Research

Preventing tuberculosis among health workers in Malawi

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Objective Following the introduction of guidelines for the control of tuberculosis (TB) infection in all hospitals in Malawi, a study was carried out to determine whether the guidelines were being implemented, the time between admission to hospital and the diagnosis of pulmonary TB had been reduced, and the annual case notification rates among health workers had fallen and were comparable to those of primary-school teachers.

Methods The study involved 40 district and mission hospitals. Staff and patients were interviewed in order to determine whether the guidelines had been adopted. In four hospitals the diagnostic process in patients with smear-positive pulmonary TB was evaluated before and after the introduction of the guidelines, with the aid of case notes and TB registers. In all hospitals the proportion of health workers registered with TB before and after the guidelines were introduced, in 1996 and 1999, respectively, was determined by conducting interviews and consulting staff lists and TB registers. A similar method was used to determine the proportion of primary-school teachers who were registered with TB in 1999.

Findings The guidelines were not uniformly implemented. Only one hospital introduced voluntary counselling and testing for its staff. Most hospitals stated that they used rapid systems to diagnose pulmonary TB. However, there was no significant change in the interval between admission and diagnosis or between admission and treatment of patients with smear-positive pulmonary TB. The TB case notification rate for 2979 health workers in 1999 was 3.2%; this did not differ significantly from the value of 3.7% for 2697 health workers in 1996 but was significantly higher than that of 1.8% for 4367 primary-school teachers in 1999.

Conclusion The introduction of guidelines for the control of TB infection is an important intervention for reducing nosocomial transmission of the disease, but rigorous monitoring and follow-up are needed in order to ensure that they are implemented.

Keywords Tuberculosis, Pulmonary/transmission/prevention and control; Disease transmission, Patient-to-professional/prevention and control; Infection control/methods; Guideline adherence; Malawi (*source: MeSH, NLM*).

Mots clés Tuberculose pulmonaire/transmission/prévention et contrôle; Transmission maladie malade-personnel médical/prévention et contrôle; Lutte contre infections/méthodes; Adhésion à directives; Malawi (*source: MeSH, INSERM*).

Palabras clave Tuberculosis pulmonar/transmisión/prevención y control; Transmisión de enfermedad de paciente a profesional/prevención y control; Control de infecciones/métodos; Adhesión a directriz; Malawi (*fuente: DeCS, BIREME*).

Bulletin of the World Health Organization 2002;80:526-531.

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Introduction

Nosocomial outbreaks of tuberculosis (TB) in industrialized countries have focused attention on the need to control the transmission of the disease in hospitals (*1–3*). Control measures such as the improvement of ventilation systems, the use of protective face masks, and the individual protection of staff were introduced in United States and European hospitals and successfully protected health workers against acquiring TB in the workplace (*1*, *4*, *5*).

The high prevalences of TB and human immunodeficiency virus (HIV) infection in sub-Saharan Africa suggest that the risk of nosocomial transmission of TB is substantial (*6*). Nosocomial transmission certainly occurs in Africa (*7*), where tuberculous infection in health workers is related to the level of exposure to TB patients (*8*). The incidence of TB among health workers is high and in the last 10 years has been increasing mainly as a result of the coincident HIV epidemic (*9*, *10*).

In Malawi there has been a high incidence of TB among health workers (*11*, *12*). The country's National Tuberculosis Control Programme responded in mid-1998 by producing written guidelines on the control of TB infection in hospitals. These were distributed to all hospitals and in the same year a seminar was conducted in each hospital for hospital-based health workers on ways to prevent the transmission of the disease. The guidelines were produced after consultation with stakeholders (*12*) and took account of what could realistically be achieved in a setting with very limited resources. The main technical aspects of the guidelines (Table 1) follow some of the recent recommendations issued by the Centers for Disease Control and Prevention, the International Union Against Tuberculosis and Lung Disease, and WHO (*13*). The emphasis

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Ref. No. **01-1477**

Table 1. **Staff and patient responses to the adoption of tuberculosis (TB) control guidelines in 40 hospitals in Malawi**

Category	*n*
Outpatient department	***40***
• Priority to patients with chronic cough	13 (33)[a]
General wards	***40***
• Rapid collection of sputum specimens	37 (92)
• Sputum request forms specially marked to ensure rapid laboratory processing	38 (95)
• Pulmonary TB suspects placed in one part of ward near good ventilation	31 (78)
• Pulmonary TB suspects spend daylight hours outside ward whenever possible	30 (75)
• Pulmonary TB suspects to be educated on proper cough hygiene	38 (95)
Hospital laboratory	***40***
• Rapid processing of sputa, especially from general wards	37 (93)
• Sputum examination to be performed five days a week	14 (35)
Radiology department	***34***
• Chest X-rays to be taken at quiet times of day	7 (21)
TB wards	***34***
• Windows left open whenever possible	34 (100)
• Visitors kept to a minimum	23 (68)
• Directly observed therapy (DOT) provided	32 (94)
Operating theatre	***40***
• Masks to be worn by pulmonary TB patients when undergoing surgical procedures	2 (5)
Staff health facility	***40***
• Staff offered counselling and human immunodeficiency virus testing	1 (3)

[a] Figures in parentheses are percentages.

was on rapid diagnosis of patients with smear-positive pulmonary TB, administrative attempts to isolate infectious patients, and the education of patients on cough hygiene. Hospitals were requested to consider offering confidential counselling and HIV testing to their staff and to advise those who were HIV-seropositive against working on general wards and TB wards.

Between 1998 and 2000 the National Tuberculosis Control Programme carried out a series of studies to determine whether: the guidelines for TB infection control had been adopted in district and mission hospitals; there had been a consequent reduction in the interval between the admission and diagnosis and between admission and treatment of patients with smear-positive pulmonary TB in hospital wards; and the annual TB case notification rate among health workers had decreased and was comparable to that of a group of people who were not exposed to the disease in their work setting.

Methods

Setting

In Malawi there are 22 district hospitals and 18 mission hospitals which register and treat TB patients. In all of them the general wards are multipurpose, treating medical and surgical cases. The diagnosis is made either in the outpatient department or during admission to the general wards. Persons suspected of having pulmonary TB submit three sputum specimens within 24 h. Smear examinations for acid-fast bacilli are performed on these specimens in hospital laboratories on weekdays only. Allowing for the admission of patients at weekends, most smear-positive pulmonary TB patients should be diagnosed, registered, and started on anti-TB treatment within five days of admission. If a hospital has a special TB ward, registered patients are transferred to it for the initial phase of treatment.

The 40 hospitals were visited in 1997 in order to collect the TB case notification data on various categories of health worker for 1996 (*12*). The same hospitals were revisited in order to conduct operational research studies between 1999 and 2000.

Adoption of TB control guidelines in hospitals

Visits were made to all the hospitals in 1999, when a structured form was used in interviews with patients and staff about the adoption of the guidelines for the control of TB infection. In the hospital laboratories a record was made of the number of trained laboratory staff and the number of times sputum smear examination was performed each week.

Diagnostic process for smear-positive pulmonary TB patients

The diagnostic process for patients with smear-positive pulmonary TB was evaluated in a district hospital from each of three regions and a mission hospital. A comparison was made between the situation in January–June 1998, before the introduction of the control guidelines, and that in January–June 1999, after they were introduced. During each of these periods a record was made of all patients registered with smear-positive pulmonary TB and of the number who were investigated and diagnosed as outpatients or in the general wards. For ward admissions, case notes were retrieved in order to determine the number of days between admission and diagnosis, and TB registers were inspected to determine the number of days between admission and the start of anti-TB treatment.

TB among health workers

Information was collected on hospital-based health workers with frequent exposure to medical patients. Included were doctors, clinical officers, medical assistants, nurses, patient attendants, ward attendants, and TB officers (*12*). The procedure used for obtaining data on these workers for 1996 has been described previously (*12*). It was again employed during 2000 in order to obtain data for 1999, i.e. after the introduction of the guidelines. Details of personnel working in the hospitals between January and December of 1996 and 1999 were obtained from the administrative records and were checked with the matrons and officers in charge. TB officers and health workers were asked whether the disease had been diagnosed in a health worker between 1 January and 31 December during the years 1996 and 1999. If it had, information was obtained from the hospital TB register on the case registration number, the date of diagnosis, and the type of TB. A diagnosis was only accepted if it could be confirmed by consulting the register.

TB among primary-school teachers

Teachers working in primary schools in or near the township covered by each hospital served as controls. They were chosen because they were less exposed than health workers to TB during their routine work, were in approximately the same age band, had a similar sex distribution, were civil servants, as were the health workers, and had the same educational status as them.

In each hospital the TB officer was requested to make a list of the primary schools in the township that had 10 or more teachers and to visit the four nearest schools. The head teacher of each school was interviewed using a structured form and a record was made of the number and names of teachers working in the school in 1999, together with details of the age, sex, and number diagnosed to have TB between 1 January and 31 December 1999. If the disease had been diagnosed, the information was checked by consulting the hospital TB registers. Positive diagnoses were only accepted if they could be confirmed in this way. TB officers were informed that random visits would be made to some of the schools by National Tuberculosis Control Programme staff in order to check that the data obtained were correct. Of the 156 schools, 26 were visited by staff from the central unit and it was confirmed that the data collected by teachers were satisfactory.

Data analysis

The data for each operational study were analysed by means of EpiInfo, version 6.0. Differences in categorical variables between groups were compared using the χ^2 test, while differences between continuous variables were compared using Student's *t* test. Differences at the 5% level were regarded as significant, and relative risks and their 95% confidence intervals were calculated where appropriate.

Results

Adoption of TB control guidelines in hospitals

In one-third of the hospitals the staff stated that priority was given to outpatients with chronic cough in order that they could be screened for pulmonary TB as soon as possible (Table 1). In over 90% of the hospitals the general ward staff stated that they had instituted a system of rapid collection of sputum specimens, and the laboratory staff stated that they processed such specimens rapidly for smear examination. However, sputum smear examination was performed on five days a week by only 14 laboratories, i.e. 35%, this being the only way, in theory, to produce rapid results. The frequency was once a week in one laboratory, twice a week in 13 laboratories, and three times a week in 12 laboratories. The median number of trained laboratory staff was two per hospital; one hospital had no trained staff on site; and 12 hospitals had one trained person.

In over 70% of the hospitals, windows were kept open, persons suspected of having pulmonary TB were placed in well-ventilated parts of wards and, whenever possible, spent the daylight hours outside the wards, and staff stated that they regularly taught patients about cough hygiene. Most hospitals with TB wards provided directly observed therapy (DOT) for their patients. Less successful were attempts to ensure that chest X-rays were obtained for TB suspects at quiet times to prevent patients from coughing over each other and over staff in crowded corridors, and that TB patients wore face masks when going to theatre for minor operations. One hospital had introduced a system for staff counselling and HIV testing but, according to the medical officer in charge, there had been no uptake of this service.

Diagnostic process in patients with smear-positive TB

In the 6 months before the introduction of the control guidelines, 239 men and 263 women of mean age 34 years who had smear-positive pulmonary TB were registered in four of the hospitals. In the six months after the introduction of the guidelines, 178 men and 218 women, also of mean age 34 years, were registered. In the outpatient departments, 299 patients (60%) and 257 patients (65%) were diagnosed before and after the introduction of the guidelines, respectively. For patients diagnosed in the general wards the lengths of the intervals between hospital admission, diagnosis and treatment before and after the introduction of the guidelines are shown in Table 2. There were no differences between the two groups. During each 6-month period the median interval between admission and case note diagnosis was four days and that between admission and the commencement of anti-TB treatment was five days.

Sputum specimens were said to be rapidly collected in the general wards in three hospitals, and to be rapidly processed in the laboratory in all four hospitals. In the hospital where sputum specimens were examined five days a week, 79% of patients were treated within five days of admission. In the three hospitals where sputum specimens were examined two or three times a week, 32–48% of patients were treated within five days of admission.

TB among health workers: 1996 versus 1999

There were 2697 health workers in 1996 (938 men; 1759 women; mean age $\pm$ SD = 36 $\pm$ 8 years) and 2979 in 1999 (1002 men; 1977 women; mean age $\pm$ SD = 37 $\pm$ 9 years). In 1996 and 1999, 100 (3.7%) and 96 (3.2%) health workers, respectively, were registered with TB. The difference was non-significant. For men and women and for each category of health worker there were no significant differences in the case notification rate of TB between 1996 and 1999 (Table 3).

Table 2. **Length of time from hospital admission to diagnosis and treatment in patients with smear-positive pulmonary tuberculosis (TB) before and after introduction of guidelines**

TB infection control guidelines	No. of days after admission	Case note diagnosis	Start of anti-TB treatment
Before introduction 1998	1–5	111 (69)[a]	75 (48)
	6–10	38 (23)	58 (37)
	11–15	5 (3)	14 (9)
	>16	8 (5)	10 (6)
	Total	162	157
	Missing information	41	46
After introduction 1999	1–5	90 (65)	69 (50)
	6–10	37 (27)	51 (37)
	11–15	8 (6)	12 (9)
	>16	3 (2)	5 (4)
	Total	138	137
	Missing information	1	2

[a] Figures in parentheses are percentages.

Table 3. **Tuberculosis (TB) among health workers, in the study hospitals, 1996 and 1999**

Category of health worker	1996 before guidelines		1999 after guidelines	
	n	No. registered with TB	*n*	No. registered with TB
Total health workers	2697	100 (3.7)[a]	2979	96 (3.2)
Men	938	40 (4.3)	1002	36 (3.6)
Women	1759	60 (3.4)	1977	60 (3.0)
Medical officer	33	0	22	0
Clinical officer	162	12 (7.4)	222	8 (3.6)
Medical assistant	164	7 (4.3)	154	5 (3.2)
Nurse	917	26 (2.8)	1019	21 (2.1)
Patient attendant	339	17 (5.0)	368	16 (4.3)
Ward attendant	1016	36 (3.5)	1138	45 (4.0)
TB officer	66	2 (3.0)	56	1 (1.8)

[a] Figures in parentheses are percentages.

TB among health workers and primary-school teachers in 1999

Information was gathered on 4367 primary-school teachers at 156 schools near the 40 hospitals. At 37 hospitals information was obtained from four primary schools. Because of a shortage of schools with sufficient numbers of teachers in some areas, information was obtained from only three schools at two hospitals and from only two schools at one hospital. There were 1551 male teachers and 2816 female teachers (mean age $\pm$ SD = 33 $\pm$ 8 years). The sex ratio for teachers was similar to that for health workers but their age was significantly lower $P < 0.05$. In 1999 there were 78 teachers registered with TB (1.8%), 32 of them men (2.1% of all men) and 46 of them women (1.6% of all women).

TB case notification rates for health workers in 1999 were significantly higher than those for teachers. The differences were similar for men and women assessed separately (Table 4). When stratified by age groups, the differences were most apparent for the age groups 25–34 years and 45–54 years for men and women, whether assessed together or separately.

Types of TB among health workers and teachers in 1999

In 1999 the types of TB among health workers were as follows: smear-positive pulmonary in 34 (35%), smear-negative pulmonary in 36 (38%), and extrapulmonary in 26 (27%). This pattern was not significantly different from that observed among teachers: smear-positive pulmonary TB in 38 (49%), smear-negative pulmonary in 25 (32%), and extrapulmonary in 15 (19%).

Discussion

According to the staff and patients, the district and mission hospitals had adopted TB infection control guidelines in varying degrees. However, in the four hospitals that were evaluated the introduction of guidelines made no difference to delays in the diagnosis and treatment of the smear-positive pulmonary form of the disease. The guidelines were not associated with any significant decrease in the case notification rate of TB among health workers, which was higher than that among primary-school teachers.

Table 4. **Tuberculosis (TB) case notification rates in health workers and teachers in 1999, by age and sex**

Age range (years)	Rate per annum %		Relative risk
	Health workers	Teachers	
Men and women			
18–24	4.4	2.4	1.49; *0.7–3.2*[a]
25–34	3.0	1.5	1.57; *1.2–2.0*[b]
35–44	3.8	3.0	1.12; *0.9–1.4*
45–54	2.9	0.8	1.41; *1.1–1.7*[b]
⩾55	0	0	
All ages	3.2	1.8	1.37; *1.2–1.6*[b]
Men			
18–24	0	2.9	
25–34	2.9	1.5	1.52; *0.9–2.4*
35–44	5.5	3.6	1.24; *0.9–1.7*
45–54	2.2	1.3	1.23; *0.7–2.2*
⩾55	0	0	
All ages	3.6	2.1	1.36; *1.1–1.7*[b]
Women			
18–24	5.3	2.3	1.70; *0.8–3.5*
25–34	3.1	1.5	1.59; *1.2–2.2*[b]
35–44	2.9	2.4	1.07; *0.8–1.4*
45–54	3.2	0.5	1.46; *1.2–1.7*[b]
⩾55	0	0	
All ages	3.0	1.6	1.38; *1.2–1.6*[b]

[a] Figures in italics are 95% confidence intervals.
[b] $P<0.05$.

We consider that this study represents the current situation in Malawi. All district and mission hospitals that registered and treated TB patients were included. Central hospitals were excluded because they were specialist referral facilities with different ward structures to district and mission hospitals. Exactly the same method of determining TB case rates in health workers was used before and after the introduction of the guidelines. Care was taken to ensure that staff numbers at the hospitals were correct. Only registered TB diagnoses were accepted.

Primary-school teachers are less likely than health workers to be exposed to TB at work, because children who develop the disease are usually sputum smear-negative or have an extrapulmonary form (*14*). We considered primary-school teachers to be a good comparison group and used the same principles of determining TB case rates for them as for health workers. We do not have HIV-seroprevalence data for health workers or teachers. This is a weakness of the study, because HIV status is the most important risk factor for the development of active TB in sub-Saharan Africa (*15*). However, their residence in semi-urban areas and their employment and educational levels indicate that health workers probably have HIV-seroprevalence rates similar rates to those of teachers (*16*).

Attempts had been made in a large number of hospitals to place TB patients in well-ventilated areas of the wards, to

encourage them to spend daylight hours outside the wards, and to teach basic cough hygiene. These measures may play some part in the control of TB infection in hospitals (*6*, *13*). However, in settings where resources are very scarce the rapid diagnosis of infectious cases of TB is one of the most important ways of reducing nosocomial transmission. Although the majority of hospitals stated that they had set up rapid systems of diagnosis, in the four hospitals evaluated there had been no reduction in the interval between admission and diagnosis nor in that between admission and treatment. Our findings suggest that practice did not match the statements recorded in the questionnaires. Poor staff motivation perhaps contributed to this state of affairs but another factor was an insufficiency of manpower. There was a shortage of personnel in most laboratories, less than 40% of which were able to perform daily sputum smear examinations. This is probably a crucial factor in reducing diagnostic delays. Of the four hospitals assessed for diagnostic processes, one managed to perform sputum smear examinations five days a week, and nearly 80% of patients began to receive treatment within five days of admission.

The guidelines had no significant impact on TB case notification rates among health workers. It is not clear how well hospital guidelines were implemented. The interviews with staff and patients possibly yielded insufficient information about practice. A better picture might have been obtained by observing what was taking place. There was no responsible individual or infection control committee to oversee the application of the guidelines, and it is likely that written documents and one-off seminars were not enough to induce changes in behaviour. It may also be optimistic to expect significant reductions in TB case notification rates within a year after the introduction of guidelines. Only one hospital had introduced a system of confidential counselling and HIV testing for its staff, and in that instance there was no uptake. HIV-seroprevalence rates in health workers have not been measured in Malawi but they are likely to be high. The HIV-seroprevalence rate in women aged 15–49 years attending antenatal clinics in semiurban areas was 27% in 1999 (*16*). The rates are possibly higher in health workers because seroprevalence studies in pregnant women may underestimate the HIV infection rate in the general adult population (*17*, *18*). High rates of HIV infection translate into high rates of TB either because of reactivation or increased susceptibility to new infections.

Recommendations for countries with limited resources

What more should be done in a country with very limited resources? Each hospital should appoint an individual or infection control committee to be responsible for infection control procedures. More laboratory staff should be employed and hospital laboratories should find ways of performing sputum smear examinations on a daily basis. Hospitals should consider setting up occupational health and safety services, including confidential voluntary counselling and a package of care for persons who are found to be HIV-seropositive. At the very least, HIV-positive health workers should not work in either general wards or TB wards, but in safer parts of hospitals. Health workers are a skilled and valuable resource in sub-Saharan Africa and every effort should be made to keep them healthy. ■

Acknowledgements

We thank the administrative, clinical and nursing staff and the TB officers of the district and mission hospitals, and the head teachers of primary schools, for their assistance in collecting the data. We thank the United Kingdom Department for International Development, the Norwegian Agency for Development Cooperation and the Royal Dutch Tuberculosis Association for financial support. The work received the support of the National Tuberculosis Control Programme Steering Group and the ethical approval of the Malawi Health Science Research Committee.

Conflicts of interest: none declared.

Résumé

Prévention de la tuberculose chez les agents de santé au Malawi

Objectif Après l'introduction de directives pour la lutte contre l'infection tuberculeuse dans tous les hôpitaux du Malawi, une étude a été réalisée en vue de déterminer si ces directives sont appliquées, si le délai entre l'admission et le diagnostic de tuberculose pulmonaire a été réduit et si le taux annuel de notification de cas parmi les agents de santé a diminué et s'il est comparable à celui des enseignants du primaire.

Méthodes L'étude a porté sur 40 hôpitaux de district et de mission, dont le personnel et les patients ont été interrogés afin de déterminer si les directives ont été adoptées. Dans quatre hôpitaux, la procédure de diagnostic chez les patients atteints de tuberculose pulmonaire à frottis positif a été évaluée avant et après l'introduction des directives, à l'aide des données figurant dans le dossier des patients et des registres de la tuberculose. Dans tous les hôpitaux, la proportion d'agents de santé enregistrés comme cas de tuberculose avant et après l'introduction des directives (soit en 1996 et 1999) a été déterminée par des entretiens et en consultant les listes de personnel et les registres de la tuberculose. Une méthode similaire a été utilisée pour déterminer la proportion d'enseignants du primaire enregistrés comme cas de tuberculose en 1999.

Résultats Les directives n'ont pas été uniformément appliquées. Seul un hôpital a introduit le conseil et le dépistage volontaires pour son personnel. La plupart des hôpitaux déclaraient utiliser des systèmes rapides pour diagnostiquer la tuberculose pulmonaire. Cependant, on n'a pas observé de changement significatif au niveau du délai entre l'admission et le diagnostic ni du délai entre l'admission et le traitement des patients atteints de tuberculose pulmonaire à frottis positif. Le taux de notification de cas de tuberculose parmi les 2979 agents de santé concernés était de 3,2 %, ce qui ne représente pas une différence significative par rapport au chiffre de 1996, qui était de 3,7 % parmi 2697 agents de santé, mais qui est sensiblement supérieur au taux observé de 1,8 % chez 4367 enseignants du primaire en 1999.

Conclusion L'introduction de directives pour la lutte contre l'infection tuberculeuse est une intervention importante pour réduire la transmission nosocomiale de la maladie, mais exige une surveillance et un suivi rigoureux pour assurer qu'elles sont bien mises en application.

Resumen

Prevención de la tuberculosis entre los agentes de salud en Malawi

Objetivo Después de introducir las directrices para el control de la tuberculosis en todos los hospitales de Malawi, se llevó a cabo un estudio para determinar si se estaban aplicando efectivamente, si se había reducido el tiempo transcurrido entre el ingreso en el hospital y el diagnóstico de la tuberculosis pulmonar, y si las tasas anuales de notificación de los casos registrados entre los agentes de salud habían disminuido y eran comparables a las de los maestros de primaria.

Métodos El estudio abarcó 40 hospitales de distrito y de misión. Se entrevistó al personal y a los pacientes para determinar si se habían adoptado las directrices. En cuatro hospitales, el proceso de diagnóstico de los pacientes con tuberculosis pulmonar y frotis positivo fue evaluado antes y después de introducir las directrices, con la ayuda de las notas de casos y de los registros de tuberculosis. En todos los hospitales, la proporción de agentes de salud registrados con tuberculosis antes y después de que entraran en vigor las directrices, en 1996 y 1999 respectivamente, se determinó realizando entrevistas y consultando las listas de personal y los registros de tuberculosis. Se usó un método similar para determinar la proporción de maestros de primaria registrados con tuberculosis en 1999.

Resultados Las directrices no se aplicaron de manera uniforme. Sólo un hospital introdujo el asesoramiento y las pruebas voluntarios para su personal. La mayoría de los hospitales declararon que usaban sistemas rápidos para diagnosticar la tuberculosis pulmonar. Sin embargo, el intervalo entre el ingreso y el diagnóstico o entre el ingreso y el tratamiento de los pacientes con tuberculosis pulmonar y frotis positivo no se modificó sensiblemente. La tasa de notificación de casos de tuberculosis para 2979 agentes de salud en 1999 fue del 3,2%; esta cifra no difiere significativamente del 3,7% logrado entre 2697 agentes de salud en 1996, pero es significativamente superior al 1,8% observado en el caso de 4367 maestros de primaria en 1999.

Conclusión La introducción de directrices para el control de la infección tuberculosa es una intervención importante para reducir la transmisión nosocomial de la enfermedad, pero es necesario aplicar un monitoreo y un seguimiento rigurosos para asegurar que se pongan en práctica.

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