A Weak Link to Improving Health Outcomes in Low-income Countries:

Laboratories

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Introduction

1. While the focus on health systems in the global health agenda is growing, there is equally increasing recognition of the need to continue to invest in disease-specific approaches. In this spirit, and as part of the preparation of the Regional Health and TB Support Project recently approved by the Regional Integration Department of the World Bank, this paper explores the importance of laboratory issues, critical factors in their linkage with health services delivery, and their potential contribution to achieving greater health outcomes on the road to the Millennium Development Goals. Given the regional nature of the operation, the opportunities and constraints to invest in laboratories from a regional perspective are also examined. It is aimed at World Bank collaborators in the identification of the operation, and more widely, at Bank staff involved in other operations. Its objective is two fold, (i) contribute to the justification of the Regional Health and TB support Project, and (ii) provide guidance to the integration of laboratory issues in Bank operations. A first part of the paper will examine the reasons why laboratories are a cornerstone of achieving health outcomes in developing countries. After reviewing the reasons why laboratory challenges have been inadequately addressed, the opportunities and modalities for the support of the World Bank will be proposed. In the following pages, tuberculosis will occupy an important position, not only because it is the focus of the operation being developed, but also because since its early stages, tuberculosis control has consistently demonstrated that, by putting the principle of appropriate technology of the Alma Ata declaration into practice, laboratory medicine can be a faithful allied to disease control in the most remote circumstances. Although most issues pertaining to clinical laboratories are valid under all economic circumstances, the following parts will also consider more specifically the situation of laboratories in the context of the health systems of low-income countries.

A cornerstone of health systems on the road to MDGs

The value of medical laboratories

2. By providing objective data that enable diagnosis, support follow-up and document treatment results, laboratory tests contribute to improving individual patients’ outcomes and providing public health information. Data from industrialized countries indicate that lab testing has an impact on over 70 percent of medical decisions. By equipping physicians with critical information, laboratory tests ultimately save lives and reduce overall health care costs. Clinical labs support the practice of evidence-based medicine and laboratory results are increasingly incorporated into disease management guidelines. In low-income countries, laboratory medicine increasingly contributes in a significant way to the understanding of the etiology of illness, hence
progressively replacing presumptive treatment approaches that prevailed so far out of necessity. iv v vi

3. Laboratory science forms the basis of microbiology, and for diseases like tuberculosis, its interest in comparison with other non-clinical investigations or presumptive approaches has been demonstrated long ago. vii viii In pre-transitional epidemiological contexts where communicable diseases pay a mere tribute to morbidity and mortality, diagnostic insufficiency costs lives. While for many African countries the recommended presumptive diagnosis of bloody diarrhea remains infection with *Shigella species* or *Entamoeba histolytica*, recent studies evidenced the increasing responsibility of enterohemorrhagic *E.coli*. As for these patients a presumptive treatment of shigella or amoeba may lead to potentially fatal sequels, the availability of simple lab tests constitutes a life saving advantage. ix Direct economic externalities of communicable diseases became noticeable when the 2006 chikungunya epidemic hit Mauritius and later other countries in the Indian Ocean, resulting in substantial losses for the tourist industry. x Since 1970, more than 30 new infectious diseases have been identified, including hepatitis C, Ebola, SARS, and particular strains of flu and cholera. In case of an outbreak, particularly when an emerging disease is involved, the early identification of the pathogen can only be done by a state of the art laboratory.

4. Many low-income countries are also experiencing in an epidemiologic transition at smaller or larger scale, with concomitant infectious and metabolic diseases patterns. The long known link between tuberculosis and diabetes in the industrialized world has recently been highlighted in low-income countries as well.xi xii While not as large as the effect of HIV on the risk of tuberculosis, this association is important in countries like India hit by low-level AIDS epidemics, but where about 40 million people (4% of the population) live with diabetes, where diabetes may account for about 15% of pulmonary tuberculosis incidence,xiii and where adequate laboratories are necessary for the effective management of patients suffering from both diseases. Given that 40% of deaths in sub-Saharan Africa are likely to be attributed to chronic conditions by 2020xiv, adequate and affordable diagnosis services will increasingly become key to the delivery of quality health care.

5. Laboratories provide important indicators for assessing quality of care. To keep with the example above, the effectiveness of diabetes management can only be evidenced at individual level by the measurement of glycemia; at community level only microbiology can demonstrate that patients treated from tuberculosis are no longer contagious. The latter requirement has been for many years a pillar of tuberculosis control, both in industrialized and low-income countriesxv xvi, and evidence of cure is integral part of the DOTS strategy. More recently, reference laboratory work has shown that in some Sub-Saharan African countries, HIV tests performed in peripheral centers can return as high as 50% false positive resultsxvii. This demonstrates how critical laboratories can be in preventing human suffering and lowering unnecessary health system costs.
6. Laboratories are essential to the quality of health products and also water supply. The knowledge of blood grouping is essential for blood transfusion, and labs are critical in protecting recipients from blood borne diseases such as HIV, syphilis, hepatitis, etc. Through blood banking, or blood donation screening, laboratories contribute to the safety of blood supply. Increasingly laboratories become involved in medically assisted procreation, including for the benefit of wealthier population groups in low-income countries.

7. But like any biomedical practice, the value of laboratory testing is limited by the quality of laboratory inputs and processes. The fact that a test was done by a senior technician or that it was performed on a sophisticated piece of equipment in no way guarantees the accuracy of the results. To enhance quality and support laboratory accreditation, the International Organization for Standardization (ISO) has formalized laboratory standards and guidelines in 2000 (ISO 17025). More recently, the Clinical and Laboratory Standards Institute (CLSI) has introduced a model in the USA defining five levels of quality. In low-income countries, tuberculosis control programs have given early support to the introduction of systematic quality assurance measures in medical laboratories implementing smear microscopy, and sustained efforts from the World Health Organization (WHO) and International Union Against Tuberculosis and Lung Disease (The Union) have permitted external quality assurance of drug susceptibility testing. While similar efforts have been undertaken to assure the quality of AIDS laboratory procedures, some researchers have also explored the possibility of developing cross-cutting quality assurance procedures between HIV and TB programs, while the latter were involved in expanding the availability of CD4 cell counts, contributing by so doing to make a more efficient use of scarce health system resources. Reference laboratories play also a key role in maintaining the quality of services by independently controlling the quality of tests put on the market.

Laboratories are key to health outcomes also in low-income countries

8. Strong laboratory services at peripheral and referral levels are key to the management of the most frequent causes of child morbidity and mortality (MDG4). A study from Kenya found that bacterial bloodstream infections diagnosed by blood culture were responsible for 26% of deaths among children, which suggests that invasive bacterial infections may be an underappreciated cause of death in this group. By contributing to the management of pregnancy complications, but also to their prevention, laboratory tests for infection, anemia and diabetes constitute an essential component of safe motherhood programs, as well as the provision of safe transfusion (MDG5). The interest of laboratories for HIV/AIDS and tuberculosis diagnosis and follow-up is widely recognized, and the need to shift from presumptive to evidence based malaria management increasingly supported among malaria specialists (MDG6). Medical laboratories are also in many low-income settings the only place where the safety of water supplies can be tested (MDG7c).
Laboratories are essential in complying with International Health Regulations

9. Laboratories are an essential component of the Integrated Disease Surveillance and Response (IDSR) strategy that has been adopted as early as 1998 by the member states of the World Health Organization African Region. IDSR recognizes the essential role played by laboratories in the diagnosis and follow-up of communicable diseases that are the leading cause of death, disability, and illness in the African region. IDSR forms the basis of the Epidemic and Pandemic response program of the WHO.

10. The 58th World Health Assembly of 2005 has voted substantial revisions of the International Health Regulations (IHR). Enacted in June 2007, they aim at improving the early identification of public health emergencies of international concern; they are crucial to prevent and limit the risk of the international spread of diseases without creating unnecessary barriers to international trade. By signing in to IHR2005, WHO member states commit themselves to acquire epidemic surveillance and verification capacity, and all have taken such commitment.

Laboratory networks are key to the provision of public health goods

11. Laboratories are critical to identifying new threats to human health, such as exposure to toxic substances, or antimicrobial resistance. The latter also provide a good means to indirectly assess the impact of clinical practices. In low-income countries, tuberculosis programs have been pioneer in sensitizing health leaders to the risks of multiple drug resistance (MDR) and to the need to adequately monitor it. At the same time in the early 90s, initial surveillance reports on MDR-TB from national programs in Africa were shared with the public health community. While laboratories have permitted to identify the emerging threat of extensive drug resistance (XDR), reports from African countries on HIV resistance to antiretroviral therapy (ART) utilized under programmatic conditions also become available.
A public health laboratory is the national focal point for quality assurance, and in this function, it assures a reference laboratory function for all public health programs. Its functions are decentralized and integrated within clinical laboratories across the tiers of the health system. National reference laboratories may not need to be developed all at once; they should belong to the same institution as the Public health laboratory. Although the physical location of each of them may be different, there is clear institutional advantage to concentrate them in a single location. Should this be a facility, provision has to be made to accommodate all the reference laboratories.

The experience of established health systems shows that laboratories are essential in the provision of public health goods when organized as a seamless network. Networking laboratories is essential to assess the quality of tests, participate in disease surveillance and ensure a prompt response to public health emergencies of international concern (e.g. SARS, Avian influenza, etc.), or share specialized tests and reap economies of scale. What is true for networks in general is particularly true for laboratories: effectiveness hinges on strong capacity of individual members. A consequence for the development of laboratory systems is that establishing reference laboratories or a public health laboratory should go at par with, when not preceded by strengthening laboratories in the tiers involved in service provision.
Figure 1: A conceptual model illustrating the links between public health and clinical laboratory services, and between laboratories at all tiers of a health system. The function of national reference laboratory played by the Public health laboratory itself participates in networks of Regional Reference Laboratories (RRL), themselves involved in quality networks with Supranational Reference Laboratories (SRL).

14. In the framework of international health, tuberculosis control has been pioneer in defining the functions of laboratories at all levels of a tiered network providing a continuum of services from care delivery level to supranational quality management. The laboratory methods involved in the provision of the tuberculosis services package in high prevalence countries repose on an array of appropriate technologies and quality assurance procedures clearly defined for each level in the network. The emphasis placed on appropriate technology and quality offers strong potential to spearhead quality improvements but also critically assess the value of innovations. Implemented since 1994, the Global Project on Drug Resistance Surveillance of WHO and The Union also permitted to clearly identify a gap in external quality assessment systems at regional level. The methods developed for tuberculosis can serve as a base for other programs. As noted by laboratory experts « there are particularly good examples of local quality-assurance systems designed to evaluate testing in tuberculosis control programs that could be expanded to include the malaria test (another microscopy-based test) and further extended to other essential laboratory investigations, such as hemoglobin and transfusion-related tests. » (Bates, 2006)

Laboratory services have a critical impact on other aspects of health systems

15. Although clinical biology in low-income countries often falls under the umbrella of pharmaceutical services, laboratories share more with diagnosis services such as radiography or ultrasonography. Demand for diagnosis services is in principle
driven more by health providers than by patients. Rational use of laboratories by providers requires the capacity to request tests, interpret results, and build decision on results in an appropriate way. Even in environments where laboratories are available and judged by clinicians of adequate quality, and where clinical skills are expected to be high, less than a half of physicians indicate using laboratory results in their patients management. Analyzed from a medical point of view, syndromic approaches and more generally the practice of presumptive medicine may account for such approaches. Considered from an economic point of view in countries where financing still largely reposes on user charges, the hypothesis of client control is also plausible, though it may be more difficult to verify. In low-income settings, addressing the issue of financial access to laboratory services is essential not only to allow patients to benefit from tests, but also to prevent competition between care and diagnosis providers for meager resources to pay for their services. Despite these difficulties, the demand for laboratory tests exists and is largely unsatisfied. Observations during the preparatory phase of the World Bank Regional Health and TB Support Project reveal that strengthening a zonal laboratory in Tanzania resulted in a 30-fold increase in laboratory tests performed at delivery point.

16. Diagnosis services are a potential driver of healthcare costs. This may seem obvious when high-tech laboratory tests are included in the care package: costs are driven by the price of the equipment, of the tests themselves, but also by the way laboratory equipment is powered. The National Tuberculosis and Leprosy Control Programme of Sierra Leone chose for instance to outsource tuberculosis culture and sensitivity testing to a laboratory in Germany because running generator sets around the clock to power incubators made that option more cost-effective than performing cultures in Sierra Leone. In countries financing their health services from cost sharing, laboratory tests are also an integral part of the marketing mix developed by health facility managers to increase patients’ willingness to pay, and it is not rare to see unnecessary tests being included in a battery of tests to generate revenue.

17. The cost-effectiveness of health interventions involving a judicious use of laboratory tests is increasingly demonstrated in established market economies. In developing countries, the cost-effectiveness of the DOTS strategy involving direct smear microscopy was first highlighted by the World Bank in 1993. Observations from Ghana suggest that costs incurred to patients for inappropriate antibiotic therapy exceeded the costs for the laboratory tests required for evidenced diagnosis between 5- and 20-fold. Illustrating the complex economy of diagnosis services within a care system, efficiency is not limited to the use or not of laboratory tests in care procedures. In South Africa, where laboratory results have been found to influence 70% of medical diagnoses, major inefficiencies were found in the organization of communication between medical wards and laboratories. In Uganda, the decision to send a patient sample to a private or public laboratory varies within the same hospital ward by physician preference, patient socioeconomic status, and laboratory reputation, resulting in ineffective and inefficient care delivery. These findings are of particular social concern where financial access to health care and essential drugs is limited, particularly for the poor. It is of equal medical concern in a region of the world where indiscriminate use of antibiotics is frequent and,
likewise tuberculosis, can lead to antibiotic resistance requiring the use of alternative and often more costly treatments. Finally, the cost-effectiveness of laboratory procedures will improve as the market for tests and equipments increases, but strong incentives from major donors may also be useful as market may take time to establish. To strengthen the market, parallel interventions will be necessary to develop the supply side and ensure the solvency of the demand.

18. In absence of financing policy adapted to the various circumstances where laboratory services are provided, equitable access to those can also be compromised. A study evaluating the impact of the Bamako Initiative on the delivery of health care in Nigeria demonstrated that people with financial means had a higher probability of accessing laboratory resources and seeking care in private clinics than the poor.\textsuperscript{d\textvisiblespace} Equity issues are not specific to user fee based financing systems; the evaluation of the supply chain for HIV/AIDS commodities in Niger revealed that earmarking reagents for complete blood count (CBC) to AIDS patients led to rationing, as facilities could not refuse access to CBC to other severely ill patients for obvious ethical considerations.\textsuperscript{d\textvisiblespace}

19. While improved laboratory capacity could enable health care workers to deliver more effective treatment, enhance efficiency in use of resources, and improve quality of care, these benefits would only materialize if laboratories were properly staffed with qualified personnel. The availability of qualified staff introduces a critical bottleneck to service provision, and beyond may jeopardize a country’s chances to achieve the MDG targets. Task shifting was successfully implemented in the early days of primary health care by many countries that shifted microscopy tasks to non-professionals for lack of laboratory technicians, particularly to perform leprosy, tuberculosis or malaria smear examination. As WHO now supports task shifting\textsuperscript{d\textvisiblespace}, this strategy may help to mitigate the crisis for lower level cadre of laboratory staff but will not fill the gap for qualified professionals. If addressing the human resource crisis is critical to develop laboratories, this will also be one of the most complex steps in the process, as it requires both policy development and policy implementation while service delivery continues, and collaboration across government sectors.

20. The pace and scope of rolling out new technologies needs careful review; as technology gaps widen, introduction of expensive high-tech equipment raises concerns with appropriateness, equity, and sustainability, highlighting policy dilemmas facing countries. While the Alma Ata declaration stressed the need to develop appropriate technology\textsuperscript{d\textvisiblespace}, this component currently lags behind\textsuperscript{d\textvisiblespace}, and few countries have so far invested in developing technology policies beyond maintenance issues. Technology policies are complex ones, linked with human resource, maintenance, energy use, and supply chain management. Technological improvements become cost-effective if both prescribers and users have adequate skills to make optimal use not only of the piece of equipment but also of the results, and parallel steps need to be taken to improve both. Maintenance is crucial to prevent out of order equipment from littering health facilities, as can be seen in many developing countries. Maintenance options for modern laboratory equipment also require a shift in the organization of maintenance services, from in-house arrangements to a market based provision of preventive maintenance and repair services. The implementation of health technology drives energetic
choices, and increasing attention has to be paid to CO2 emissions. It also has consequences on infection control and waste management systems, often sacrificed to the benefits expected from the new technology. Last but not least, technology choices also impact on the organization of supply chain. In addition to these policy considerations, different technological options for a given test may not be equivalent, and it is the responsibility of public health laboratories to assess which technological options suits better the epidemiological profile and infrastructure environment of a given country. In absence of this capacity, low-income countries are in an imbalanced position when confronted to the sophisticated marketing of the biomedical equipment industry, and technology choices become difficult to make. This critical role may have to be endorsed by supranational reference laboratories, and for a certain period of time, financing mechanisms will have to be developed to facilitate this role, until it can be financed from the demand itself.

21. Many modern test reagents have short shelf life, require a cold chain, imposing substantial demand on over stretched, centralized supply systems, which have limited experience with laboratory inputs. Short shelf life imposes a shift from centralized systems managing important stocks to lighter systems and zero-stock procedures. This partly explains reagent shortages that are found where modern test technologies are implemented. While zero-stock systems are increasingly implemented directly from manufacturers, the prevailing centralized approaches, the size of market and the development of infrastructure do not support their extension to peripheral areas.

**Laboratory challenges remain inadequately addressed**

**The case of laboratory systems remains to be strengthened in global policies**

22. The major developments in health system thinking of the past decades have paid only marginal attention to the place of diagnosis services in health packages. The 1993 World Development Report does not specifically mention diagnoses as a subset of health systems, and limits reference to laboratories to some tests included in health package components. Diagnosis services appear in “Better health in Africa” at the level of the first referral hospital in the form of “basic laboratory services” without further detail, while no specific mention is made to imaging. Although surgery or emergency care are identified as distinct services in the latest Disease Control Priorities, clinical diagnoses remain confounded in hospital or primary care. While the importance of strengthening health systems to achieve better health outcomes is increasingly recognized, diagnosis systems remain absent from the various models and frameworks developed to better understand the forces at work in developing health systems.

23. On more technical grounds, confounding signals from the WHO technical programs did not facilitate clear decisions by countries. For instance, while the DOTS strategy recommended strengthening direct smear microscopy, leprosy control abandoned the use of microscopy using the same technique despite its
contribution to the quality of diagnosis\textsuperscript{1}. Confronted to the challenges of innovation in their specific domain, the WHO technical programs develop comprehensive sets of policy tools and recommendations to control for the risks of introducing new laboratory technologies in low-income countries health systems.\textsuperscript{lxii} However, despite health system strengthening has become the new mantra for global health development, no guidance is available for country non-disease specialist policy makers to smoothly absorb innovation in the national systems.

24. Business interests influence the development of new health technologies, and market priorities drive their roll out. While low-income countries are individually in a weak position to negotiate technologies more adapted to their specific needs, neither have supra-national organizations endorsed this role, nor have health activist groups, which have achieved significant successes on drug issues, been vocal on laboratory services. As pointed out by observers, clinical diagnoses, and particularly laboratories, will move up among sector priorities only “if [they] represent themselves on key decision-making bodies, rather than being represented by other sections of health care services, such as pharmacy” (Bates, 2006 \textsuperscript{39}).

25. The limited interest paid to laboratory systems in global health policy development is in sharp contrast with the investments consented in health products and equipment from grants by The Global Fund against AIDS, Tuberculosis and Malaria, and the increasing trend of those.\textsuperscript{lxiii} Diagnosis services will be key in the 74,000 – 97,000 newly created health facilities anticipated by the Taskforce on Innovative International Financing for Health Systems, and laboratory equipment and tests will absorb a significant part of the capital and recurrent costs comprised in the additional 36-45 billion US$ required to achieve the MDGs.\textsuperscript{lxiv}

26. Previous sections in this paper have illustrated how earmarked investment generates inequity. Earmarked investment, a common feature of external aid to low-income countries, also results in fragmentation of laboratory systems development, lack of broad public health focus, and insufficient attention to systemic issues. Strengthening laboratories involves several fields across health systems, and requires coordination of skills building, staff career development, technology choices, capital investment and adequate provision to support recurrent expenditure, to allow provision of quality services. The development of synergies between the different fields is particularly vulnerable to distortions resulting from seeking rapid results. It becomes critical that global and bilateral partners start addressing laboratory – and beyond medical diagnosis issues, as systemic ones.

\textsuperscript{1} As an example, Madagascar has reintroduced leprosy direct smear microscopy in view of a high proportion of inaccurate diagnoses with the clinical presumptive approach.
Figure 2: The different fields of health systems involved in strengthening laboratories. Red sparks highlight critical interfaces where uncoordinated interventions expose to risks ranging from efficiency loss in stable environments to system destabilization in fragile contexts.

Sub-regional nodes or gaps in laboratory networks?

27. The growing needs in cross-border disease prevention and control, and preparedness for emerging diseases outbreaks, stress the importance of laboratories with sub-regional scope to maintain proficiency on rare tests and reap economies of scale. In addition, the need to assure quality of diagnoses in national networks requires a supra-national level of quality assurance. For tuberculosis, WHO and IUATLD have long advocated the strengthening of the embryonic network, with variable success depending on the region. In the Pacific, the Secretariat of the Pacific Commission maintains a network of laboratories with double responsibility in epidemiological surveillance and TB quality assurance. The South Asian Association for Regional Cooperation is equipping a facility for TB quality assurance in Nepal to serve its eight member countries. The Indian Ocean Commission is developing a lab network among its member countries, while one of them is seeking WHO accreditation for TB supranational reference. In continental Africa, a clear gap exists as TB supranational reference laboratories in Johannesburg, Algiers, Yaoundé and Cairo find it difficult to satisfy current demand. In some parts of Africa, developing and sustaining such facilities is compounded by overlapping sub-regional organizations with vested responsibility on health matters, and confronted to financing difficulties. Conversely, no Regional organization has so far succeeded in putting up a successful proposal to The Global Fund to support the development and operation of a regional reference laboratory. While the Technical Review Panel of The Global Fund questions the needs base for proposals presented, the reasons why such a need has not justified a regional proposal so far remain to be clarified, and the added value of different financing channels to that end explored.
Main challenges in developing national laboratory services

28. Although most features presented below may be generic findings in low-income countries, the examples are drawn from field findings during the preparatory mission to the Regional Health and TB Support Project of the World Bank that took place during spring 2009 in Uganda, Tanzania and Kenya. When relevant or deemed necessary, examples from other countries are presented that draw on the personal experience of the authors.

29. Few low-income countries have so far invested in developing national laboratory or diagnosis services policies. Conversely, countries like Kenya that have taken steps in that direction find it difficult to move towards planning, financing and implementation of these policies. The lack of reference to diagnosis services in global health frameworks may partly account for this situation, but other local factors have to be sought. From country observations, the explanation arises that implementing a laboratory policy involves a reform process that no major stakeholder in sector development has so far championed. Obtaining effectiveness, efficiency and equitable distribution of the benefits of strengthened laboratory systems requires a shift in the medical culture from presumptive to evidence based medicine, for which time will be critical. In 1994, the World Bank publication Better Health In Africa already noted: “As health technology choices determine human and financial resources for health care allocation, it is essential that African governments support operational research that will facilitate decision on adoption of new tests and treatments, and the corresponding technologies within the health care system of their countries. Factors to be considered include the pertinence and cost-effectiveness of interventions, their links with the primary health care program, their impact on equity in the health sector, and their recurrent cost”. Few countries have today developed this operational research capacity that would enable them to make such policy choices. When countries spurred by the MDG timer adopt global strategies rather than develop their own ones based on comprehensive analyses of health outcomes, disease burden and trends, recent attempts to revitalize the dynamics of the Alma Ata Declaration is a welcome initiative. Besides, the institutional toolkit for development has lost its value with time: projects have progressively lost their research and development value to become an indiscriminate vector for developing strategies, scaling them up, or sustaining service delivery, particularly in situations of market or institutional failure; and the useful delineation between principal, financier and agent roles is progressively blurred by the promotion of plural governance.

30. Other possible reasons for weak policy support at national level include the lack of country leadership on laboratory issues, itself undermined by multiple and insufficiently flexible stakeholders with inadequate coordination. In the three countries visited by the preparatory mission to the Regional Health and TB

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2 Reasons range from bureaucratic constraints to output binding due to payment for performance mechanisms.
Support Project, a significant effort has been produced by the African Medical and Research Foundation (AMREF) to develop laboratory standard operating and quality procedures on behalf of ministries of health of Kenya, Uganda, Tanzania and Zanzibar, and with financial support from a US based philanthropic foundation. This document was produced without consulting national programs and guidelines on quality for tuberculosis procedures differ from those issued by national TB programs. The production of such reference documentation, and the steps taken by Kenya to develop a national laboratory plan backed by an inter-agency coordination committee, constitute significant steps towards strengthening laboratory systems.

31. Going at par with policy weakness, laboratories suffer from a lack of dedicated budgets to finance their contribution to public health interventions. In health institutions financed from user charges, these also finance the execution of tests required by epidemiological surveillance, tuberculosis control, etc. for which inadequate provision is made to support the human resource component of the cost. Beside, the easy quantification of laboratory activities provides the opportunity to experiment innovative financing mechanisms. In Kenya for instance, private non-for-profit hospitals may be prepared to negotiate their delivery of free laboratory testing under public health programs against tax credits.

32. Findings in Tanzania summarize well the challenges met at country level with laboratory human resources. Forecasts developed according to the recommendations of the Commission on Macroeconomics and Health reveal a current gap in laboratory personnel above 80% in Tanzania. The study also highlighted the inadequacy of national laboratory staffing norms and concluded that “even in the most optimistic scenario, human resource availability will limit the extent to which priority interventions addressing MDG related conditions could be expanded in Tanzania, let alone a package of priority interventions that more comprehensively addresses the country’s disease burden”. At the same time, the mission found that around 8,000 laboratory staff could be available on the Kenya labor market. In general, there is limited recognition of laboratory professions in developing countries health systems. The examples above summarize well the challenge to simultaneously work on technical norms, pre- and in-service curricula, career development, staff retention and motivation packages. They highlight how essential it is to take adequate care of human resource challenges for the sustainability of investments in laboratories.

33. The organization of laboratory services, and in particular the roles and responsibilities of public health, clinical and reference laboratories remains to be clarified not only across but also within a given tier of services. In a country like Kenya where clinical services and public health are the responsibility of two distinct ministries, this is of particular importance to keep high quality and efficiency. For public health functions, country findings retrieve the imbalance between the laboratory component of disease programs and laboratory systems described a global level. Countries like Kenya or Nepal implement and plan to scale up new diagnosis tools in the framework of their national strategies for tuberculosis control, and under the umbrella of their national TB programs. This is done in both cases independently from general laboratory systems, and
regardless of the WHO recommendations on the necessary precautions to implement those tools. Observations made for laboratory tools also apply to the infrastructure necessary to implement these tools, and particularly provision for safety. Laboratories involved in testing for communicable diseases raise biohazard, safety and regulatory concerns that are not properly addressed. According to WHO, culture and sensitivity testing of tubercle bacilli require biosafety level 3 (BSL3) laboratories. The creation and scale-up of such facilities is a costly undertaking and a national tuberculosis program successfully implementing the DOTS strategy may not generate enough cases of multidrug resistant tuberculosis to justify a full time use of the facility. Conversely, such facilities may be indispensable for the manipulation of other pathogens out of the scope of a TB program, strengthening the case for enhancing laboratory systems at large. At a lower level, adequate incineration of laboratory waste remains a challenge.

34. Quality assurance systems throughout laboratory networks are embryonic in many countries. Field implementation of quality assurance could only be observed for tuberculosis at programmatic scale during the country visits. Quality accreditation and ISO certification requirements stress the need to rapidly enhance capacity in the public sector to implement international quality standards, or conversely to develop adequate public-private mechanisms that would allow private sector facilities to endorse national system or program responsibilities. In Kenya, a hospital owned by a private charitable foundation was found to seek its quality control for tuberculosis from abroad to obtain ISO accreditation, as the national reference laboratory of the TB program was not itself accredited to provide this service at home.

35. Despite the implementation of modern tests in the field, provision for preventive and curative maintenance remains inadequate even in Kenya where the most up-to-date policy was found. Similar observations are valid for supply chain requirements. Necessary adjustments have been described elsewhere in this document. In Uganda, Kenya, Tanzania, and other countries, no provision is made by health systems to network laboratories, and ensure adequate transfer of information and specimen between the different levels, while inadequate courier services supply makes outsourcing sample transfer a debatable option at programmatic level.

36. The volume of activity to manage, the participation in disease surveillance, and the requirements for quality impose on laboratories to manage a substantial volume of information. In the facilities visited, laboratory information systems hardly fulfill this triple requirement. Most of the time, information is collected on paper registers; reports compiled manually deprive laboratory managers from

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3 The creation of a BSL3 facility requires a capital investment between 1 and 1.5 million US$

4 Scaling-up BSL3 facilities for tuberculosis should also be discussed in view of a possible standardization of MDR-TB treatment in the medium term, at least for countries with low MDR and XDR-TB burden. Standardized treatment would no longer impose sensitivity testing for MDR cases.
the potential of modern tools to enhance efficiency. In most settings, reports remain transmitted by mail or ad-hoc channels for lack of access to communication technology.

**Tuberculosis control offers a fertile ground to address laboratory systemic challenges**

**The TB policies compost**

37. Previous sections in this document have highlighted the capacity of tuberculosis programs to provide responses to laboratory challenges at the different levels of health systems, from the peripheral health unit to the supranational reference laboratory. When direct responses are not already available, they can be provided through reasonably simple operational research. While existent components still require to be strengthened, particularly if to be used as a backbone for system strengthening, bridges can be created with other field of laboratory science. TB direct microscopy with Ziehl Neelsen stain can for instance be used to implement Gram stain, and offer access to improved diagnoses of sexually transmitted infections and of meningitis. Quality assurance mechanisms can be shared by both and also by malaria smear microscopy, etc. In a more advanced phase, the feasibility of implementing modern tools such as liquid culture and molecular methods could be assessed according to WHO guidelines, no longer from the point of view of a TB program, but with an oversight on their value for the sector at large.

Figure 4: The three phases for developing laboratory systems from the starting point of the tuberculosis laboratory. SNRL: Supranational reference laboratory; EQA: External quality assurance; DSM: Direct smear microscopy, SOP: Standard operation procedures; DRS: Drug resistance surveillance; ZN: Ziehl Neelsen staining, Gram: Gram staining, CBC: Complete blood count, PCR: Polymerase chain reaction (molecular diagnosis).
38. At international level, tuberculosis laboratory systems also benefit from the favorable environment created by the StopTB policy and its ambition to share the strategic assets developed by tuberculosis control to contribute to developing health sectors. A positive response from the health system side may offer an opportunity to create the synergies necessary for a mutual reinforcement. By creating space for dialogue and share of experience, it may also contribute to making the “vertical-horizontal” debate pendulum rest (in peace).

The system development tools

39. The toolkit to inform policy development includes two key instruments: evaluation of existing approaches to document strengths and weaknesses in the existing system, and pilot projects to (i) assess the feasibility of proposed interventions by identifying ways to overcome constraints to achieving quality and efficiency, document constraints of going to scale, and examine alternative options, and (ii) document the elements of sustainability by clearly documenting the costs, institutional arrangements, mechanisms for financing the capital and recurrent costs of the operation, and assessing whether sufficient fiscal space is available to bring the intervention to scale and achieve the desirable level of equity. Beyond strengthening laboratory services, an enhanced use of these instruments within health systems will benefit national strategies at large by documenting the attributes of sound national strategies along the lines defined by the International Health Partnership.

Opportunities for an investment by – and role of the World Bank

40. The World Bank has an institutional mandate to address health systems issues, and its convening power can be used to elevate importance of laboratory issues in health policy dialogue. This convening power can also be used to promote...
partnerships to engage the private sector and to bring in technical partners (CDC, WHO, Union, KNCV), policy makers, and financing organizations at macro level. At country level, it can be used to promote comprehensive approaches to diagnosis systems strengthening by convening technical programs, laboratory systems, financiers, and planning departments, to strengthen ministries of health leadership. The World Bank’s analytic capacity can also be mobilized to strengthen the research agenda around laboratory issues and promote evidence based approaches and knowledge sharing.

41. Through its set of various financing instruments, the Bank can provide flexible financing to fill gaps not funded by other partners, and contribute to restore the value of public investment programs for developing sound national strategies, beside creating physical infrastructure. The Bank also has a comparative advantage to tackle regional public health issues. By doing so, it may offer its client countries an easier opportunity to develop regional systems and solid arguments to approach other financial partners such as The Global Fund to sustain them.

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Conclusion

46. By clarifying the value of medical laboratories in modern health systems including in low-income countries, this paper throws light on diagnosis services, a component of health systems that has remain so far neglected in debates on health system strengthening. Laboratory services are important as they constitute a driver of both services quality and cost – and beyond, cost-effectiveness – within health systems. This analysis shows that tuberculosis may offer a valid and solid entry point for strengthening health systems, provided a stakeholder vested in sector development can partner with technical stakeholders and champion the cause. The World Bank appears a strong candidate to take the role of such a champion. Beyond laboratories and tuberculosis, this paper stresses the need for countries to regain leadership on policy development. It also contributes to better understanding health systems by highlighting the link between policy development and mobilizing financing both for developing and sustaining systems, through direct creation of resources (workforce, facilities, technologies, commodities, partnerships, etc.) that will permit systems to deliver, or through indirect purchase of outputs from systems (care, diagnosis, supply chain, maintenance, etc.), with the objective of achieving quality, equity and efficiency in the delivery of health programs and services to achieve the MDGs. To ensure cohesion and coherence of health systems, it is as important to focus on what is between blocks than on the building blocks themselves.
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This paper explores the importance of laboratory issues in Sub-Saharan Africa, critical factors in their linkage with health services delivery, and their potential contribution to achieving greater health outcomes on the road to the Millennium Development Goals. Its objective is twofold, (i) contribute to the justification of the Regional Health and TB support Project, and (ii) provide guidance to the integration of laboratory issues in the Bank.