

Improving laboratory services and workforce in rural health facilities

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ABSTRACT

Provision of efficient laboratory services is an essential aspect of a functioning healthcare system. However, as a result of paucity of funds, irregular power supply, limited equipments, administrative bottlenecks and few licensed medical laboratory scientists at rural medical laboratories, several rural healthcare facilities are without functioning medical laboratories. This article explores the training limitations of rural laboratory workforce and presents focus investigations that rural laboratories should carry out in accordance with WHO standards and recommendations. It also recommends methods that have been proven to be highly sensitive and specific, need minimal automation and training, could be easily controlled, and are reliable and reproducible. Laboratory health workforce in rural health

facilities can aid safe motherhood by providing antenatal screening services for hemoglobin estimation using HemoCue method for early diagnosis of anemia. This article also recommends immunochromatographic testing methods for HIV, syphilis and malaria. Although a larger percentage of rural laboratories are ill-equipped to carry out tuberculosis screening, they can get involved by collecting, collating, storing and transporting the sputum samples to and from designated regional diagnostic facilities. With adequate exposure, provision of recommended diagnostics, retraining, quality control and assurance, laboratory officers in rural healthcare workforce can be trained to issue investigation reports that are not marred by the location of the laboratory, or circumstances in their health facilities.

Keywords: Laboratory diagnosis, Rural healthcare, Training, Diagnostics, Safe motherhood

Almost half of the world population — over three billion people — live on less than \$2.50 a day [1]. At least 80% of humanity lives on less than \$10 a day [2]. More than 80 percent of the world's population lives in countries where income inequality is widening [3]. The rising income inequality is driving more people to urban slums and rural areas where the low cost of living can help them to live within their limited resources. Globally, urban slum and rural growths are outpacing the overall urban growth by a wide margin; rural areas account for three in every four people living on less than 1USD a day and a similar share of the world population is suffering from malnutrition [4]. However, malnutrition is just one of the numerous health challenges that have a higher incidence in rural areas [1]. Therefore, pooling these data together, it can be stated that healthcare in rural areas deserves similar amount of attention and

investment like what is obtained in urban health facilities.

Several publications and researches have documented the barriers rural dwellers face in their quest for quality healthcare [5], and it has been identified as a major reason for migration to urban areas [6]. Due to the resource-limited healthcare services available and the lower cadre of the healthcare workforce attending to their health needs, residents of rural areas have fewer visits to health care providers and are less likely to receive recommended laboratory services [7]. Provision of efficient laboratory services is an essential part of a functioning healthcare system [8]. Medical laboratories provide confirmation of clinical diagnoses, facilitate improved management of diseases, generate essential public health information and with adequate government funding, they can facilitate disease surveillance at the grassroots [7]. However, at the

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rural level, laboratory services are often ignored or taken for granted [10] and are rarely embedded in rural healthcare, especially in developing countries of Africa [8] and Asia [6].

In the presence of functioning laboratories, limited resources are optimally utilized since only patients with confirmed diagnosis will get treatment [9]. For instance, in tropical climate, malaria is highly endemic and patients presenting with a febrile syndrome are often empirically treated with anti-malarial drugs without a laboratory diagnosis [11]. Such empiric treatment not only results in misdiagnosis and mistreatment but may also lead to development of drug resistance, an expensive and greater public health challenge.

Even when there is a desire to provide qualitative laboratory services in rural areas, several problems remain. These include economic issues in lieu of the fact that medical laboratories are expensive to set up and more costly to maintain hence many healthcare facilities are set up without laboratories [10]. The economic issues can be dealt in a cost-effective manner by setting up a referral laboratory system for a network of rural healthcare centers.

The reliability of results of laboratory investigations continues to be the major challenge facing rural laboratory scientists, technologists and technicians, especially those who don't have access to latest automated machines [5]. However, with quality and control measures, adequate knowledge and with training and retraining, simple methods can give reliable results.

Another major challenge that healthcare laboratory in rural facilities is facing is lack of power supply [10]. Superficially, it may appear that laboratory diagnosis is not feasible without electricity. But this is not true. Hence the focus of any result-driven training program is finding ways to keep the laboratory running even when there is no or limited power supply.

Currently, there is an avalanche of diagnostics that do not require elaborate machineries to function [12]. An advantage of these diagnostics over conventional methods is that they are much easier to operate with minimal training and are best suited for the tests and procedures that are expected of rural healthcare laboratories [13]. In addition, the diagnostic kits often come with instruction manuals to make them easier to use by laboratory officers who are barely qualified to work in the laboratory.

The rural health care facilities have pivotal responsibilities in developing nations. These are:

safe motherhood [14], diseases (HIV, malaria and tuberculosis), basic chemistry and hematology. With proper training, rural officers can optimize the use of the rural medical laboratory, repositioning their services to meet the immediate needs of the rural communities, while maintaining adequate standards.

SAFE MOTHERHOOD: Everyday, approximately 1000 women die from preventable causes related to pregnancy and childbirth [14]. Of all the maternal deaths, 99% occur in the developing countries and according to the World Health Organization, maternal mortality is higher in rural areas and among poorer and less educated communities [14]. Achieving safe motherhood requires elements of laboratory support which rural laboratory workforce can offer satisfactorily.

As a way of promoting safe motherhood and better outcomes for newborns, antenatal screening services such as hemoglobin estimation for early diagnosis of anemia, HIV, syphilis and malaria tests can be carried out at rural healthcare laboratory facilities.

Hemoglobin estimation during pregnancy is a standard recommendation by WHO [14]. The gold standard for assessing hemoglobin concentration is the direct cyanmethemoglobin method [15, 16]. However, this method requires that a laboratory with a spectrophotometer is available and the test is run within a few hours after blood collection. In some remote areas without electricity, performing hemoglobin test might be impossible.

One possible method is the indirect measurement of cyanmethaemoglobin, for which blood is dried on filter-paper for transport to a regional laboratory where it is then re-dissolved for measurement [16]. Another method uses a new generation hemoglobin photometer, the HemoCue (Hemo- Cue, Angelhom, Sweden). The HemoCue method can be used in the field to analyze blood collected in a microcuvette [16]. The photometer is easy to transport because it is small and light; it is battery operated and gives consistent results. Both methods are easy to carry out with minimal supervision. But in terms of cost, HemoCue method is more expensive [16].

Mayang Sari and colleagues compared these methods in their 2001 study [16]. They reported that when tests were carried out using new microcuvettes, HemoCue method had a sensitivity of 82.4% and the specificity was 94.2%. While the sensitivity and specificity values of the indirect cyanmethaemoglobin

method were 76.5% and 76.0%, respectively. Hence the method of choice for evaluating anemia in remote areas is the HemoCue method because of its higher level of sensitivity and specificity. Since hemoglobin measurement is also important in assessing patients with malaria [11] and may be a proxy indicator used in decisions about ARV treatment [17, 18, 19], performing the tests at the rural facilities will go a long way in reducing maternal mortality.

MALARIA: Malaria predominantly affects rural and poor populations that have little or no access to current prevention, diagnostic and treatment tools [11]. In Africa alone, it is estimated that malaria costs the continent more than US\$12 billion every year in lost GDP, due to the heavy toll it inflicts on families [2]. Presently the majority of malaria diagnosis at rural facilities is based on symptoms and treated empirically with sulphadoxine-pyrimethamine (SP) [11]. This approach leads to misdiagnosis and may promote development of resistance to SP.

Light microscopy is the “gold-standard” method for detection of malaria parasites in blood films but it is difficult to provide this test in rural healthcare centers that lack necessary facilities and a qualified microscopist [20]. The main barriers include high investment in technical expertise, quality monitoring, microscope maintenance and time needed to correctly identify malaria parasites in blood films. However, rapid diagnostic devices for malaria are offering a solution and are bringing effective diagnostic devices for malaria to the primary health care [21]. These devices are simple, provide rapid results, and use immunochromographic assays to detect malaria-specific antigens. These devices do not require electricity or complex technologies – except a laboratory technician who is trained to identify indicators of positive and negative reactions in malaria diagnostic kits.

In an informal meeting organized by the WHO and the United States Agency for International Development (USAID), recommendations were presented on the scope and utility of rapid diagnostic tests. The document recommended that the sensitivity should be above 95% for all malarial parasites when expert microscopy is used as a gold standard and that at 100 parasites/ μ l or higher levels of parasitemia sensitivity should be closer to 100% [22]. Other suggested criteria were a specificity of at least

90% for all malarial parasites, ability to distinguish viable parasites from parasite products such as antigens or nucleic acids, and to predict treatment outcomes or drug resistance. Chansuda et al [23] compared microscopy and rapid diagnostic tests. They reported that without expert microscopy, poor specificity is imminent as a result of poor blood film preparation, artifacts mistaken for malaria parasites, and normal blood components like platelets also confound diagnosis. Furthermore, the chance of false negative results increases with decreasing parasite densities [24], errors in species identification have been documented [25] and mixed-species infections underreporting is also common [26]. However, these in no way belittle microscopy but further highlight the reasons for improved RDTs and quality control. Humar et al [27] and Pieroni et al [28] investigated the sensitivity and specificity of the ParaSight F antigen capture test for *P. falciparum* compared with PCR. They demonstrated a sensitivity and specificity for the ParaSight F test of 88% and 97%, respectively. The reduced sensitivity was indicative of the greater ability of PCR to detect low levels of parasitemia.

TUBERCULOSIS (TB): The current international recommendation is that all patients (with a few specified exceptions) have sputum specimens examined for TB bacilli before TB treatment is considered [29]. Unlike malaria, reliable rapid diagnostic tests for tuberculosis are not yet available hence microscopy remains the only reliable method to establish diagnosis [30-33]. Considering the manpower and infrastructure involved, rural laboratory workforce should only be trained in sample collection, collation, handling and transportation to the nearest regional laboratory that has required manpower and equipment for TB microscopy.

The current WHO recommendation is that each TB suspect should produce three consecutive sputum specimens before ruling out open pulmonary TB as a diagnosis [29, 30]. On the other hand, evidence shows that patients from rural areas drop out of the diagnostic process because it requires repeated visits to a diagnostic center often far away from their home [29, 30]. Presence of laboratory technicians trained in TB sample collection in rural areas [34] will make it convenient for patients to submit sputum samples for transportation to a regional diagnostic center.

HUMAN IMMUNODEFICIENCY VIRUS (HIV): Simple HIV diagnostics are currently ubiquitous, although confirmatory tests cannot be carried out with simple kits [35, 36]. However, rural laboratory officers can utilize current diagnostic kits for screening purposes. Those patients who test positive should be referred to a regional reference laboratory for confirmatory test. Furthermore, in addition to performing HIV screening tests, the laboratory workers in rural areas may sometimes find themselves attending to patients especially when the healthcare centers cannot afford the services of more healthcare professionals hence they (rural laboratory healthcare workforce) also need to know how to break the news of a HIV-positive or negative result to patients considering the fact that suicidal ideations, frustration and depression could be an aftermath of reckless unprofessional result disclosure [35]. That's why adequate counseling and informed consent should be carried out and gotten respectively before venipuncture for screening and/or confirmatory tests [36].

QUALITY ASSURANCE AND CONTROL: Training of laboratory health workforce in rural healthcare facilities also entails adequate training on quality control. This could be described as the foundation for every laboratory operation. Quality control (QC) in healthcare laboratories ensures that the results are accurate, reliable, and reproducible [37]. It comprises of two key components: internal quality control and external quality assessment scheme. Internal quality control (IQC) includes appropriate measures taken during day-to-day activities to control all possible variables that can influence the outcome of laboratory results. This is a continuous process that operates concurrently with each laboratory analysis [37, 38]. External quality assessment scheme (EQAS) is necessary to ensure comparability of results among laboratories. External quality assurance, at least in some countries, may be both retrospective and prospective. In retrospective, an auditing organization may conduct audits of the test results. In prospective, laboratories strive to have results that can be translated across different laboratories. Laboratories report reference ranges, which may be different from one laboratory to another.

The heterogeneity, broadness and vastness of reports, documents, publications and guidelines on the subject of quality control for rural

laboratories may seem daunting for a busy laboratory technician. Perhaps the best approach for a laboratory officer is to study their respective country's policy statement and official protocols on quality control. Indian Council of Medical Research published the nation's quality assurance guidelines in 2008 [39] and is available for free download online.

At the international level, the WHO is actively involved in ensuring the quality of laboratory investigations being carried out across the world. For instance, in March 2003, its regional office for South-East Asia in New Delhi published a report entitled "Quality in Health Laboratory Services: A Status Report" [37].

Provision of quality healthcare is as big a concern of developed countries as it is for developing countries. For example, to ensure standards are met and maintained at rural healthcare facilities (including laboratories) across the United States, US Department of Health and Human Services' Health Resources and Services Administration published a manual on how to start a rural health clinic [40]. It detailed the minimum standards and facilities in addition to procedural expectations, professional qualifications and institutional limitations. Thus, collaboration between developing and developed countries will benefit both and foster an optimal healthcare system in rural areas.

CONCLUSION

While getting the right information on the most appropriate method is paramount, utilizing available information, attaining set standards and updating current knowledge are equally important. Explicit job definition, clearer understanding of limits and restrictions based on professional qualification and improved quality of training would ensure that although rural laboratories lack the equipments that are available to urban medical facilities, the quality, reliability and reproducibility of the test results they provide are not substandard.

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