AD-A123 634 SUITCASE-SIZED MICROBIOLOGY AND CLINICAL LABORATORIES FOR DEPLOYED MILITARY MEDICAL USE(U) NAVAL HEALTH RESEARCH CENTER SAN DIEGO CA M E KILPATRICK ET AL. 1/1

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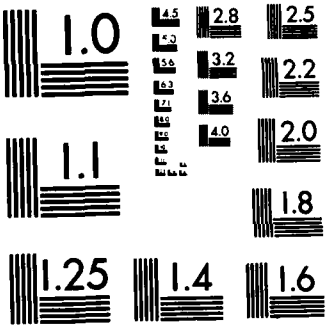

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SUITCASE-SIZED MICROBIOLOGY AND CLINICAL LABORATORIES FOR DEPLOYED MILITARY MEDICAL USE

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REPORT NO. 82-26

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BETHESDA, MARYLAND

Suitcase-sized Microbiology and Clinical Laboratories for Deployed Military Medical Use

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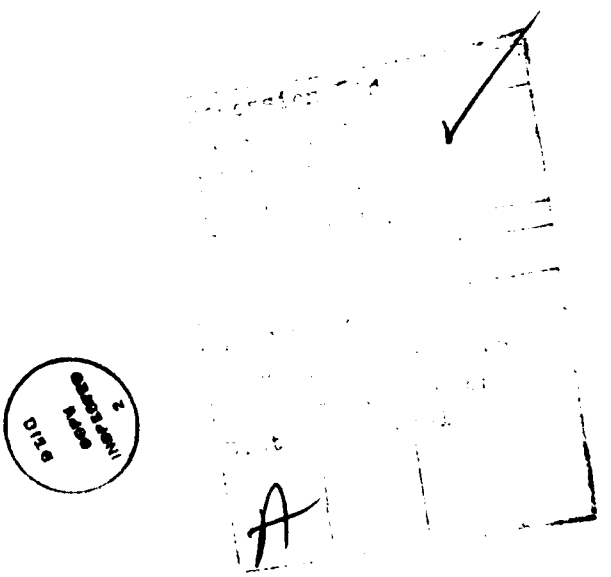
Report No. 82-26, supported by Naval Medical Research and Development Command, Bethesda, Maryland, Department of the Navy, under research Work Unit M0095-PN.002-5068. The views presented in this paper are those of the author(s). No endorsement by the Department of the Navy has been given or should be inferred.

SUMMARY

Microbiology and clinical laboratory capabilities are necessary wherever military personnel are deployed. Two suitcase-sized prototype laboratories were developed at the Biological Sciences Department of Naval Health Research Center. Their combined weight is 25 kg, with a volume of 4.5 cubic feet. Equipment includes a McArthur microscope, an electrophoresis apparatus, a waterbath-incubator, a reflectance spectrophotometer, and a centrifuge. Diagnostic reagents for counterimmunoelectrophoresis and coagglutination allow for detection of the bacterial causes of meningitis, diarrheal disease, and pneumonia. Urinalysis, routine hematology, serology, and limited chemistry studies can be performed. These laboratories were tested during deployments in jungle, desert, and cold weather environments. Results from the portable laboratories were comparable with those from standard laboratories. Portable, rapid diagnostic laboratory services should be considered a reality.



INTRODUCTION

Infectious diseases have always been responsible for major reductions in military combat effectiveness. During wartime, more military personnel are hospitalized because of infectious diseases than from combat injuries.[2] For the peacetime military, infectious diseases continue to be the leading cause of morbidity among deployed troops.[1] Early, specific diagnosis of infectious diseases permits prompt therapy and institution of control measures. In the field or on board ship, laboratory diagnostic services are limited or unavailable. Delays in diagnosis contribute to hospitalization rates.

Medical diagnoses in tertiary treatment centers utilize high technology. The required complex equipment, electrical power, and trained personnel are seldom available to deployed medical personnel. Simplified rapid laboratory methods have been developed for office practice or for bedside use. Examples are counterimmunoelectrophoresis (CIE), inert particle aggregation tests such as coagglutination (COAG) or latex agglutination, and dip-stick biochemistry tests for blood glucose or blood urea nitrogen. Miniaturization and simplification of medical laboratory equipment have increased portability.

The Biological Sciences Department of the Naval Health Research Center realized that rapid diagnostic techniques and miniaturized equipment could be adapted to create portable microbiology and clinical laboratories for use in the field. Two prototypes of suitcase-contained laboratories were developed; one was primarily for rapid diagnosis of infectious diseases and the other was for clinical hematology, serology, urinalysis, and chemistry. The equipment and supplies of these two laboratories are complementary. This paper describes the laboratories and reports the experiences of Navy medical personnel using them on deployments with the U.S. Marines and on board ship.

MATERIALS AND METHODS

Portable Microbiology Laboratory

This laboratory has been described.[4] The equipment and supplies are contained in a 47 x 39 x 21 cm plastic case measuring 2.1 cubic feet (Figure 1). It weighs 15 kg when fully supplied with reagents. Equipment is shock-protected with foam padding which also provides temperature insulation for delicate reagents. The equipment includes a McArthur microscope (Figure 2), a 15 x 15 x 8 cm electrophoresis apparatus with adjustable DC output, a 24 x 12 x 10 cm waterbath-incubator, a test reading device, a water purification system, a slide staining system, and expendable materials.

Diagnostic reagents for the CIE test are antibodies to *Hemophilus influenzae*, *Neisseria meningitidis* or *Streptococcus pneumoniae*. Reagents for the COAG test are antibodies attached to killed, stabilized *Staphylococcus aureus* cells. *H. influenzae*; *N. meningitidis*; *N. gonorrhae*; *S. pneumoniae*; *Streptococcus* species groups A,B,C, and G; *Salmonella* groups A,B,C_1,C_2,D, and E; and *Vibrio cholerae* are bacteria detectable by COAG.

There are sufficient screw cap plastic bottles for Gram stain, Wright-Giemsa stain, acid fast stain, India ink, KOH, saline, and fecal stains. The McArthur microscope may be operated while hand held or on a stand. The light source is a AA battery powered lamp. Attachment of a mirror allows external lamps or sunlight to be used as light sources. Extensive field tropical medicine use of this instrument has demonstrated its durability.[3]

The electrophoresis apparatus operates on 110 or 220 volt AC current or on a 12 volt DC automobile battery. Twelve specimens can be tested simultaneously. The waterbath-incubator also operates on 110 or 220 volt AC current or on a 12 volt DC automobile battery. It holds 34 samples. Ion exchange columns purify water for reagent preparation. The test reading device has a dark background with oblique lighting from a AA battery powered light source. The slide staining system reduces the amount of stain required per slide.

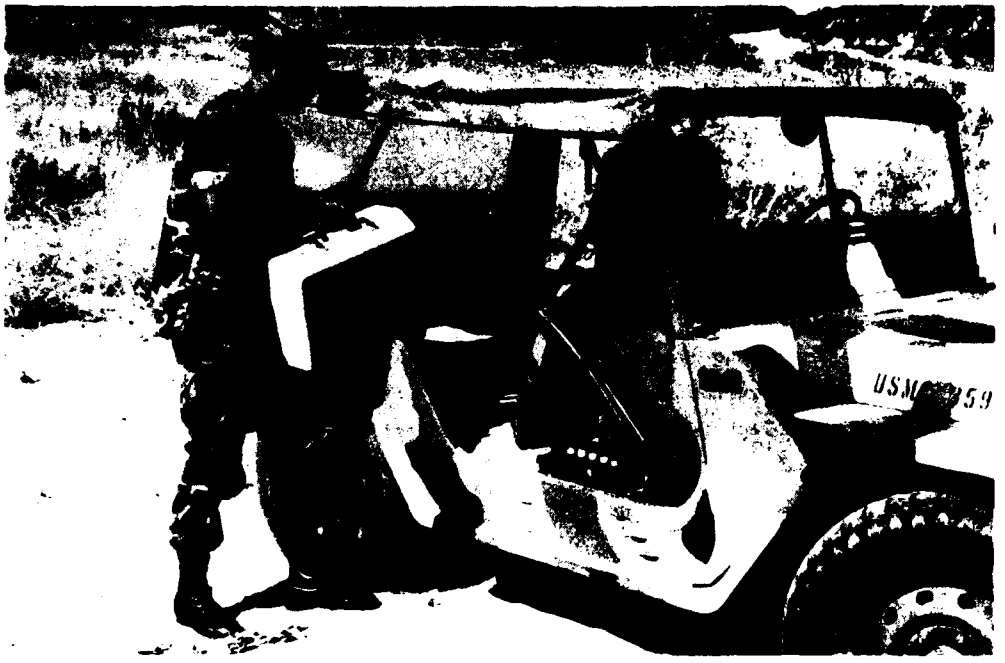


Figure 1: Portable Microbiology Laboratory

Figure 2: McArthur microscope compared to standard microscope

Portable Clinical Laboratory

The equipment and supplies for this laboratory are contained in a foam padded plastic case measuring 52 x 38 x 22 cm (2.4 cubic feet). It weighs 10 kg (Figure 3). The equipment includes a reflectance spectrophotometer; a 20 x 6 x 9 cm centrifuge (Figure 4); dipsticks for serum glucose, serum urea, and urinalysis; reagent card test systems for syphilis and mononucleosis; a blood counting chamber with dilution pipettes and a special microscope ocular; and expendable supplies.

The reflectance spectrophotometer measures blood glucose. It is compact, light weight, and easily operated. The centrifuge will spin capillary hematocrit tubes, urine for microscopic examination, and blood for serum. Its power source is six C batteries or it can operate on 110 or 220 volt AC current.

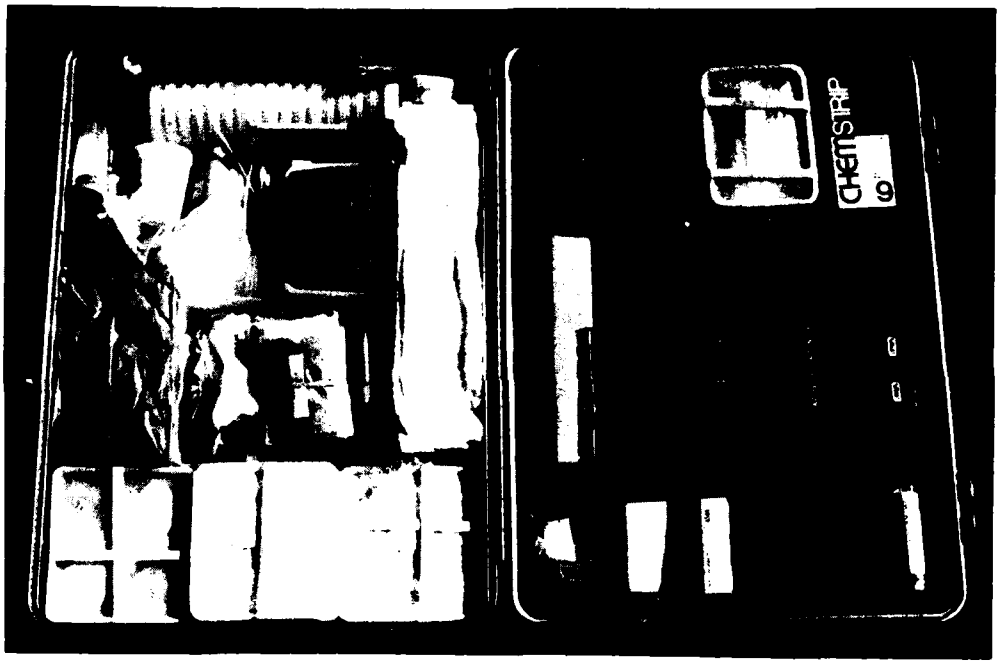


Figure 3: Portable Clinical Laboratory

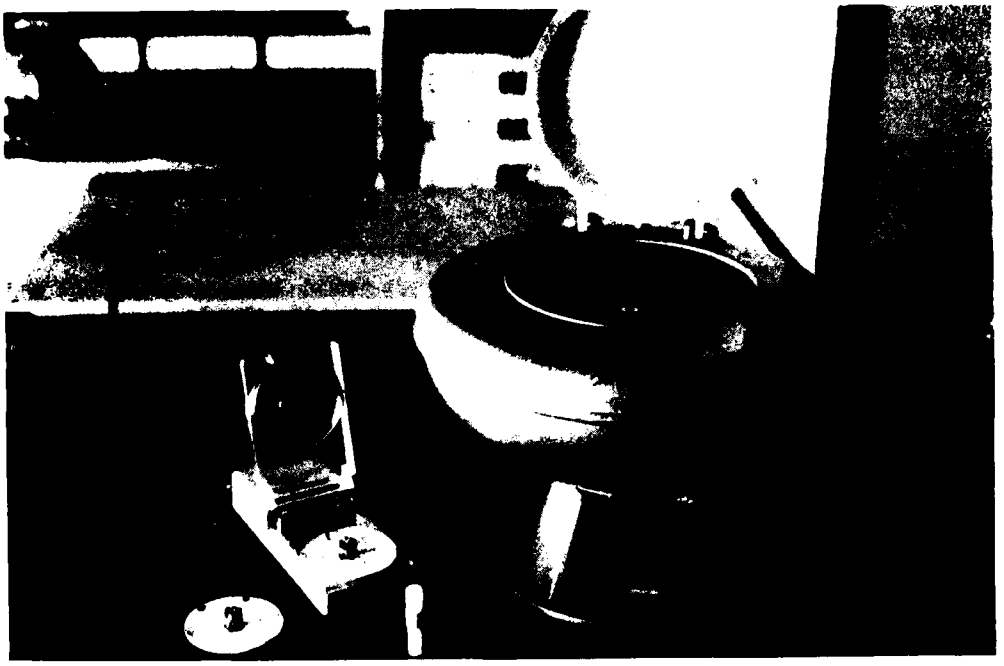


Figure 4: Miniature centrifuge compared to standard table-top centrifuge

Military Experience with the Portable Laboratories

During seven deployments in 1980 and 1981, the portable microbiology and clinical laboratories were evaluated by Navy medical personnel assigned to the U. S. Marine Corps. Comparison of results from the portable clinical laboratory and a standard laboratory were done at two Marine bases and on board ship. Field evaluation of the portable laboratories was done during jungle warfare training in Panama, desert arms exercises at Twenty-nine Palms, and cold weather exercises in Norway.

RESULTS

The manufacturers of the miniaturized equipment used in the portable laboratories had demonstrated that test results from their products were comparable to results from standard laboratory equipment. Navy personnel compared standard and portable laboratory test results on board a ship, at Camp Lejeune, North Carolina, and at Camp Ripley, Minnesota. Results using the McArthur microscope were identical to those using a standard microscope for microscopic urinalyses (46 samples), Gram stains (eight samples), and white blood cell counts with differentials (18 samples). The reflectance spectrophotometer gave blood glucose values comparable to those using the standard laboratory (13 samples). The miniature centrifuge hematocrits were 2-3 percent higher than Coulter counter results but were the same as standard centrifuge hematocrit results (18 samples).

When used in the field, the portable laboratories provided data that would not have been available to medical personnel under normal field operations. In Panama and at Twenty-nine Palms all equipment functioned well. Some fine sand did get into the plastic cases. In Norway the laboratories were used in shelters where the temperature ranged from 4-15°C. At these temperatures the reflectance spectrophotometer calibrated 2-3 percent lower than required. The waterbath-incubator temperature did not rise above 20°C. Staining time for slides had to be increased and dry-cell batteries had a markedly shortened life. The McArthur microscope was the most useful instrument and performed

well under field conditions in all environmental extremes.

DISCUSSION

A major segment of military personnel receive their medical care on board ship, at small dispensaries, or from a corpsman deployed with a field unit. Injuries and acute infectious diseases are the major medical problems of deployed personnel. Medical care requires that laboratory diagnostic capability be available, but the high technology diagnostic and therapeutic techniques available at military hospitals are not adaptable to field conditions.

Many rapid diagnostic procedures to identify bacterial antigens have been developed. The Biological Sciences Department of Naval Health Research Center has adapted several of these procedures for deployed use. From 1978 to 1982, suitcase-sized, portable microbiology laboratories capable of detecting the bacterial etiology of enteric disease and meningitis had extensive field use in Africa.[5,6] The diagnostic tests were done in remote areas far from conventional laboratories. Cerebrospinal fluid samples from patients with clinical meningitis were tested by CIE and COAG. CIE detected the bacterial cause in 37 percent of 273 patients while COAG was diagnostic in 54 percent of 296 patients. Stool samples from 80 patients with clinical enteric disease were tested by COAG: enteric pathogens were identified in 44 percent. These results allowed for appropriate prophylaxis to avoid epidemics and for specific patient treatment. No other diagnostic capability was available.

The portable clinical laboratory was developed to complement the microbiology laboratory. The military experience with these two laboratories was very positive. There was no major outbreak of infectious disease during the seven deployments these laboratories were used. The 4.5 cubic feet volume of these laboratories is a major improvement over the 200 cubic feet the standard field laboratory requires. The problems encountered with the equipment or laboratory design resulted in modifications. The plastic laboratory cases now have a knife-edge and gasket seal which is dust-proof and water-proof. Rechargeable batteries and rechargers are included and offer a dependable electrical source. The power of the heating unit for the waterbath-incubator has been increased and achieves operating temperature during cold weather conditions.

Research to expand and update the capabilities of the portable laboratories continues. Specific antibodies are constantly being developed for use in CIE and COAG diagnostic systems to detect infections caused by a broad range of bacteria, fungi, and viruses. Micro-techniques using enzyme linked immunosorbent assays are being adapted. Monoclonal antibodies offer the possibility of increased test sensitivity and specificity and a broad range of rapid diagnostic procedures. The current research goal is to develop disease-specific diagnostic modules which can be incorporated into the portable laboratories. Each module would contain the reagents for the most sensitive and specific diagnostic test system. When a military unit is preparing to deploy, medical personnel would select modules appropriate to diagnose infectious disease threats in the geographic region of the deployment. The modules would be packed in the portable microbiology laboratory. Adapting serum electrolyte determination and blood banking procedures into modules for the portable clinical laboratory would enlarge field laboratory capabilities.

To make this research product available for military use, an agency must be designated to supply the portable laboratories, the diagnostic modules, the specific antibodies and reagents, and the expandable materials. The concept of efficient, portable microbiology and clinical laboratories appropriate for military deployed use should be considered a reality.

REFERENCES

[1] Gunderson, E.K.E., Erickson, J.M.: Variability in Shipboard Morbidity Rates: Environmental and Occupational Influences. Naval Health Research Center Report No. 76-70, 1976.

[2] Heggers, J.P.: Microbial Invasion - the Major Ally of War (Natural Biological Warfare). Military Medicine, 143:390-394, 1978.

[3] McArthur, J.: A new concept in microscope design for tropical medicine. Am. J. Trop. Med. Hyg. 7:382-385, 1958.

[4] Sanborn, W.R.: A portable laboratory kit for rapid diagnosis of infectious diseases. WHO Chronical 34:384-385, 1980.

[5] Sanborn, W.R.: Development of portable rapid diagnostic microbiology systems for support of primary health care delivery. Indian J. Pediat. 49:311-316, 1982.

[6] Sanborn, W.R.; Toure, I.M.: A simple kit system for rapid diagnosis of cerebrospinal meningitis in developing areas. Naval Health Research Center Report No. 82-21, 1982.

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NHRC Report #82-26	2. GOVT ACCESSION NO. AD-A123634	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* Suitcase-sized Microbiology and Clinical Laboratories for Deployed Military Medical Use		5. TYPE OF REPORT & PERIOD COVERED Final 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) CDR M.E. Kilpatrick, MC, USN; CDR W.R. Sanborn, MSC, USN(Ret); E.A. Edwards, MS; LT W.T. Harrington, MC, USNR; LT R.K. Boehm, MSC, USN		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Health Research Center San Diego, CA 92138		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS M0095-PN.002-5068
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Medical Research & Development Command Bethesda, MD 20014		12. REPORT DATE Oct. 1982 13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS(*if different from Controlling Office*) Bureau of Medicine & Surgery Department of the Navy Washington, DC 20372		15. SECURITY CLASS. *(of this report)* UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Rapid diagnostics
Portable Microbiology Laboratory
Portable Clinical Laboratory
Military Application

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

Suitcase-sized microbiology and clinical laboratories were developed for use in the field. Their combined weight is 25 Kg, with a volume of 4.5 cubic feet. A McArthur microscope, an electrophoresis apparatus, a waterbath-incubator, a reflectance spectrophotometer and a miniaturized centrifuge compose the equipment. Rapid diagnostic tests for bacterial causes of meningitis, diarrheal disease, and pneumonia can be performed. Urinalysis, routine serology and hemotology, and limited chemistry studies can be done. The laboratories per-

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formed satisfactorily under jungle, desert, and cold weather conditions and gave results comparable to those from a standard laboratory. Portable laboratory capability should be considered a reality.

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