HYGIENE, SANITATION, EPIDEMIOLOGY AND MEDICAL ECOLOGY

N.G. Pavlov, G.I. Alekseeva, M.K. Vinokurova, E.I. Ermolaeva, M.V. Chernykh

DOI 10.25789/YMJ.2019.67.18

COMPREHENSIVE INDICATIVE ANALYSIS OF THE PERFORMANCE AND QUALITY OF ACID-FAST BACTERIA DETECTION BY PRIMARY CARE FACILITIES IN THE SAKHA REPUBLIC (YAKUTIA)

The study takes a look at the work of clinical laboratory service performing microscopic diagnosis of tuberculosis in the Sakha Republic (Yakutia). We analyzed results of Ziehl-Neelsen microscopic detection of tuberculosis (TB) in clinical diagnostic laboratories of primary care facilities in 2005, and over the period from 2012 to 2016.

Analysis was based on national-level and industry sectoral reports, and annual reports of laboratories performing microscopic diagnosis of TB. Data from the following statistical forms were studied: Form 30, Form 33, Form '7-ТБ', Register '03-ТБ/у', Register '4-ТБ/у' for the years 2005, and 2012-2016.

Keywords: Mycobacterium tuberculosis, clinical diagnostic laboratory, acid-fast bacilli, Ziehl-Neelsen microscopy, primary care.

Introduction. Today's epidemiological situation with tuberculosis (TB) in Russia, and in the world, is demanding fast and effective detection and control of the causative agent, to prevent its spread. Microscopic method based on acid-fast biological properties of Mycobacterium tuberculosis is one of the detection methods that are both fast and inexpensive [9].

Detection of acid-fast bacilli (AFB) in diagnostic specimens is significant in terms of identifying infectious TB cases, which present the biggest epidemiological risk. As is recognized, these patients can infect 20-30 or even more persons a year, on average [1, 5, 9].

In this view, intensifying the detection of cases by microscopic methods is considered more and more as an urgent task for laboratory services within all medical and preventive healthcare facilities, irrespective of their departmental affiliation or forms of ownership [9].

One of the viable focus areas in raising the effectiveness of anti-TB measures is the application of indicative approach to state monitoring and management system. Monitoring trends in indicators can be useful in terms of more effective management of prevention and treatment practices, and to assess the performance of anti-TB measures. Based on indicative approach, improved epidemiological monitoring and quality assessment systems in TB care system have been developed and implemented at a regional level [7].

Aim. Analyze performance and quality of AFB detection by means of Ziehl-Neelsen staining-based microscopic examination performed in laboratories of primary care facilities in the Sakha Republic (Yakutia).

Material and methods. We analyzed the work of laboratory service performing microscopic diagnosis of TB in Yakutia. Analysis was based on national-level and industry sectoral reports, and annual reports of laboratories performing microscopic diagnosis of TB.

Data from the following statistical forms were analyzed: Form 30, Form 33, Form '7-ТБ', Register '03-ТБ/у', Register '4-ТБ/у' for the years 2005, and 2012-2016.

Statistical data processing was performed using commonly available software (Microsoft Excel), and StatSoft Statistica 6, and was based on mean values (M±m), and statistical significance measure for observed statistical differences (P).

Results and discussion. As of January 1, 2017, 209 clinical laboratories of all levels were functioning in the Sakha Republic (Yakutia).

Of 209 laboratories, Ziehl-Neelsen microscopic tests for AFB were performed by 144 (68.9%) labs. Due to substandard resources, 60 (28.7%) labs were not licensed to work with RG3 and RG4 biological agents, and were not performing tests for AFB.

Based on WHO recommendations for primary care facilities, the key performance quality indicators for Ziehl-Neelsen (ZN) microscopy are AFB detection rate in diagnostic specimens, multiplicity of tests performed, population coverage (%) with tests, and proportion of new TB cases with positive ZN sputum microscopy detected in primary care laboratories. Based on these criteria, we assessed performance for ZN microscopic tests conducted in clinical diagnostic laboratories of primary care facilities over the period from 2012 to 2016.

As is seen in Table 1, over the specified period, number of tests performed and number of individuals tested for AFB in primary care laboratories had remained practically at the same level, with minor variations ranging from 79 258 (2012) to 79 544 (2016) tests/year, and from 30 760 (2012) to 30 174 (2016) patients/year. Proportion of AFB-positive patients had been declining each year (WHO reference level: 1%), with 0.3% in 2016, compared to 0.5% in 2012. Multiplicity of tests (WHO reference value: 3.0) remained stably at 2.6. Population coverage (WHO reference level: 5%) ranged from 3.4% to 3.1%.

It can be said, that AFB detection rate, multiplicity of ZN tests, and population coverage with ZN testing in primary care

PAVLOV Nikolai Gerasimovich, Cand.Sci. (Veterinary Medicine), senior researcher, Bacteriological laboratory, Phthisiatry Research-Practice Center, Yakutsk, Russia; Mobile: 79644240417 E-mail: png_74@mail.ru, **ALEKSEEVA Galina Ivanovna**, Dr.Sci. (Medicine), Head of Bacteriological laboratory, Phthisiatry Research-Practice Center, Yakutsk, Russia; Mobile: 79644260609 E-mail: agi_nik@mail.ru, **VINOKUROVA Maria Konstantinovna**, Dr.Sci. (Medicine), Deputy Director for Science, Phthisiatry Research-Practice Center, Yakutsk, Russia; Mobile: 79644239494 E-mail: mkvin61@mail.ru, **ERMOLAEVA Elena Innokentievna**, Head of Clinical diagnostic laboratory, Phthisiatry Research-Practice Center, Yakutsk, Russia; Mobile: 79142378470 E-mail: ermolaeva.50@mail.ru, **CHERNYKH Marina Valerievna**, bacteriologist, Bacteriological laboratory, Phthisiatry Research-Practice Center, Yakutsk, Russia; Mobile: 79142221306 E-mail: maviche@bk.ru.

laboratories had been below the reference WHO levels over the period from 2012 to 2016, and showed a trend to decline.

Therefore, with the aim to comprehensively assess performance of microscopies for AFB, we analyzed some aspects in generating the values for indicative statistics.

The first indicator, *AFB detection rate*, is used to describe the percent of smear-positive TB patients among patients suspected for TB and tested in primary care laboratories. Indicative value is calculated based on ratio of smear-positive patient number to total number of persons tested for TB (% of infectious TB patients identified by microscopy). Calculation is made using the formula:

$$\frac{\text{Number of smear-positive patients}}{\text{Number of patients with suspicion tested for TB}} \times 100$$

This indicator is used to assess performance of primary level laboratories in detecting TB cases. It is in correlation with TB prevalence level in a region. Reference value for AFB detection rate should be 1%.

Data in Table 1 show that in the Sakha Republic, the reference value for AFB detection rate is achieved only in specialized TB service facilities. Considering the existing estimated TB incidence in Russia, primary level laboratories could be able to detect, respectively, 1-2% and 2-3% of TB cases in cities and in rural areas, per every 100 individuals tested [6].

Reaching these proportions will demand rigorous adherence to requirements: appropriate patient referral for AFB-test; adequate multiplicity of tests performed; adequate quality of diagnostic specimens.

The second indicator, *multiplicity of tests*, is calculated using the formula:

$$\frac{\text{Number of samples tested}}{\text{Number of patients with suspicion tested for TB}} \times 100$$

WHO recommends collecting three samples from each patient suspected for TB to perform sputum microscopy. Ideally, an average number of slides (samples) observed to diagnose 1 patient should be 3 or close to 3. Too many (>3) or too few (<2) samples would be considered as noncompliance to sputum collection procedure [6]. But taking into consideration the new recommendations, cancel of further diagnostic tests of specimens is allowed, if AFB are detected in the first sputum sample. Optimal multiplicity for sputum tests per 1 patient, performed with diagnostic purpose, could be 2.7.

The third indicator describing the performance of primary-level facilities is *population coverage with microscopy*, calculated using the formula:

$$\frac{\text{Number of patients with suspicion tested for TB}}{\text{Total population of an area}} \times 100$$

Reference level for this indicator is 5%. This level is achievable with adequate patient classification to social and medical risk groups for TB.

The forth indicator, a significant one, is the *proportion of smear-positive patients with TB detected in primary-level laboratories among all notified new smear-positive TB cases*.

With well-organized workflow, the majority of infectious TB cases identified by sputum microscopy should be detected by primary-level facilities. Recommended detection level is estimated as no less than 50-70%. This indicator is calculated using the formula:

$$\frac{\text{Number of smear-positive TB patients detected by primary-level facilities}}{\text{Number of all notified new smear-positive TB cases}} \times 100$$

To analyze this indicator, results of microbiological examinations were studied in newly identified patients within annual cohorts of pulmonary TB cases in Sakha Republic for the years 2005, and 2012-2016.

Over the study period, there was a decline trend in number of new cases of pulmonary TB, with a decrease by 15.3%, on average (from 577 in 2005 to 489 in 2016). Among new pulmonary TB cases, diagnosis of infectious TB (i.e. case identification and notification) by means of microscopy (ZN, fluorescence) decreased by 5% (from 34.0% in 2005 to 32.3% in 2016) (Table 2).

There was a noticeable increase in AFB detection rate by microscopies performed in primary-level facilities. In 2005, proportion of AFB+ results in primary-level facilities was 18.4%, but during the period from 2012 to 2016, there was a statistically reliable increase by a factor of 2.4 ($p<0.05$), and in 2016, the proportion was 44.3%.

In the Far-East Federal District, the proportions of new infectious (smear-positive) TB cases detected by microscopy were lower, compared to Sakha Republic (Table 3): 32.2 (2012); 30.2 (2013); 31.5 (2014); 32.8 (2015); 30.2% (2016). In Russian Federation, the proportions were almost the same as in Sakha Republic: 33.8 (2012); 34.2 (2013); 34.0 (2014); 34.1 (2015); 33.8% (2016) [2,3,4,8].

For the last 5 years, the proportion of AFB-positive cases detected by primary-level facilities, among all notified AFB+ cases, was stably above 40% (except 39.8% in 2015), which was meaningfully higher, compared to Far-East Federal District and Russian Federation (2.3 and 2.4 times ($p<0.05$), respectively).

Hence, taking into consideration the increase in microscopic detections by primary-level facilities in Sakha Republic, observed over the study period, an appropriate reference level for this indicator would be no less than 60%.

Conclusion. All reference indicators discussed are suitable for estimation of the performance, quality of work, and work-

Table 1

Number and quality of ZN microscopies for AFB in clinical diagnostic laboratories of primary care facilities in 2012-2016

Indicators	Years				
	2012	2013	2014	2015	2016
Number of tests, total	79258	83501	79305	80034	79544
Of them, AFB+	322	228	226	187	162
Detection % (WHO reference: 1%)	0.4	0.3	0.3	0.2	0.2
Patients tested	30760	32584	30797	29920	30174
Of them, AFB+	149	126	110	101	87
Detection % (WHO reference: 1%)	0.5	0.4	0.4	0.3	0.3
Test multiplicity (WHO reference: 3.0)	2.6	2.6	2.6	2.7	2.6
Population coverage % (WHO reference: 5%)	3.2	3.4	3.2	2.8	3.1

flow management of primary-level laboratories performing ZN microscopy for AFB.

The indicators are easy to calculate, and are currently included in official statistical recording and reporting forms.

In conclusion, present-day reality is demanding further dedicated managerial efforts to continue actively using microscopic method in case detection, in particular, pulmonary TB cases, and especially, among social and medical risk groups. In view of this, more emphasis is put on comprehensive indicative approach to estimation and continuous monitoring of workflow organization and quality of microscopic tests performed, for the purposes of TB detection.

Table 2

AFB detection among new cases of pulmonary TB, Sakha Republic, 2005, 2012-2016

Year	Total number	Of them AFB+ (microscopy)		Of them, AFB+ (microscopy in primary care)	
		n	%	n	%
2005	577	196	34,0	36	18,4
2012	576	215	37,3	88	40,9
2013	591	199	33,7	81	40,7
2014	558	212	38,1	94	44,3
2015	517	171	33,1	68	39,8
2016	489	158	32,3	70	44,3
Trend over 2005-2016	- 15,3%	- 19,4%	- 5%	+1.9 times	+2.4 times

Table 3

Proportion of new cases of pulmonary TB with positive microscopy, Sakha Republic, Far-East Federal District, Russian Federation, 2012-2016

Indicator	Years				
	2012	2013	2014	2015	2016
Notified with AFB+ microscopy:					
Yakutia: (M±m) = 34.9±1.2	37.3	33.7	38.1	33.1	32.4
Far-East: (M±m) = 31.4±0.5	32.2	30.2	31.5	32.8	30.2
Russia: (M±m)=34.0±0.1	33.8	34.2	34.0	34.1	33.8
Of them. proportion of AFB+ detected in primary care facilities:					
Yakutia: (M±m) = 42.0±0.9	40.9	40.7	44.3	39.8	44.3
Far-East: (M±m) =17.9±0.5	19.2	18.7	16.1	17.2	18.1
Russia: (M±m) =17.5±0.3	18.3	17.9	16.8	17.5	16.8
Increase in Yakutia, compared to Far-East Federal District and Russia: by a factor of 2.3 and 2.4.					

References

1. Выявление туберкулеза методом микроскопии: учебное пособие для проведения базового курса обучения. Москва, Тверь: Триада; 2008. [Detection of tuberculosis using microscopy method: study guide for basic studies courses. Moscow, Tver: Triada Publ.; 2008. (In Russ.)].

2. Ревякина О.В. и др. Основные показатели противотуберкулезной деятельности в Сибирском и Дальневосточном федеральных округах. Новосибирск; 2013. [Revyakina OV et al. Key indicators for anti-tuberculosis measures in Siberian and Far-East Federal Districts. Novosibirsk; 2013 (In Russ.)].

3. Габбасова Л.А. и др. Отраслевые и экономические показатели противотуберкулезной работы в 2009-2014 гг. Методика расчета показателей и статистические материалы по результатам пятилетнего наблюдения. Москва: ЦНИИОИЗ; 2015. [Gabbasova LA et al. Industry sectoral and economic indicators for measures against tuberculosis in 2009-2014. Indicator calculation methodology and statistical materials, based on the results of 5-year observation. Moscow: TSNIIOIZ Publ.; 2015 (In Russ.)].

4. Стерликов С.А. и др. Отраслевые и экономические показатели противотуберкулезной работы в 2015-2016 гг.: статистические материалы. Москва: ЦНИИОИЗ; 2017. [Sterlikov SA et al. Industry sectoral and economic indicators for measures against tuberculosis in 2015-2016: statistical materials. Moscow: TSNIIOIZ; 2017 (In Russ.)].

5. Павлунин А.В. и др. Проблемы организации выявления и диагностики туберкулеза в общей лечебной сети. Проблемы туберкулеза. 2014;11:18-22. [Pavlunin AV et al. Problems in organizing the detection and diagnosis of tuberculosis in primary care network. Problemy tuberkuleza. 2014; 11:18-22 (In Russ.).] https://doi.org/10.21292/2075-1230-2014-0-11-18-22

6. Севастьянова Э.В. и др. Разработка критериев оценки качества и эффективности микробиологических исследований в учреждениях противотуберкулезной службы и общей лечебной сети. Проблемы туберкулеза и болезней легких. 2009; 3:55-60. [Sevast'yanova EV et al. Development of criteria for assessing the quality and performance of microbiological testing in TB facilities and in primary care network. Problemy tuberkuleza i bolezney legkikh. 2009;3:55-60 (In Russ.)].

7. Скачкова Е.И. Научное обоснование и разработка региональной модели организации борьбы с туберкулезом в современных социально-экономических и эпидемиологических условиях [диссертация]. Москва; 2008. [Skachkova E.I. Scientific substantiation and development of the regional model for organization of the fight against tuberculosis in the current socioeconomic and epidemiological settings [dissertation]. Moscow; 2008 (In Russ.)].

8. Туберкулез в Российской Федерации 2011 г.: аналитический обзор статистических показателей, используемых в Российской Федерации и в мире. Москва; 2013. [Tuberculosis in Russian Federation 2011: analytical review of indicators used in Russian Federation and in the world. Moscow; 2013 (In Russ.)].

9. Ерохин В.В. и др. Унифицированный метод микроскопического выявления кислотоустойчивых микобактерий: руководство для клинико-диагностических лабораторий лечебно-профилактических учреждений. Москва, Тверь: Триада; 2008. [Erokhin VV et al. Unified method of microscopic detection of acid-fast mycobacteria: manual for clinical diagnostic laboratories of healthcare facilities. Moscow, Tver: Triada Publ.; 2008 (In Russ.)].