Laboratories in emergencies

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Role of the diagnostic laboratory

• Confirm diagnoses
• Support and monitoring of treatment
  – Test for organisms (bacteria, viruses etc)
  – Sensitivity testing
  – Serology
  – Haematology
  – Biochemistry
  – Blood safety and typing
• Screening
• Outbreak investigation
• Lowered costs
• Provision of epidemiological data
  – Surveillance
  – Disease trends
• Health planning
Essential principles for a diagnostic laboratory

- Able to undertake the types of test required
- Able to handle the specimen load
- Safe and comfortable for the staff
The laboratory in emergencies

- Not a priority in acute emergency phase
- Identify most diseases/causes of death clinically: treat presumptively or symptomatically

- After the acute phase a basic lab will help improve diagnosis and quality of care
- The lab can help:
  - to identify causes of infection
  - to monitor treatment
  - for blood safety and typing
  - provide data for epidemiology
  - to identify causes of outbreaks
  - reduce expenditure on drugs
  - provide data for planning and programme assessment

- Establish strict indications for lab testing
Is a basic lab sufficient?

- Usually the type of lab that will be set up in the early stages of an emergency will be basic.
- In many areas where disasters occur there is a risk of exposure to very dangerous organisms.
  - Take account of this when the lab is set up.
  - The tests that can be done may be limited by the potential risk - some tests may not be able to be done because safe working cannot be guaranteed.
- Health emergencies may require advanced lab work or the handling of dangerous pathogens.
Any departure from the most basic type of laboratory implies a marked increase in complexity and expense, and a concomitant increase in the difficulties of maintaining the unit and providing suitable staff.
Communication

- Talk to your lab director
- Make sure you/your staff know:
  - what tests the lab can do
  - what these mean
    - Sensitivity (the proportion of people with disease who have a +ve test)
    - Specificity (the proportion of people without disease who have a -ve test)
  - time involved in different tests
  - specimens required
  - information required
  - any other limitations on lab output
- If specimens have to be sent elsewhere
  - what tests can be done
  - how long will it take
Basic laboratory

- Malaria
  - Smears
  - Rapid diagnostic tests (RDTs)
- Other RDTs
- Blood
  - typing
  - hepatitis B
  - HIV
  - differential counts
  - red cells (sickling etc)
- Bacteria – Gram’s stain
  - Gm +ves, -ves
  - bacterial meningitis (from spinal fluid)
  - TB: Ziehl Neelsen
- Parasites (internal/external)
- Water quality
Malaria microscopy
the need for trained personnel!

- b = *P. falciparum* (trophozoite)
- c = Babesiosis

- j = *P. falciparum* (schizonts)
- k = bacteria

Pictures: WHO Bench Aids
Maintenance of skills

• Technical staff need to be able to examine a certain number of slides/perform a certain number of tests daily to keep their skill levels up

• External QC
  – provision of training material
  – checking of output
Rapid diagnostic tests (RDTs)

• Many different types available:
  – Malaria
  – Dengue
  – HiV
  – Meningitis (Neisseria, S.pneumoniae, viral)
  – HbsAg,
  – Cholera
  – Typhoid
  – Urine
  – Pregnancy
  – Blood typing

• Not all can be done in simple labs or at the bed-side
• Operating temperature range
• Storage conditions
• Sensitivity
• Specificity
Basic lab and bacterial infections

• Cannot do:
  – Culture
  – Sensitivity

• Can do:
  – Gram’s stains
    • Gm+ve/-ve
      – Staphs
      – Streps
      – Bacterial meningitis
      – Mixed infections
  • Yeasts
    – Ziehl Neelsen stain (TB)
Water testing
Oxfam DelAgua kit

- Thermotolerant (faecal) coliforms
- Total coliforms
- Turbidity
- Chlorine
- pH Tests
- Conductivity
The laboratory and epidemiology

- Confirmation of outbreak (e.g. cholera)
- Confirm extent/size of outbreak
- Detailed identification of organism (e.g. *V. cholerae O1 El Tor*)
- Identify source
- Monitor spread & distribution of organism

Lab needs specimens to do this!
Using other laboratories

• If the basic lab cannot do certain essential tests (e.g. confirming a cholera outbreak) you will need to use a lab elsewhere in the country or abroad.

• Need to assess capacity of national laboratory service of host nation as a part of initial assessment, (if communicable disease treatment and control is part of your programme)
  – Types of test
  – QC systems
  – Reporting systems
  – Storage (specimens, media etc.)
  – Transport
    • Internal
    • Abroad
  – Staff & training
    • Can the lab provide suitable staff for you?
Can local labs cope?
Need expert assessment

• Lab of Connaught hospital in Freetown – diagnostic & national ref lab
• Looks good!
  
  \textit{But}

• No:
  – electricity
  – water
  – fridges
  – safety cabinets
  – etc

• Little storage – no temperature controlled storage
Transport of specimens

• Whether you are using a local laboratory or one in another country you will need to set up a system of transporting specimens.
• This may already exist in country – check as part of the initial assessment
A laboratory should have:

- A suitable building or room(s) appropriately laid out and furnished.
- Good infrastructure (water, drainage & waste disposal, power, environmental control etc.)
- Adequate numbers of staff trained in the tests to be undertaken.
- SOPs covering the tests to be undertaken & all other lab activities.
- QC (internal and external) to ensure consistency and accuracy of output.
- A safety policy based on the tests undertaken and the risks posed by the organisms present in the area.
- The appropriate equipment, reagents, media, glassware and disposables.
- Technical, engineering and logistic support.
- Good access and external communications.
The laboratory building

- Poor conditions will affect work efficiency
- Structurally sound
- Secure
- Windows - security grilles/mosquito screens/sun screens (not curtains!!)
- Well painted (oil paint)
  - easy to clean/disinfect
  - prevent dust falling onto work surfaces.
- Good benches
  - stable
  - suitable height (90 cm usually).
  - chemical resistant (acids, alkalis, stains, solvents, disinfectants)
- Good seating
Water & drains

- Adequate supplies essential
- Cover tanks
- Purification system?
- Still/deioniser
- Good drainage (large soakaways, no risk of contaminating water table)
- If town drainage is used, trap lab waste system
Waste disposal

- Treat liquid microbiological waste with heat or chemicals before discard
- Burn infectious solid waste
- Provide sharps bins and burn when full
Power

- Electricity supply - depends on number of items of equipment and run duration.
- This affects type/size of generator.
- Backup generator essential.
- Automatic switch-on system may be needed.
- Battery bank (with inverters) may be needed.
- Solar power?
- Gas (propane/butane) may be needed for Bunsen burners and/or gas refrigerators.
- Lab may take power from system used to supply clinical unit
Temperature control

- PPE is uncomfortable in high temperature (>30 °C) or humidity.
- Many rapid tests perform unpredictably above 28–30°C
- Equipment works better when cool
- Difficult to control in tents or labs built from plastic sheeting
- May require an air conditioners
- Avoid fans - can blow organisms around
- May need heating rather than cooling
Ventilation

• Helps control temperature
• Directional airflow to protect workforce
• Usually provided via doors and windows
• Don’t vent lab air into areas where people may be at risk.
• When determining lab site and layout note:
  – prevailing wind direction,
  – the situation of other buildings, paths, etc.
  – use made of the space around the building
• Ducted air extraction may be needed
Vector/pest control

• Keep pests out of the lab
  – fit windows with insect screens
  – control rodent access

• May interfere with lab work or contaminate media, specimens etc.

• Can spread pathogens from the lab to the outside.
• Initially use trained staff
  – no time to train lab assistants
  – possibility of using local staff
• Need staff experienced in relevant fields
  – parasitology
  – haematology
  – biochemistry
  – bacteriology
  – virology
• Experienced lab head (technical skills, external liaison, personnel management, stock control, etc).
• When situation stabilizes, increase staff & train/retrain local staff
Standard Operating Procedures (SOPs)

• All procedures undertaken in a lab should be laid down in SOPs.
• These should include:
  – types of tests done and methods
  – risk and hazard assessments
  – safety procedures
  – protocols for internal and external QC
  – protocols stock control
Quality Control

• Internal
  – Tests on new batches of reagents, stains etc.
  – Use of standard slides, cultures etc.
• External (national/international)
  – Examination of a % of lab specimens by external lab
  – Provision of QC specimens by external lab
Safety

• Implications for lab design and working.
• Depends on:
  – basic safety precautions
  – good staff training
  – adherence to safety requirements
  – maintaining and sustaining safety equipment
• Safety levels depend on:
  – types of tests done (whether high risk work is appropriate at local level)
  – types of organism present (pathogenicity, mode of transmission, etc)
• Safety manual
• Safety equipment
  – PPE
  – first aid
  – eyewash
  – fire extinguishers
  – safety shower
Equipment

• Must be
  – suitable
  – safe to operate
  – simple to
    • install,
    • operate,
    • maintain,
    • decontaminate
    • clean.
Fridges and Freezers

- Electrical (compression fridges)
- Multi fuel (absorption fridges)
- Solar refrigerators are available
- Ice-lined fridges useful where electricity supplies intermittent
- Use top opening equipment where possible
- May not be suitable for lab to share other fridges (specimens and antimicrobials/vaccines may not mix!)
Mobile laboratories

- Varying levels of complexity
- Available “off the shelf”
- Can just be a 4WD used to transport staff and equipment to different sites
- Same requirements as other labs
- Limitations:
  - size
  - storage capacity
  - infrastructure
  - temperature control
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