ЦЕНТР АНАЛИЗА
ПОЛИТИКИ
ЗДРАВООХРАНЕНИЯ

Policy Research Document #72

Effectiveness of microbiological laboratories in diagnostics and treatment of infectious and parasitic diseases

`

A. Abdraimova, A. Ibraimov, D. Iskhakova [1]

Z. Nurmatov, D. Ashyralieva[2]

B. Ismailova[3]

Bishkek, 2010

[1] Health Policy Analysis Centre
[2] State Department of Sanitary and Epidemiological Surveillance
[3] Public Health Unit of the Ministry of Health of the Kyrgyz Republic

Contents

List of tables

List of figures

Abbreviations

ATCC	American Type Culture Collection
CCT	Cross-checking tests
PCR	Polymerase Chain Reaction
RCQHI	Republican Centre for Quarantine and Hazardous Infections
RCHI	Republican Clinical Hospital of Infections
TH	Territorial Hospital
FMC	Family Medicine Centre

Acknowledgements

The Health Policy Analysis Centre is grateful to managers of all oblast, rayon, and municipal Sanitation and Epidemiological Surveillance Centres, territorial hospitals, bacteriological laboratories, Republican Clinical Hospital for Infections in Bishkek, Family Medicine Centres in Batken, Chui, and Issyk-Kul oblasts that were involved in the study, for contribution with requested data.

In addition, we acknowledge the valuable input of staff of the State Department of Sanitation and Epidemiological Surveillance and Public Health Unit of the Ministry of Health in developing the research methodology and during report writing.

1. Introduction

The laboratory service is a set of health facilities that act and are organized in accordance to relevant regulations. The medical use of the laboratory tests determines the conditions of the implementation of those regulations in health facilities of different levels, profiles and capacities. Regardless of conditions and forms of arrangement of the laboratory service, the laboratory test results must meet requirements in terms of reliability, clinical value, and timing.

Laboratory tests can be subdivided into several specialized sections, such as general clinical tests, clinical biochemical tests, bacteriological tests, parasitic tests, etc. At present, in the Kyrgyz Republic the network of microbiological laboratories is comprised of 50 laboratories that are functioning under the SES Centres and 19 diagnostic laboratories under the territorial hospitals. The microbiological laboratories perform sanitation-bacteriological and diagnostic tests for detecting pathogenic infection agents.

The objects of the sanitation-bacteriological tests are mainly environment units, including food products, water, air, etc. On average, 53 percent of tests are performed for sanitation-bacteriological use, while tests for diagnostic use confine to 47 percent. Composition wise, 45 percent of the diagnostic tests are conducted for cases of intestinal infections, 21 percent - on biological substrates, 18 percent for droplet infections, and 16 percent for other disease categories and objects. Tests for sanitation use are in 29 percent performed on food products, 14 percent on water products, 28 percent on washouts from environment units, and 29 percent on other objects.

The State Sanitation and Epidemiological Norms and Rules establish main parameters and define environment units from perspective of safety for human-beings. For detecting values of main parameters, the laboratories use standardized test methods that are developed by the Ministry of Health and included in relevant normative documents, GOSTs and methodological recommendations. Use of the normative documents enables reliable tests with comparable results.

It should be noted that a well-functioning system of ensuring test reliability and validity is the basis for obtaining objective data which is used for timely diagnostics and correct management of infections.

For assessing the reliability and comparability of test results, laboratories perform the so called cross-checking tests (CCT). The CCTs exploit control panels with standard stains of ATCC (American Type Culture Collection) received from the Tarasevich Institute in Moscow, Russia. The review of CCTs demonstrates that on average 20 percent of microbiological tests are unreliable.

Main determinants of reliability of diagnostic tests are as follows:

- Availability of material and technical means in the laboratories
- Staffing of the laboratories
- Availability of expendables
- Timelines and justification of sampling and transportation of samples
- Availability of the system for ensuring reliability of test results

The study conducted in 2009 to explore factors behind the increased records of incidence of acute intestinal infections of unknown origin[4] demonstrated that procedures for bacteriological test process and sampling in cases of suspected intestinal infection were not followed. This hampers reliability of test results. In addition, health workers do not systematically use the test results when choosing treatment options, which contributes to drug resistant infections, facilitates allergies, and increases side-effects of treatment process.

Since correct and timely laboratory detection of infection agents is a significant factor in prevention and reducing incidence of infections, it is essential to study the overall status of the laboratory service engaged in microbiological tests and the system for ensuring test reliability and validity, and identify determinants of invalid microbiological tests.

2. Study aims and objectives

Study aim is to explore key determinants of effectiveness of microbiological laboratories in diagnostics and treatment of infections

Study objectives:

- ✓ To study the material and technical means available in laboratories:

  - availability of equipment, materials, amount of delivered services, conditions of storage and transportation of diagnostic materials, availability of normative documents and standards

  - maintenance of equipment and continuity of supplies of expendables and chemicals

  - staff capacity (qualification, availability)

  - extent of the use of modern information technologies in the laboratory service

[4] Policy study document №62 'Factors of the growth of acute intestinal infections of unknown etiology' by Abdraimova A. (Centre for Health Policy Analysis), Nurmatov Z., Ismailova B. (State Department of Sanitation and Epidemiology Surveillance), December 2009

- ✓ To study the system in place for ensuring reliability and validity of tests and their use for treatment process:

    - mechanisms of interaction of laboratory staff with medical workers in charge of managing infection cases (rationale of laboratory testing) and use of test results for treatment processes

3. Methodology

1. Data on the amount and composition of lab tests were collected through reviewing in selected facilities of the available normative documents and reports (available normative documents, registries of samples in laboratories under the territorial hospitals, SES Centres, monthly and annual reports) that regulate activities of the laboratories.

2. Interviews were conducted with health workers in territorial hospitals, FMCs, and microbiological laboratories under SES Centres. Interviews relied on questions concerned with the use of diagnostic tests, observance of microbiological test protocols, interaction of laboratories with other healthcare services etc.

3. The material and technical capacities were studied with use of a matrix that included assessment of quantity, actual functional status and characteristics of the available equipment, devices, test-kits and other resources.

4. To assess the rationale of the laboratory tests and follow-up use of the test results in treatment of infections, the case records in THs and medical cards in FMCs were studied. The case records and medical cards were selected randomly. In each selected health facility (THs and FMCs), 20 medical documents (case records and medical cards) were studied.

4. Selection of organizations and regions

The study was conducted in Bishkek city and Chui, Issyk-Kul, and Batken oblasts (Batken oblast was selected because it is the most remote location and borders several neighboring states with the most frequent outbreaks of infections).

- Bishkek (RCHI, NH, MCB №4)
- Tokmok, Kara-Balta, Alamedin rayon (Chi oblast)
- Issyk-Kul oblast: Karakol ad two rayons (Issyk-Kul and Jeti-Oguz rayons)
- Batken oblast: Batken and two rayons (Kadamjai rayon and Kyzyk-Kia)

Laboratories of two levels were focused for the study:

- National level – laboratories of RCQHI, RCHI, NH,
- Oblast level – laboratories of Osh oblast infection hospital,
- Municipal and rayon level – 6 rayon and municipal laboratories (Municipal SES Centres, bacteriological laboratories in MCH №4, in Issyk-Kul, Jeti-Oguz, and Kadamjai rayons, and Kyzyl-Kia town).

5. Situational review of microbiological laboratory service under the SES Centres

Bacteriological tests performed by the laboratories under the SES Centres significantly contribute to diagnosing infections and monitoring environment units (water, air, soil, food products). Human and material resources of the microbiological laboratory service under the SES Centres (municipal, oblast, and rayon) enable around 6,700-7,000 lab tests annually (Table 1). Within 2008-2009, the diagnostic tests on average accounted for 47 percent, and 53 percent were made for sanitation purposes.

Table 1. Number of tests carries out by laboratories of SES Centres across the country within 2008-2009

Tests / year	**2008**	**2009**
Diagnostic tests, including serological tests	322,327	328,282
Sanitation-prevention tests	351,072	366,945
Total	**673,399**	**695,227**

Within 2009 the 3 percent increase of bacteriological tests was observed. This increase was mainly due to scatological tests, tests on food products and water.

Starting from 2005 there has been a process of rationalization of tests across the country. The process is thought to result in significant increase in tests on water and food samples that in 2009 reached 14 percent and 29 percent correspondingly (Table 2).

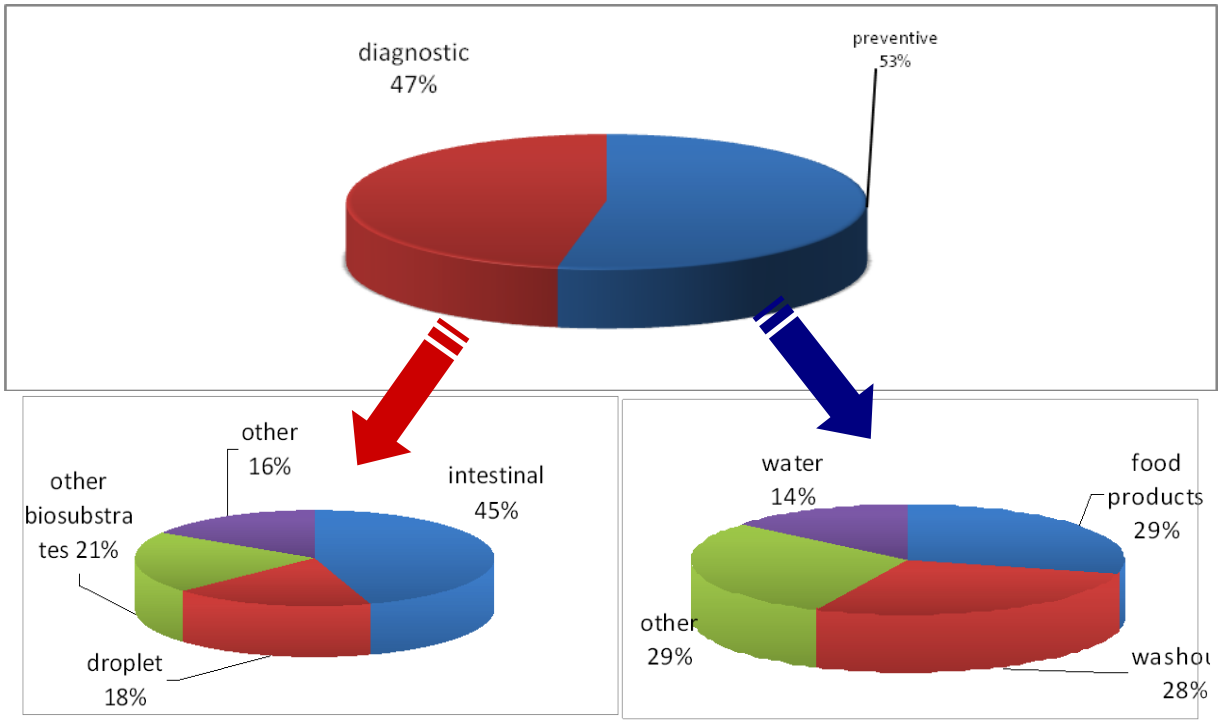
Table 2. Composition of sanitation-prevention tests within 2008-2009

Tests	**2008**	**(percent)**	**2009**	**(percent)**
Water	51,654	15	53,042	14

Food products	100,168	28	108,045	29
Washouts	102,919	29	103,954	28
Other objects	96,331	28	101,904	29

In 2009, 47 percent of the diagnostic tests were conducted for diagnostic purposes, while 53 percent of them were conducted for preventive purposes. Diagnostic tests included tests of biological substrates (21 percent), cases of suspected intestinal infections (45 percent), droplet infections (18 percent) and other (16 percent). Preventive tests comprised of water tests in 14 percent, food products in 29 percent, washouts in 29 percent, others in 29 percent (Figure 1).

Figure 1. Relation of preventive and diagnostic tests across the country in 2009 (percent)



Often in unjustified or unsystematic treatment with antibacterial drugs patients develop Disbacteriosis. Tests for Disbacteriosis comprise 10 percent of the overall number of diagnostic tests.

Unfortunately, results of this type of tests are not properly used in choosing treatment options. This results in development of drug resistance, facilitates allergies and side-effects.

Over the last three years, 40 percent of all laboratories under SES Centres have passed certification for technical competence in accordance to international standards GOST P ISO/MEK 17025 ‘General requirements to competences of testing and probing laboratories’.

However, despite significant scales of the infrastructure and amount of work, the laboratory service is suboptimal in terms of effectiveness and is experiencing difficulties due to a number of problems.

The Ministry of Health has taken measures to improve material and technical capacities. Health facilities have received a range of equipment needed for running bacteriological and other types of tests. Laboratory equipment was supplied to the primary and secondary level health facilities (FMCs and THs). Under the Health Reform Program – 2 funded by the World Bank in 2000-2005, to improve quality and to extend the range of lab tests, many laboratories were supplied with modern high-performance equipment (PCR-labs, gas-and-liquid chromatographs, analytical balance, laminar boxes with class II biological protection, lyophilic drying oven etc.). Nevertheless, extent of equipment in many laboratories does not correspond to international quality assurance standards.

For example, optimal operation of a rayon level sanitation-bacteriological laboratory requires 6 thermostats, 2 autoclaves, 1 hot air sterilizer, 2 weighing devices, 1 distillatory, 1 pH-meter, 1 microscope, 1 centrifuge, 2 fridge-bags, 4 refrigerators. Increase in number of tests increases the requirement in thermostats, autoclaves, and hot air sterilizers.

Number of 6 thermostats is needed for cultivating microorganisms with varying growth temperatures (22°C, 30°C, 35°C, 37°C, 44°C, and 55°C). Standards require that bacteria for sanitation-prevention and diagnostic tests should be cultivated in different thermostats. However, none of the laboratories across the country has the needed number of thermostats.

Similar situation has developed in relation to autoclaves. According to norms of sanitation-prevention laboratories, the sterilization of nutrient media and disinfection should be conducted in different autoclaves. Many autoclaves were received in the 70-80-s, while those received in recent years within foreign aid are short in number. This shortage results in that some laboratories conduct sterilization of nutrient media and disinfection in the same autoclaves which is forbidden and infringes standards.

Many laboratories are located in premises that do not meet quality and safety standards. Nearly all premises of laboratories need capital repair and many laboratories need complete reorientation of operational rooms with account to flow of pathogenic materials.

In addition to the shortage of up-to-date equipment, the equipment is unevenly distributed across laboratories; it is poorly packed and barely exploited by the lab staff. Not all laboratories, particularly in regions, can access timely calibration and repair. All these issues result in poor and rare use of the high-tech equipment. As illustrated in the table below, in Batken oblast only 40 percent of equipment is calibrated, and in Jalalabat oblast this figure reaches 49 percent. The limited calibration also affects quality of tests (Table 3).

Table 3. Coverage with calibration of measuring devices and equipment across the country

№	Regions	Coverage in percent
1.	Г. Bishkek	89
2.	Chui oblast	90
3.	Talas oblast	65
4.	Naryn oblast	70
5.	Issyk-Kul oblast	60
6.	Osh oblast	87
7.	Jalalabat oblast	49
8.	Batken oblast	40

In laboratories under SES Centres the staffing looks as follows: bacteriology doctors – 72 percent, bacteriology lab assistants – 92 percent. There is significant turnover of human resources that reaches 30 percent annually. In general, available staff number does not correspond to the requirement and this shortage is uneven across regions with particular gaps in remote administrative locations. Currently taken measures to offset the shortage of staff confine to specialization courses or on-the-job trainings.

The suboptimal productiveness of the laboratory service is also due to insufficient professional competence of some staff in relation to the fundamentals of analytical technologies, understanding the rational for conducting tests and clinical interpretation of lab tests.

6. Study findings

6.1. Material and technical capacities of the laboratories

32 laboratories were visited during the study. All laboratories had permission of the regime commission to work with microorganisms of the pathogenic groups III and IV, except for diagnostic laboratory in Kadamjai TH that is operational since June 2010. 11 of the selected laboratories (34,4 percent) performed diagnostic microbiological tests on different biological materials from hospital patients, including serological tests for infection agents. 13 (40.6 percent) clinical laboratories performed only helminthological tests, 4 (12.5 percent) laboratories performed sanitation-bacteriological, preventive, and diagnostic tests for

infections and parasitic diseases, while other 4 (23.5 percent) laboratories performed only sanitation-bacteriological and preventive tests.

Equipment of the studied laboratories does not meet essential international standards of quality assurance as the available equipment fill 63 percent of the requirement.

Of the available equipment, 79 percent is operational. However, 75 percent of the units are outdated, with many units produced as early as in the 1980s (Table 4).

Table 4. Availability of the modern equipment

№	Sections	Batken oblast (n-10)	Chui oblast (n-8)	Issyk-Kul oblast (n-10)	RCQHI (n-1)	RCHI (n-1)	NH (n-1)	MCH №4 (n-1)	Total (n-32)
		Total/of them 1980-1990	Total/of the 1980-1990	Total/ of the 1980-1990	Total/ of the 1980-1990	Total/ of the 1980 - 1990	Total/ of the 1980 - 1990	Total/ of the 1980 - 1990	Number of equipment units produced in 1980-1990 and percent
2.1	Autoclaves	16/14	11/8	18/17	2/1	3/3	0	0	43 (86 percent)
2.2	Ovens	10/7	10/7	10/4	1/1	1/1	0	0	20 (63 percent)
2.3	Thermostats	16/12	15/10	16/14	2/1	4/1	0	0	38 (72 percent)
2.4	Refrigerators	10/8	12/8	14/12	2/1	3/3	2/1	2/1	34 (76 percent)

Extent of use of the modern information technologies in the system of laboratory control is very limited. That is explained with that not all laboratories (69 percent) have computer hardware and, therefore, have access to Internet for searching informational and methodological materials and normative documents. To illustrate, none of the studied laboratories under THs was equipped with computers.

In addition, all laboratories under THs do not have normative documents and standards regulating operations with microorganisms of pathogenic groups III-IV, or internal quality control process.

Table 5. Availability of basic normative documents in the selected laboratories

№	Laboratory (n-32)	Availability	
		СП 1.2.036-95	МУ 2.1.4.1057-01
1	Batken oblast	2	2
2	Chui oblast	3	3
3	Issyk-Kul oblast	3	3
4	RCQHI	1	1
5	RCHI	1	1
6	NH	-	-
7	MCH №4	-	-
	TOTAL	10	10

The study revealed that bulk of equipment in laboratories is not used due to lack of skills.

Another important dimension in the laboratory network is the location of laboratories. Ideally, laboratories should have detached premises, with two separate entry points, isolated ventilation system for working with microorganisms of pathogenic groups I and II to ensure flows of clean and contaminated materials. The latter is required by SP 1.2.036-95 'Procedures of accounting, storage, transferring and transportation of microorganisms of pathogenic groups I-IV' and SP 1.2.731-99 'Safety of operations with microorganisms of pathogenic groups III and IV and Helminthes'.

Of 32 studied laboratories only 4 (12,5 percent) were located in detached premises, with 28 (87,5 percent) sharing buildings with other institutions or occupying a section of the stages in buildings of curative health facilities (Table 6).

Table 6. Location of laboratories

№	Laboratory (n-32)	Detached premises	Section of buildings	Part of a stage
1	Batken oblast (n-10)	20 percent	40 percent	40 percent
2	Chui oblast (n-8)	12,5	37,4	50,1 percent

		percent	percent	
3	Issyk-Kul oblast (n-10)	20 percent	50 percent	30 percent
4	RCQHI (n-1)	0	100 percent	0
5	RCHI (n-1)	100 percent	0	0
6	NH (n-1)	0	0	100 percent
7	MCH №4 (n-1)	0	100 percent	0

Considerable portion of laboratories is located in premises that do not ensure quality of tests, nor safety when working with infected and potentially infected materials of pathogenic groups I-IV due to absence of conditions for appropriate flows.

Of 32 studied laboratories only 2 (6,2 percent) observed the principles of air flow and had required sets of premises (laboratories in RCHI, RCQHI, and those located in Bishkek).

4 (12,5 percent) laboratories (in Batken, Kadamjai, Issyk-Kul SES Centres, and Kyzyl-Kya territorial hospitals) had required detached premises, however with preparatory rooms and washing (clean zone) rooms combined with incubation rooms, autoclave rooms ('dirty' zone). The latter circumstance is an infringement of the principle of flows. Diagnostic bacteriological laboratory in Kadamjai TH is comprised of only 3 functional rooms. In this laboratory, all types of tests are conduced in a single room with area of 40 m^2. The warehouse is a detached room with, however, functions of autoclaving of pathogenic materials and nutrient medium preparatory. In all studied laboratories there were no shower or toilet rooms for personal hygiene and safety (Table 7).

Table 7. Rooms for observing the principle of flows

№	Sections	Batken oblast (n-10)	Chui oblast (n-8)	Issyk-Kul oblast (n-10)	RCQHI (n-1)	RCHI (n-1)	NH (n-1)	MCH №4 (n-1)	Total (n-32)
1	**'Dirty' zone**								
1.1	Admission	5	3	3	1	1	1	1	46,8

									percent
1.2	Registry	2	1	0	1	0	0	0	12,5 percent
1.3	Room for tests for intestine infections	3	4	4	0	1	0	0	37,5 percent
1.4	Room for tests for droplet infections	1	0	1	0	1	0	0	9,3 percent
1.5	Incubation room	0	0	0	1	1	0	0	6,2 percent
1.6	Room for sanitation bacteriologic tests	3	2	3	0	0	0	0	25 percent
1.7	Autoclave room	5	4	4	1	1	0	0	46,8 percent
2	**'Clean' room**								
2.1	Preparatory room	0	0	0	1	0	0	0	3,1 percent
2.2	Room for nutrient medium preparation and room for filling nutrient media	4	3	4	0	1	0	0	37,5 percent
2.3	Washing room	1	1	0	0	1	1	1	25 percent
2.4	Room for staff	2	2	3	1	1	0	1	31,2
2.5	Warehouse	1	1	0	1	1	0	0	12,5 percent

Tests for parasites on samples from FMCs and hospitals are conducted in clinical laboratories that operate under those facilities. In SES Centres, these tests are conducted in

bacteriological laboratories that occupy one or two rooms, except for Kadamjai SES Centre that has a separate entrance.

For observing the regimes in laboratories when conducting the helminthes tests, for preventing intoxications with chemicals, and for disinfecting the operational materials with chemicals (disinfectants) or with physical (autoclaves) methods, the waste utilization requires a drying box where all preparations for testing the sample should be made.

> *'Feces samples for detection of eggs of helminthes and the intestine protozoa are prepared in the* drying box*, while tests are to be conducted in a designated room with sufficient ventilation''*
>
> (section from the Order of the Ministry o Health of 11.01.2010 №2 'On improving the system of epidemiological surveillance over parasitic diseases in the Kyrgyz Republic')

The study found that only 4 out of 32 laboratories were equipped with drying box, with 6 laboratories failing to ensure adequate ventilation conditions (Table 8). This factor significantly affects the operations, which is illustrated by the figures of 'positive' test results. For instance, in Kadamjai rayon, of all tested samples within 2009 only 3,8 percent were positive, in Alamudun rayon – 1,3 percent, while in Kyzyl-Kya town the proportion of 'positive' results reaches 15,5 percent.

Table 8. Conditions for parasitological tests

№	Facilities	Drying box available	Window leaf and/or window available for natural ventilation	No conditions for natural ventilation
1	Batken oblast(n-10)	2	6	2
2	Chui oblast (n-8)	0	7	1
3	Issyk-Kul oblast (n-10)	1	6	3
5	RCHI (n-1)	1	0	0
6	NH (n-1)	0	1	0
7	MCH №4 (n-1)	0	1	0
	TOTAL (n-31)	4 (12,9 percent)	21 (67,6 percent)	6 (19,5 percent)

Note: laboratory in RCQHI does not conduct helminthes tests

Interview section (respondent from Kadamjai FMC)

'…it is particularly in summer time when we are not capable to prepare all samples, therefore we prepare only those samples with indication to suspected helminthes and those for children under 4…'

6.2 Quality assurance and quality control

The system of quality assurance and quality control (QAQC) of lab tests is a basis for reliable results for timely diagnostic and correct treatment, as well as for successful implementation of clinical, epidemiological and preventive programs to secure public health.

Currently the process of QAQC has been introduced only in HIV laboratories at national and oblast levels. In general, the laboratory service does not have such a system introduced in the operational processes. There are difficulties to introduce it that are related to:

- Lack of institutionalization and financial resources;
- Lack of normative and legal regulations that would define standards of conditions for all stages of lab tests;
- Lack of knowledge and skills in bulk of lab staff on QAQC;

In 2005, to introduce the quality control system in the laboratory service, the Republican Centre for Quality Control of Laboratory Diagnostic of Infectious Diseases and two cross-reference laboratories for clinical and biological tests were founded. However, the effective functioning of this system is impossible without creating a coordination body and without ensuring adequate material and financial resources on sustainable basis.

Currently, to assess the quality of tests the laboratories use the system of external and internal quality control. It aims to ensure reliability and validity of test results.

Internal quality control of microbiological tests is a set of measures and procedures intended to ensure and control the stability of conditions required for growth of the concerned microbiological agent, as well as to prevent unfavourable factors arising during the process of preparation, implementation of tests, and evaluation of test results, all of which potentially affect reliability of results.

External control is an evaluation of the quality of tests through testing routine samples in a reference laboratory, testing benchmark samples, or through accreditation and inspectorate check visits.

As Table 9 illustrates, availability of internal and external control programs ranges from 31,2 percent to 93,7 percent.

Quality of tests is determined in many ways by the use of nutrient media and chemicals. Thus, it is essential for facilities to conduct internal quality control of nutrient media on regular basis. The study found that some laboratories do not control quality of the nutrient media, with only 10 (31,2 percent) out of 32 laboratories having the process in place. Control of air quality in operational rooms is also suboptimal, with only 12 (37,5 percent) out of 32 laboratories having this process in place. Meanwhile, regular air quality control is intended to clean the air from pathogenic microorganisms that can contaminate the tests objects and used expendables. Control of the equipment operation was also found suboptimal. The temperature regime control in thermostats, a process that directly impacts the growth of microorganisms, is conducted only in 43 percent of laboratories. Similar picture was observed in relation to operations with high pressure equipment when it is essential to control pressure levels, run tests to achieve appropriate pressure levels, and register the data (Table 9).

To ensure reliability and validity of test results, all laboratories must go through cross-reference tests. The study found that only 11 (34,3 percent) of laboratories participate in the cross-reference tests.

Table 9. Internal and external quality control

№	Sections	Batken oblast (n-10)	Chui oblast (n-8)	Issyk-Kul oblast (n-10)	RCQHI (n-1)	RCHI (n-1)	NH (n-1)	MCH №4 (n-1)	Total (n-32)
	Availability of registries and test protocols								
1	**For control of:**								
1.1	Nutrient media	3	2	3	1	1	0	0	10 (31,2 percent)
1.2	Sterility of glassware	5	4	3	1	1	0	0	14 (43,7 percent)
1.3	Air in operational rooms	4	3	3	1	1	0	0	12 (37,5 percent)
2	**For equipment units**								
2.1	Autoclaves	4	4	4	1	1	0	0	14 (43,7 percent)

2.2	Hot air sterilizers	3	5	4	1	1	0	0	14 (43,7 percent)
2.3	Thermostats	5	4	4	1	1	0	0	15 (46,8 percent)
2.4	Refrigerators	8	8	10	1	1	1	1	30 (93,7 percent)
3	**Control of distilled water**	2	3	3	1	1	0	0	10 (31,2 percent)
4.	**Participation in cross-reference tests**	3	3	4	0	1	0	0	11 (34,3 percent)

These figures demonstrate the internal and external quality control processes are suboptimal and seemingly do not assure quality of tests.

To assess the quality of tests, the tests for growth of intestine flora were reviewed based on registries of the test processes and reporting data covering 2007-2009. The review found that growth of pathogenic intestine flora in patients with acute intestine infections is very poor reaching only 1,8 percent (Table 10).

Table 10. Composition of the growth of pathogenic intestine flora (2007-2009)

№	**Laboratory (n-32)**	**Total tests for intestine infections for 2007-2009**	**Growth of pathogenic intestine flora (in percent)**
1	Batken oblast	15,866	7,6
2	Chui oblast	15,545	2,8
3	Issyk-Kul oblast	17,201	1,6
4	RCHI	6,876	4,5
Total		55,488	1,8

It is worth noticing the methodology of bacteriological tests establishes that samples can be grown only after 5 days, or in 3 days in special circumstances. However, the review found

that only in 23,6 percent of cases the test results were ready and handed over on the fifth day after the test, with 36,8 percent cases with tests results handed over on the second day following the test.

These facts are evident of inobservance of test methodology in bacteriological tests, which limits chances to establish causal agents. Moreover, in some facilities the sampling and bacteriological test processes employed physiological solutions as a transportation media, thus failing to use the transportation media itself. This also can affect reliability of bacteriological tests. Another finding is that in the selected laboratories the process focuses mainly on opportunistic infections, thus preventing the search for other pathogenic agents. Finally, the laboratories were found not to systematically identify type cultures.

Another significant determinant of poor growth can be the fact that in many cases the pathogenic agents are viruses that cannot be tested due to absence of virology labs.

6.3. Funding of bacteriological laboratories, procurement of equipment and expendables

Presently the laboratories are funded following procedures established for health facilities under which the laboratories are operating. Laboratories are funded from the special account (specialniy schet). Tests are paid in accordance to the Order of the Ministry of Health № 92 of 03.03.08 ‘On standard agreements for microbiological diagnostic tests’.

Equipment, nutrient media, chemicals and other expendables for laboratories under SES Centres are procured centrally. The State Department of SES forms an order that reflects requirements in all oblast and rayon laboratories and further distribution of the procured materials. This process ensures that users receive essential materials in good quality as the central level goes through all procedures for ‘entrance control’ conducted by an independent accredited laboratory.

The study found that laboratories under THs and FMCs procure equipment units and materials for tests independently and do not go through the ‘entrance control’ of quality of procured materials, nutrient media, and chemicals, which accordingly affects the quality and reliability of tests. The lack of centralized procurements and ‘entrance control’ and internal quality control processes in these laboratories is seemingly a consequence of that many of these laboratories use expired chemicals and nutrient media without any additional quality confirmations. These evidently negatively affect the reliability of tests.

6.4 Staff capacity

The selected laboratories had the following staff at disposal: 24 specialists with high education, of them 54,2 percent had medical education and 45,8 percent had biological education. 12 percent of doctors had qualification categories.

In the selected laboratories there were 46 specialists with nursing education; ratio of doctors/nurses was found as 1:2 (Table 11).

The laboratories were by 68 percent equipped with staff, with 45 percent of doctor competences performed by specialists with background of biology science. Staff working in parasitological laboratories was composed of specialists with nursing or biological background.

Table 11. Number of specialists working in the selected microbiological laboratories

№	Laboratory (n-32)	Doctors with medical background	Doctors with biological background	Nurses
1	Batken oblast	5	3	13
2	Chui oblast	3	5	14
3	Issyk-Kul oblast	2	2	11
4	RCQHI	2		3
5	RCHI	1	1	3
6	NH			1
7	MCH №4			1
	TOTAL	13	11	46

Bacteriology doctors annually conduct training seminars with staff of laboratories, however, during the study the team could not find mechanisms of pre- and post-training knowledge testing.

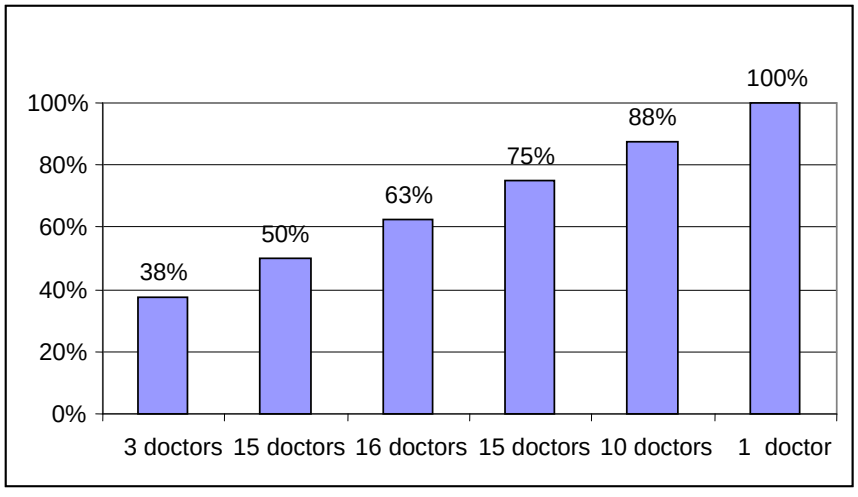
6.5 Knowledge evaluation of doctors in health facilities on methods of laboratory testing of infectious and parasitic diseases

Laboratory tests are crucial in diagnostics of infections; they enable adjustments in treatment and avoiding complications. To obtain correct information it is important that doctors know what to sample for testing, rules of sampling, sample preservation, transportation and storage for testing. Other important determinants of reliable and accurate test results are the justified prescription of tests, and timely and correct sampling by clinical staff. In order to define knowledge of doctors, a quiz was developed with questions concerning rules and methods of sampling for laboratory testing.

Overall 60 doctors were asked, with 20 doctors in each region (20 – in Batken oblast, 20 in Bishkek and Chui oblast, and 20 in Issyk-Kul oblast).

Interviews with doctors demonstrate that not all doctors know rules of sampling. Only 1 doctor of all interviewed answered correctly to all questions, while 10 doctors (17 percent of respondents) correctly answered to 88 percent of questions, 15 doctors (25 percent of respondents) - to 75 percent of questions, 16 doctors (17 percent) - to 63 percent of questions, 15 doctors (25 percent of respondents) - only to half of questions, and 5 percent of doctors correctly answered only to 38,5 percent of questions.

Figure 2. Number of correct answers, %



The interviews found that 90 percent of laboratories run trainings for clinical doctors following the established plans and covering issues of sampling and transportation of samples. However, the quiz results make doubtful the effectiveness of the trainings. It might be rational to revise methodology of teaching and regularly evaluate the knowledge obtained and application in practice.

6.6. Analysis of the use of lab test results based on medical records

6.6.1. Rational for laboratory tests

To explore the extent of justified bacteriological tests and their use in managing infection cases, the out-patient medical cards and in-patient case records were reviewed in THs and FMCs. Medical cards and case records were selected randomly. In each TH and FMC 20 cards and records with infection cases were retrieved. Overall 358 medical cards and case records were reviewed. Lab tests are performed after clinical examination and are used for confirmation of the initial diagnosis. In all cases of in-patient treatment, patients were taken samples for bacteriological tests (virology tests were not performed). The review of medical documents demonstrated that in 89,3 percent cases the lab tests were prescribed in accordance to the clinical diagnosis. In 11,7 percent the bacteriological tests were conducted to clarify the clinical diagnosis following the initial diagnosis ‘Fever of unknown origin’. It is worth noting that nearly in all cases the parasite (helminthes) tests were unjustified regardless of clinical manifestation and complaints.

In addition, the review of medical documents revealed that doctors, when prescribing the bacteriological and serological tests, often fail to account for antibacterial drugs patients had used before receiving care in hospital or policlinic. It is important since the results of the bacteriological tests will depend on the previously administered drugs.

Moreover, often doctors merely do not use the lab test results when managing cases. That is explained with that nearly all microbiological laboratories use classic methods that take rather long (from 3 to 35 days). Within that timeframe the treatment course finishes and the patient is discharged from hospital, leaving the lab test results valueless.

For instance, diagnostic test for a case suspect to Brucellosis is performed following the methodology guidelines established by the Order of the Ministry of Health of 24.02.10 № 103 ‘Bacteriological tests for haemal type culture for Brucellosis’. According to these guidelines, the bacteriological test will take up to 35 days, thus, in many cases the test results reach health facilities after patient has been discharged.

The above stated issues call for revision of regulations of methodology of laboratory testing of infectious diseases. It is essential to account for the fact that presently the laboratory testing for Brucellosis and other infections is increasingly exploiting molecular and biological methods (e.g. PCR) that take less time, are more specific and sensitive.

It is also worth reiterating that the affected value of laboratory testing due to long timeframe results in the absence of control over timeliness of handing in of the test results. During our cite visits, in the shelves for storing the test results the study team found papers with ‘positive’

results for tests that had been performed 2-3 months earlier and were not requested by health facilities.

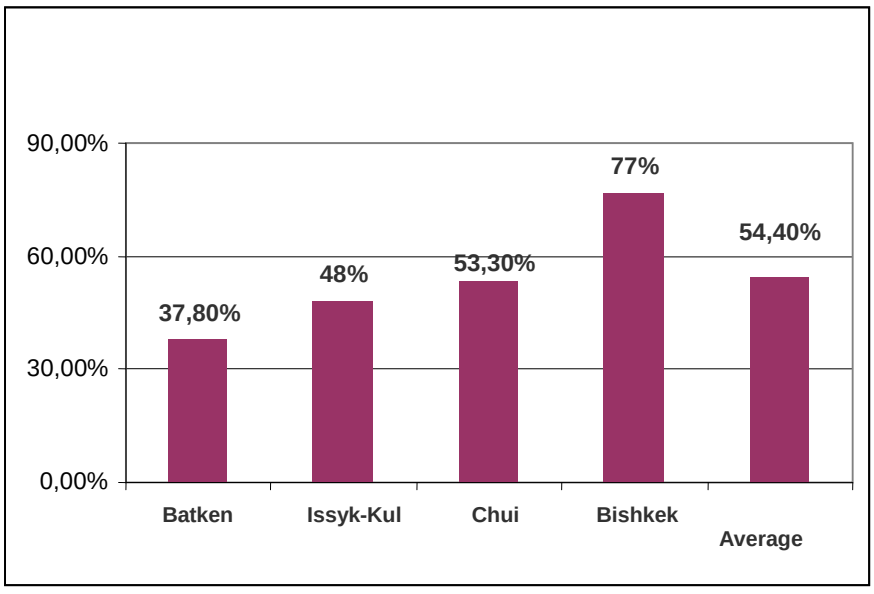
6.6.2 Correspondence of the initial diagnosis to results of microbiological tests

Use of lab tests for ultimate diagnosis and follow-up adjustments in treatment is very important.

The review of medical documents found that in 54,4 percent cases were with initial diagnosis confirmed by lab tests and, correspondingly, in 45,4 percent cases were without confirmation with laboratory test.

The lowest percent of correspondence of the etiological agent in the initial diagnosis to laboratory test results was found in Batken oblast with 37,8 percent of reviewed cases confirmed with laboratory tests. This figure in Issyk-Kul oblast comprised 48 percent, in Chui oblast - 53,3 percent, and the highest correspondence was found in Bishkek with 77 percent (Figure 3).

Figure 3. Correspondence of etiological agent in the initial diagnosis to lab test results



In general, except for Bishkek, there is rather poor laboratory test confirmation of initial diagnosis which can also be explained by that all microbiological laboratories conduct only bacteriological tests while many infectious diseases are of viral origin.

Moreover, in the studied laboratories the tests focus on opportunistic agents and do not search for other pathogenic agents, failing to systematically conduct identification of type cultures.

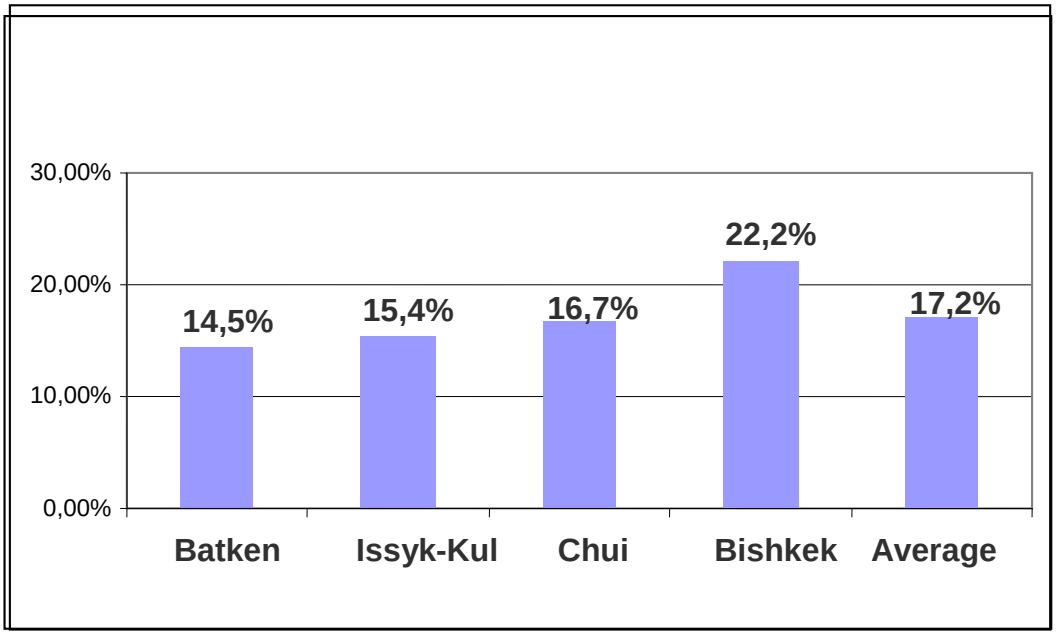
For instance, not all patients with initial diagnosis 'Brucellosis' are tested for other infections with similar clinical manifestation (such as Chlamydia, Streptococcus infections, acute respiratory viral infections). In doctors' opinions, often the 'positive' results of serological tests for Brucellosis (Huddleson and Wright tests) may occur along with absence of clear clinical signs of Brucellosis that suggests the specificity of serological tests is poor. Therefore, it is essential to introduce the up-to-date methods such as PCR and IFA that are comparatively more specific and sensitive.

6.6.3. Adjustment of treatment based on lab test results

On average in 45,4 percent of the reviewed medical documents (out-patient medical cards and in-patient case records) the initial diagnosis was not found to correspond to laboratory test results; therefore, these cases were subject to treatment adjustments. At the same time, doctors decided to adjust treatment depending on the change in the patient's overall status. Often the changes in patient's overall status were found to prevent decisions to adjust treatment.

Review of medical documents found that in 17,2 percent cases in all regions the treatment was adjusted based on microbiological test results, although the analysis showed the adjustments were required in 45,6 percent of cases. The most frequent cases with treatment adjustments were found in Bishkek with 22,2 percent, while the least cases were found in Batken oblast with 14,5 percent of cases (Figure 4). These findings suggest only in Bishkek doctors systematically practice adjustments in treatment in accordance to test results: in 22,2 percent out of 23 percent cases when adjustments were required.

Figure 4. Adjustment in treatment in accordance to laboratory tests



The so poor use of lab test results for treatment decisions can be primarily explained by that they do not timely receive test results; it also instructs that interactions of staff in lab service and health facilities are inadequately poor. Moreover, in all laboratories under THs there were no standard forms of referencing for lab tests and test result delivery.

7. Conclusions

The study findings demonstrate the need in systematic rearrangements and correction of individual sections of the laboratory service, with account to possible costs of re-equipment and actions to improve its effectiveness.

It was shown that bulk of microbiological laboratories are operating in premises that do not meet requirements for high quality and safe tests with materials of I-IV pathogenic groups. In 32 studied laboratories only 4 (12,5 percent) were operating in a detached building with compliance to standards, while other laboratories were located in sections of buildings.

In microbiological laboratories operating with hazardous agents, there are no conditions to ensure biological safety, a determinant of test reliability and safety for staff. The study found that only 12 percent of selected microbiological laboratories were equipped with drying boxes, 20 percent laboratories did not have ventilation, and only 2 laboratories out of 32 had the required set of premises for observance of the ‘principle of flows’. Besides, in all studied laboratories there were no shower and toilet rooms for the staff to observe personal hygiene and safety.

Extent of equipment of all selected microbiological laboratories does not meet quality standards. 63 laboratories are equipped, however 75 percent of the equipment is out-dated with production dates of as early as the 1980-s. Of available equipment, 20 percent is not operational. Procurement of equipment often did not account for costs of expendables to ensure continuous operation. Deficit of up-to-date equipment was found to exist along with gaps in its exploitation, as in regions the staff is not trained to operate such equipment units. Not all laboratories, particularly in regions, had access to timely calibration and repairs. These all result in poor use of equipment. For instance, in Batken oblast only 40 percent of equipment had been calibrated and in Jalalabat this figure reaches 49 percent - this also undermines quality of tests. None of the studied microbiological laboratories under THs had computers at disposal. This was primarily due to absence of minimum standards of technical equipment of the laboratory service.

Furthermore, microbiological laboratories under THs and FMCs do not have a system for centralized supply of nutrient media and other expendables, which has resulted in poor ‘entrance’ quality control and episodes of using materials with expired dates or without

appropriate quality confirmations. All laboratories practice the internal and external quality control systems, however, few participate in cross-reference tests (only 34,3 percent).

The analysis of test quality, which was carried out through the example of flora growth of intestine infections and helminthes tests, exposed the very poor reliability of tests that we explain primarily with omissions in observing test methodologies, transportation of materials, use of materials with expiry dates of production, and lack of relevant equipment and materials.

The selected laboratories are by 68 percent equipped with staff. Requirement in doctors is met by 45 percent, with bulk of staff being specialists with biological education. The laboratory service is experiencing high staff turnovers that annually reach 30 percent.

Interviews with doctors showed that not all doctors, when managing infectious diseases, know rules of sampling, preserving, transportation, and storing biological materials for microbiological tests. This lack of knowledge often results in unreliable test results.

In addition, analysis of medical documents revealed that, when prescribing bacteriological and serological tests, doctors often do not account for the history of previously administered drugs, particularly of antibacterial drugs, that could be taken before receiving care at out-patient or in-patient facilities. This also potentially affects reliability of test results.

The study also found that often doctors do not use the test results to support treatment decisions. All laboratories use classic methods that can take long ranging from 3 to 35 days. Within such long periods the treatment course can finish and patient can be discharged, thus leaving the test results valueless. This explains the poor use of test results for adjustments in treatment (17,2 percent). These factors are evidently exposing the poor interactions between specialists of the laboratory service with medical specialists that manage infection cases.

It is essential to revise regulations of the laboratory diagnostic concerning a number of infections. We need to take into account that presently the laboratory testing is exploiting molecular methods (e.g. PCR) that take shorter timeframe and are more specific and sensitive.

8. Recommendations

1. The Ministry of Health should consider carrying out an inventory of equipment units, standards, access to maintenance services for equipment, access to nutrient media, and chemicals. The inventory should bring accurate data on material and technical conditions for further planning

2. Consider possibility of centralized procurements of nutrient media and other expendables for microbiological laboratories, in order to ensure a single entrance control of quality of procured means.
3. For appropriate introduction and development of the quality control system, it is essential to improve the existing system of quality control through involving the leading national laboratories (such as Centre for Microbiological and Molecular-Genetic Tests under the State Department of Sanitation and Epidemiology Surveillance, RCQHI, Department for Drug Supply and Medical Devices, Research Centre 'Profilakticheskaya Medicina').
4. Regulations of microbiological diagnostic of a number of infections should be developed or revised, to bring to compliance to currently acting standards.
5. To ensure reliable laboratory diagnostics, national normative regulations should be developed in order to standardize pre-test, test, and post-test stages. Based on the standards, each laboratory should hold 'Guidelines of quality assurance' that are subject to updates when needed.
6. Methodology documents and quality control programs for quantitative and qualitative microbiological tests should be developed, and measures of internal and external quality control should be strengthened in order to obtain reliable and valid test results.
7. Consider handing functions of a coordination body to the Centre of Microbiological and Molecular-Genetic Tests under the SDSES, so that it rendered methodology and practical back-up to microbiological laboratories.
8. To improve knowledge of staff, it is recommended to introduce postgraduate education programs operating in Kyrgyz State Medical Institute of Continuous Education and covering modern methods of microbiological lab tests.
9. It is recommended to strengthen responsibility of clinical doctors for correct sampling, storing, and transportation of biological materials for laboratory testing, as well as to enforce timeliness of test results for following adjustments in treatment.