INCIDENCE OF TUBERCULOSIS IN THE STAFF OF HEALTHCARE ORGANIZATIONS AND RESPONSIBILITY OF REGISTERED NURSING STAFF IN CONDUCTING ANTIEPIDEMIC MEASURES

A.I. Obutova, A.I. Gotovtseva, N.G. Pavlov

State Budgetary Institution of the Sakha Republic (Yakutia) «Research-Practice Center 'Phthisiatry», Yakutsk

Summary. We comparatively analyzed the incidence of tuberculosis in the staff of various specialty healthcare organizations, through the case of the Sakha Republic (Yakutia), and monitored clinical *M.tuberculosis* strains for susceptibility/resitance to disinfectants. Incidence of tuberculosis among the staff of anti-tuberculosis institutions was 3 to 4 times higher ($p<0.05$), than in the staff of other healthcare organizations; among them, tuberculosis occurred mostly in registered nursing staff and in nurse assistant staff.

Disinfectants types that played main role in the control of nosocomial transmission of *M.tuberculosis* were chlorine compounds, and quaternary ammonium compounds (QAC) in combination with aldehydes.

Keywords: tuberculosis, *Mycobacterium tuberculosis*, incidence, antiepidemic measures, medical staff, disinfectants

Background. Overall epidemiologic situation with tuberculosis (TB) in Russia, and in Sakha Republic (Yakutia), is still stressful, despite recent stabilization in some indicators of TB prevalence and despite organization of anti-TB activities for population protection [1,5]. Incidence of nosocomial TB keeps growing, and has increased twice over the last 10 years [4]. Intrahospital non-specific antiepidemic measures start to play increasingly important role in today's unfavorable epidemiologic situation with TB; these measures consist essentially in decontaminating various inanimate objects by means of disinfecting agents [2,3], and in preventing nosocomial transmission of *M.tuberculosis* (MTB) [9].

To prevent possible emergence of strains with resistance to disinfectants, hospital strains must be monitored for resistance to disinfectants currently in-use in the hospital, and disinfectants must be rotated subsequently, i.e. disinfectant of one chemical type must be systematically replaced by disinfectant of another chemical type, when necessary [7]. Sanitation measures aimed at

prevention of nosocomial infection, including TB, are largely defined by antiepidemic schedule [10], while registered nursing staff plays the key role in effective conduct of this schedule [6,8].

Aim. To comparatively analyze the incidence of TB in the staff of healthcare organizations of diverse specialties, through the case of Sakha Republic (Yakutia); to conduct monitoring for susceptibility/resitance to disinfectants in clinical MTB strains.

Materials and methods. The study was held from 2007 to 2011; the subjects and materials included:

Patients (staff) with occupation in healthcare organizations, newly diagnosed with TB, of them, 57 working in healthcare organizations and 23 working in anti-TB institutions. Patient groups were randomized according to job positions held by medical staff in various healthcare organizations.

Disinfectants used in anti-TB institutions, grouped by chemical composition of their main active substances.

Turberculocidal properties of disinfectants were tested using the techniques [11,12] based on procedures adopted from the widely known method accepted in disinfectant testing practice, i.e. submerging coarse calico test-objects contaminated with the test-microbes into a disinfectant.

The following test strains were used to assess the effectiveness of disinfectants: 1. Clinical strain *M.tuberculosis* No.255, resistant to streptomycin at 10 mcg/mL MIC, to isoniazid at 1 mcg/mL MIC, to rifampicin at 40 mcg/mL, and to capreomycin at 30 mcg/mL; 2. Drug-susceptible clinical strain of *M.tuberculosis* № 258.

More than 500 control samples were collected and tested to study the effectiveness of 9 disinfectants used in anti-TB institutions: 1. “Chloramine B” (0.5% concentration); 2. “Sulphochlorantine D” (1.0%); 3. “Chlormisept-R” (0.2%); 4. “Slavin” (1.2%); 5. “Brilliant” (2.0%); 6. “Aqua-chlor” (0.1%); 7. “Mirodez-univer” (1.0%); 8. “Ecobriz” (2.0%); 9. “Alphadez” (1.0%).

The study findings were summarized using statistical methods: calculation of the median, with minimum and maximum values; calculation of mean square deviation; Student’s test (t); Pearson’s/Fisher’s x^2 tests with correction factors (Yates, McNemar) to check the reliability of differences (p), with at least 9% confidence interval.

Results and discussion. TB incidence rate in medical personnel (Table 1) was lower (median 56.84; min 53.1; max 56.9), than in civil population of Yakutia (median 68.8; min 65.7; max 73.9), ($p>0.05$). Low min/max amplitude indicated that incidence level in medical staff tended to be more stable. Comparison of the incidence (per 100 000 employees) rates between healthcare

organizations and anti-TB institutions showed statistically meaningful difference: incidence among the staff of anti-TB service was 3.5-4 times higher, than in the staff of other healthcare organizations: 12 (46.7) and 3 (163.3) cases, respectfully (x^2=24.22; p<0.001).

The highest TB incidence was revealed among the staff of the "Phthisiatry" Research-Practice Center: 513.7/100 000 pop., 7.5 times higher than the incidence among civil population of Yakutia ($x^{2\text{-Pearson}}$=332.0; p<0.001) (Fig.1).

Among the rest of healthcare organizations, high TB incidence was documented in the staff of the Center for Emergency Care (Republican Hospital No.2): 459.4/100 000 pop., 6 times higher than the incidence (68.2/100 000 pop.) among civil population of Yakutia. ($x^{2\text{-Pearson}}$=282.7; p<0.001).

Patients are hospitalized to the Center for Emergency Care (Republican Hospital No.2) by emergency ambulance – unexamined patients seeking emergency care. Such high incidence may be predetermined by the absence of infection control system, low effectiveness of antiepidemic measures or disinfectants.

We analyzed TB case detection methods in 80 patients, of them, 23 employees of anti-TB institutions and 57 employees of other healthcare organizations (Table 2). In personnel of healthcare organizations, TB disease cases were detected more often on visit to a doctor due to feeling unwell, while in the staff of anti-TB institutions, TB cases were detected via occupational health examinations, and this difference was highly significant ($x^{2\text{-Pearson}}$=9.03, with Yates correction $x^{2\text{-Yates}}$=7.61; p≤0.027). Analysis of the time to case detection showed that TB cases detected in other healthcare organizations were significantly more often bacillary-positive ($x^{2\text{-McNemar}}$=6.88; p<0.05) or had destructions in lung tissue at the time of detection ($x^{2\text{-Fisher}}$=0.58; p>0.05). Hence TB disease in the staff of healthcare organizations was detected in the late stage, when bacterial expectoration and lung destruction were already present; this is confirmed also by generalized indicator of delayed detection ($x^{2\text{-McNemar}}$=9.85; p<0.01).

Study of the incidence of TB among healthcare workers in relation to different job positions (Table 3) showed more frequent incidence among registered nursing staff (36; 45.0%), followed by nursing assistants (32; 40.0%), with rarer incidence among doctor staff (12; 15.0%) ($x^{2\text{-Pearson}}$=27.64; p<0.001). This may be explained by direct exposure to patients with TB and spending much time near the patients, some of whom are bacillary-positive, as well as by low level of hospital infection control and low effectiveness of antiepidemic measures.

Decontamination of indoor spaces and inanimate objects is an important component of antiepidemic measures against TB infection in healthcare organizations. We analyzed the activity of

several disinfectants with different chemical compositions, to determine the effectiveness of disinfectants recommended for use against MTB strains (Table 4). All disinfectants tested are widely used in healthcare practice, and none of them (used in recommended regimes) demonstrated 100% tuberculocidal effect on test strains of MTB, both multidrug-resistant (MDR), and drug-susceptible. Overall, of 9 disinfectants recommended for accepted practice, 5 (55.5%) disinfectants were effective against drug-susceptible MTB, and 2 (22.2%) were effective against MDR MTB. Tuberculocidal effect on clinical MTB strains was demonstrated by the following types of disinfectants: chlorine compounds, quaternary ammonium compounds (QAC)+aldehydes.

The study showed that, because nursing and nurse assistant staff is most vulnerable to TB infection, new approaches are needed to improve the performance of these groups of anti-TB service personnel. The key measures to achieve this should include: ensuring safe working environment; staff education on principles and methods of infection control; creating the quality management system for nursing care that would help to shape the body of knowledge and skills to remain up-to-date with contemporary requirements. To conduct effective antiepidemic measures, essential emphasis must be made on monitoring for microbial susceptibility/resistance to disinfectants used in the hospital.

Conclusions:

1. Incidence of TB among the staff of anti-TB institutions was 3.5-4 times higher than in the staff of other healthcare organizations. Among the staff of anti-TB institutions, TB occurred mostly in registered nursing staff and in nurse assistant staff ($p<0.001$).
2. In the staff of anti-TB institutions, preventive health examination was the chief TB detection method in 74% of cases; in the staff of other health organizations, 63% cases were detected on visit to a doctor due to feeling unwell ($p<0.05$).
3. The personnel of emergency care was 6 times more ($p<0.001$) predisposed to TB infection, than civil population of Sakha Republic (Yakutia).
4. Among disinfectants, chorine compounds and QAC+aldehydes had tuberculocidal effect on clinical strains of MTB isolated in the territory of Sakha Republic (Yakutia).

Proposals:

1. Medical staff must be continuously educated on issues relating to high risk of nosocomial transmission of TB infection.
2. Personnel of emergency healthcare organizations must undergo mass fluorographic examination twice a year, with the purpose of early detection of TB.
3. Uniform procedure of disinfection processes (routine and final disinfection in TB infection

reservoir) for TB prevention must be developed, taking into account also data from hospital MTB strain monitoring for resistance to disinfectants in-use.

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Table 1

Incidence of tuberculosis in the staff of healthcare organizations, Sakha Republic (Yakutia), per 100.000 pop.

Year	Total		Of them:			
	Absolute number	Rate per 100 000 pop.	Healthcare organizations		Anti-TB institutions	
			Absolute number	Rate per 100 000 pop.	Absolute number	Rate per 100 000 pop.
2007	16	56.2	8	30.1	8	415.3
2008	18	63.5	14	53.0	4	205.9
2009	15	53.1	10	37.9	5	259.8
2010	16	56.9	13	49.5	3	160.5
2011	15	55.5	12	46.7*	3	163.3**
Total	**80**		**57**		**23**	

Note: */** - p<0.001

Table 2

Tuberculosis detection methods in the staff of healthcare organizations (absolute number, %)

Year	Total		Detection method				MTB (+)		CV (+)	
	Anti-TB institutions	Other healthcare organizations	Occupational examination		On visit					
			ATBI	OHO	ATBI	OHO	ATBI	OHO	ATBI	OHO
2007	8	8	7(87.5)	3(37.5)	1(12.5)	5(62.5)	4(50)	3(37.5)	2(25)	4(50)
2008	4	14	2(50)	6(43)	2(50)	8(57)	1(25)	9(64)	1(25)	7(60)
2009	5	10	4(80)	4(40)	1(20)	6(60)	4(80)	6(60)	2(40)	1(10)
2010	3	13	2(67)	5(38.5)	1(33)	8(63)	1(33)	7(53)	1(33)	7(37)
2011	3	12	2(67)	3(25)	1(33)	9(75)	1(33)	5(42)	1(33)	2(17)
Total	**23**	**57**	**17(74)***	**21(37)***	**6(26)***	**36(63)***	**11(48)**	**30(53)**	**7(30)**	**21(36)**

Note: */*- p<0.01

Table 3

Occurrence of tuberculosis in the staff of healthcare organizations in relation to job positions (absolute number, %).

Year	Total	Job positions					
		Doctors		Registered nursing staff		Nursing assistants	
		abs.n	%	abs.n	%	abs.n	%
2007	16	4	25	7	43.75	5	31.25
2008	18	1	5.5	14	77.8	3	16.7
2009	15	3	20	4	26.7	8	53.3
2010	16	3	18.75	6	37.5	7	43.75
2011	15	1	6.7	5	33.3	9	60
Total	**80**	**12***	15.0	**36****	45.0	**32****	40.0

Note: */** - p<0.001

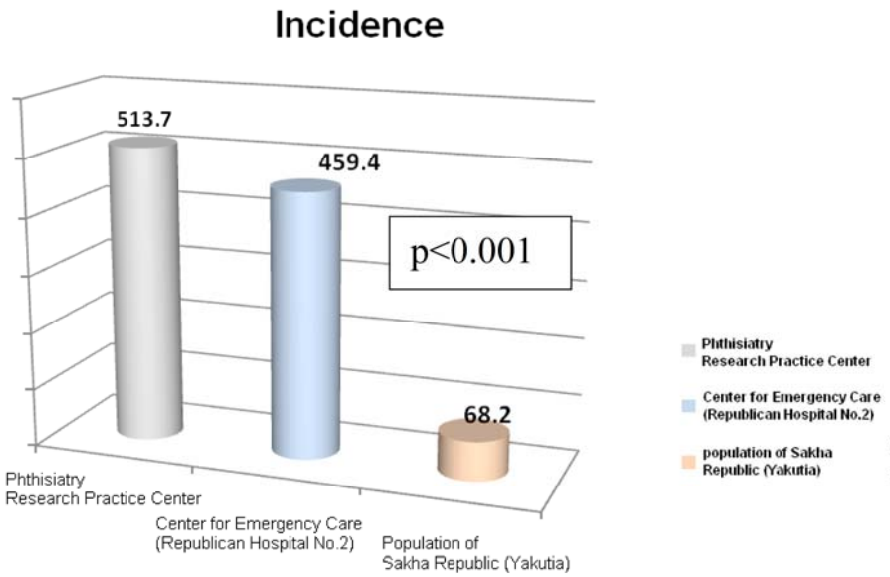

Fig.1. I **cy Care 1**

Table 4

Control of the effectiveness of disinfectants against clinical strains of *M.tuberculosis* circulating in the territory of Sakha Republic (Yakutia)

Disinfectants	**Disinfectant type and class**		**Clinical strains of *M.tuberculosis***	
	Disinfectants grouped by active substances	Toxicity class	*M.tuberculosis* strain No.258, susceptible	*M.tuberculosis* strain No.255, MDR
"Slavin"**	guanidine+aldehyde	3	Growth	Growth
"Sulphochlorantine D"****	Chlorine-based	3	**No growth**	**No growth**
"Chlormisept-R"****	Chlorine-based	3	Growth	Growth
"Ecobriz"****	QAC+amines	4	Growth	Growth
"Alphadez"****	QAC+guanidine	4	Growth	Growth
"Chloramine B"*****	Chlorine-based	3	**No growth**	Growth
"Mirodez-univer"***	QAC+aldehyde	4	**No growth**	Growth
"Brilliant"**	QAC+aldehyde	4	**No growth**	Growth
"Aqua-chlor"***	Chlorine-based	3	**No growth**	**No growth**

Notes: * – in the disinfectant instructions for use, the regime is recommended for disinfection of linen, dishes, medical products, janitorial supplies etc.; ** - exposure 15 min; *** - exposure 30 min; **** - exposure 60 min; ***** - 120 min.

Author information

Obutova Alexandra Innokentievna, Deputy Chief Doctor, State Budgetary Institution of the Sakha Republic (Yakutia) “Research-Practice Center ‘Phthisiatry”, Yakutsk, Sakha (Yakutia) Republic, Russian Federation, alobutova@yandex.ru

Gotovtseva Anna Ivanovna, Candidate of Medical Science, Deputy Chief Doctor State Budgetary Institution of the Sakha Republic (Yakutia) “Research-Practice Center ‘Phthisiatry” ,Yakutsk, Sakha (Yakutia) Republic, Russian Federation, ftiziatriya1950@rambler.ru

Pavlov Nikolay Gerasimovich, Candidate of Veterinary Science, Senior Researcher, Bacteriologic Laboratory, State Budgetary Institution of the Sakha Republic (Yakutia) “Research-Practice Center ‘Phthisiatry”, Yakutsk, Sakha (Yakutia) Republic, Russian Federation, png_74@mail.ru