provided for urine routine examination (RE), reagents for bile salts and bile pigments (BS, BP) and serology kits for HBsAg, Anti-HCV and HIV. We had planned for three weeks but our stay, though the acute phase was over, got extended by another three weeks on the request of Indonesian government making a total of six weeks.

An approved lab inventory is very important to avoid any undue confusion before departure.³ A field autoclave and a few petri-dishes provided were never used as there was no microbiology set up provided. An old fashioned still also sat idle because of lack of a continuous running tap water. However ampoules of distilled water were available in sufficient number for use with chemistry analyzer. A few reagent kits may not be suitable for your analyzer. A number of reagent kits issued were those provided by the donor countries for our own Oct 8, 2005 earthquake. These were unfamiliar to our technicians. Although with some improvisation the same could be used in peace conditions but it was difficult in such an austere environment. We kept them aside.

Dry chemistry auto-analyzer Reflotron was our backup chemistry analyzer. Except for urea dry reagent strips no other reagent strips were available in case our frontline analyzer went out of order.

We did not have electrolytes analyzer. Although surgeons did ask for serum sodium and serum potassium in a few patients but knowing non-availability of this facility did not ask us again. Same was the case for PT, PTTK, CK-MB and pregnancy tests.

The items such as useless reagent kits, distiller, autoclave and water baths only increased our load table. These could not be handed over back to the issuing authority in the very short time before departure. This emphasizes the need for a laboratory advisory board to assemble and develop a complete inven-

tory of a field medical lab including staff, equipment, reagents and other consumables.

Equipment Installation/ behavior

A thorough initial inspection of the equipment was carried out. Servicing and calibration of chemistry analyzer Metrolab 1600 by the supplier was arranged at pathology lab CMH, Rawalpindi at very short notice. When the equipment was unpacked at Tirtomarto, Central Java, the peristaltic pump of chemistry auto-analyzer was found out of order. It was found that the belt was lying loose inside the carton probably due to shocks / turbulence of flight and handling of luggage during the 18 h journey. After replacing the belt the same did not function again. It was manually moved and cleaned with dry absorbent cotton which removed the existing humidity and dust from the wheels and shaft. It started functioning smoothly and never bothered us again.

Laboratories in the field require dedicated power supply.⁴ There was a powerful generator which was installed on the very first day; moreover local electric power supply lines were still intact and soon with permission of local authorities a link was established by our electrician. There was, however, a lot of fluctuation in the voltage and we were scared of our only stabilizer getting out of order but luckily it kept working.

Reagents storage/ performance

Most of the reagent kits require storage at 2–8 C°. There was no dedicated refrigerator. Most of the reagent kits, except for a few, were kept in normal cartons and boxes. This is, of course, an unbelievable situation. We, however, tried to protect them from direct exposure to sun. It is surprising that the reagent kits behaved fairly well in extremely hot temperatures.

Lab Staff behavior

Due to long working hours from morning till evening lab staff becomes tired and starts showing 4'O clock phenomenon.⁵ Staff was motivated to be polite and show a friendly behavior to victims and refrain from expressing any irking remarks or gestures in the rush hours even if tired. Staff prepared the lab reports ready for delivery to the patients in time. This resulted in 100% staff-patient compliance. People eagerly visited the lab, submitted their specimens and waited for their test results. (Fig. 5) Lab was always kept tidy and clean. (Fig. 6)

A typical test procedure

A test procedure in a field lab is no different from the one in a hospital lab during peace time from patient preparation and collection of sample to analysis and delivery of test report. (Fig. 7) It is responsibility of lab staff to identify and control any preanalytical, analytical or postanalytical variables to minimize errors and ensure accurate and timely delivery of test reports. A pattern of work flow is shown in Fig 8.

Sample collection:

After being advised a lab investigation, patient reported in the lab with a request form for the test. Patient was advised to sit in a small reception area in a corner of the lab consisting of two chairs and a rug on the ground. Nearby, on a small table blood collection kit including syringes, sterile swabs, tourniquet, collection tubes etc were placed. After exposing the area was sterilized and blood was drawn and dispensed into appropriate blood collection tube and mixed if required.

Sample processing:

The sample was centrifuged if required and serum or plasma separated. Specimens were processed for other tests as appropriate.

Sample analysis: Chemistry tests were performed according to routine instructions provided in the literature. Calibration was done by the standards provided in the reagent kits. Multicontrol sera were not available therefore quality control (QC) was ensured by clinical correlation, limit checks, delta checks if applicable, running random duplicates and repeat testing of a few previous day stored samples.

Lab Informatics

The product of a medical laboratory is information.⁶ A field medical lab usually generates much data in its routine activity which can help play a role in improving patient care, disease prevention and medical research furthering our knowledge for future planning. The patient's data require an appropriate storage for an easy retrieval of the same. There was only one computer in our hospital and none was available in the lab for record keeping. We therefore used registers to keep date wise records of the demographics of the patients, diagnosis and the tests performed. Each day return was submitted to the commanding officer (CO) in the evening meeting for the central record keeping.

Blood Transfusion services

The injuries in a disaster are mostly due to trauma, asphyxia, dust inhalation and exposure to extreme

environment.⁷ Mobilization of donors, blood donation and provision of screened and safe blood in the austere environment is a challenge for a field medical lab. There were sufficient blood bags along with adequate facilities for hepatitis B, hepatitis C and HIV screening. There was no proper blood bank; however, we could use our refrigerator for this purpose. Fortunately, except for one, patients did not require blood transfusions. This was probably due to the nature of injuries as roofs of most of the houses were of light weight corrugated sheets and tiles instead of concrete. The public response is usually good in situations like this. When asked about possible volunteering for blood donation, people were found willing and cooperative.

Communication and Language problem

We tried to learn a few useful local words and prepared a short list of the same along with their meanings and kept it displayed in the lab as a quick reference. Interpreters played a very useful roll during early days of our camping and one was always available from English department of a local university for our help. (Fig. 9)

Local Health Services/ Damaged infrastructure

In Indonesia health facilities are provided both in public and private sectors. Their district and tehsil level hospitals are funded by the government mainly for keeping the infrastructure in place. Patients have to pay for the doctor's fee, for the medicines and for the diagnostic procedures including lab investigations. Hospital labs were just providing Urine RE, Blood CP, a few blood chemistry tests and a few serological tests. In district headquarter hospital Chewas chemistry tests included no more than blood glucose, urea and bilirubin with very limited facilities for the tests like cardiac profile, lipid profile, renal profile, liver function tests (LFTs), and other important lab tests.

Learning local techniques

Some times you may have to learn local techniques. In Pakistan Leishman stain is very popular for staining peripheral blood film for performing differential leukocyte count (DLC), MP, and RBC morphology. It is interesting to learn that Giemsa stain is almost exclusively used for this purpose in far eastern countries like Indonesia. We carried with us two bottles of Leishman stain thought to be sufficient for three weeks supply. We used this stock very miserly but ran short of stain very soon. The mission was also extended by three weeks time. I visited Chewas District Headquarter Hospital lab, to find if we could purchase the

same from some local vendor. I found that only Geimsa stain is available in the market. I decided to learn the technique and performed a few staining repeats. The results were excellent. I noted the procedure and purchased the same. For the rest of 3 weeks our lab technicians were very comfortable with the new technique.

Few visits to local labs or local market in the disaster area were helpful for replenishing the exhausted supplies due to workload or prolonged stay in the region.

Visits by Delegates/ Local media teams to the lab

The performance of the lab was admired by all the visitors like government officials, representatives of various NGOs and journalists. (Fig. 10) They discussed about prevalence of various medical problems in the area. Patients attending the lab were inquired and journalists were so pleased that a wide coverage was given in a number of news papers which acted as a morale booster for the lab staff.⁸

Visits to the other relief camps

Local infrastructure was badly damaged and the local hospitals were initially unable to provide necessary medical cover to a large number of affected people. Many countries like Cuba, Russia, Malaysia and Japan sent their medical relief teams. Some of them were stationed in luxury hotels while some had their relief camps in the suburbs of major cities. We visited Cuban field hospital and shared experience. Some of their members had served in Pakistan in the last year's earthquake in Balakot area, NWFP Pakistan. Their field lab was staffed by only a senior laboratory technologist performing a wide range of analytical tests. (Fig. 11) His workload was small; about 10 x Blood CPs, 2 x LFTs, 3 x blood sugars, a couple of RFTs and a few Urine REs along with some other tests. He however enjoyed a fully air-conditioned lab (split AC) with proper working benches and a good supply of necessary chemicals and reagents.

Some important considerations

It was very hot out there in the field. Tides of low mood were noticed at times. Only one pedestal fan was provided and was being used for comforting equipment, technicians and the waiting patients. It was only selflessness and motivation that kept the morale of my two technicians intact. It is therefore suggested that adequate air-conditioning be provided depending upon the weather conditions for the optimum performance of the lab.

In an open hot environment spirit evaporates and swabs become dry. Spirit swabs should be kept in a small steel bin to prevent them from drying.

In high workload situations washing tubes and reusing them becomes very difficult for the lab staff especially when only a couple of sanitary workers are available in the whole hospital premises. Sufficient number of syringes and various blood collection tubes should be available.

A pair of parallel bars and a small tub for collection of waste stains is a must for clean and tidy staining of blood films and other slides for microscopy. We improvised our own by cutting a plastic can for use as a tub and two steel rods as parallel bars for placing glass slides for staining.

We had no urine containers from the start. Urine containers were made by cutting the bottoms of mineral water bottles and were reused after washing. A refractometer may be provided for measuring urine specific gravity and urine proteins. Toilet was located about 100 yards away. It is cumbersome, especially for the ladies and elderly patients. It is, therefore, realized that arrangements should be provided near the lab.

A mini automated hematology analyzer like Sysmex poct 100i along with supplies should also be provided for the lab especially when the extent of devastation and morbidity is of this scale.

Although it may sound strange for a field lab doing these tests but availability of a pregnancy test kit and a few devices for troponin I is recommended. Many a times, they bring a difference to the patient management and outcome.

It is important to adhere to good laboratory practices (GLPs) because of lack of data about the prevalence of various infectious diseases like hepatitis and HIV in an austere environment. A liberal supply of disposable gloves and paraffin film (Parafilm) rolls must be available for handling specimens safely and securing tubes during mixing.

Occasionally you may have to transport some highly infectious material to a distant reference laboratory for which you may need to have a few containers of universal transport media.

Items like Non-heparinized plain capillary tubes for performing clotting time (CT), markers for labeling test tubes, a clipboard for holding small paper chits and request forms, beakers of 100, 500 and 1000 ml for mixing purposes and spare bulbs for analyzers and

microscopes should be available in the field. Never forget cedar wood oil for microscopy. Proper disposal of laboratory waste should be ensured in the field.

These considerations appear minor but are very important points once you reach your destination and start your work.

CONCLUSION

Without a lab support health care workers (doctors) have to rely on a patient's signs and symptoms to make a decision about how to diagnose and treat an illness which may be wrong and can result in increased morbidity and mortality. High standards of medical care therefore require laboratory support for appropriate diagnosis regardless of environmental conditions.

Doctors in disaster area have a natural tendency to dispense with the work load relying on their clinical acumen. They find it cumbersome to send patient to the lab, wait and attend them again after they come back with their lab reports. We encouraged our clinical colleagues to send patients for lab tests and facilitated them in their elective as well as emergency procedures.

Lab support in the field is, therefore, a unique experience in an austere setting. It becomes more demanding when same level of quality control and standard have to be maintained in an altogether different environment, with its challenging expectations and requirements, than at home.

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