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Effect of universal MODS access on pulmonary tuberculosis treatment outcomes in new patients in Peru

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Setting: Primary health care centres in Callao, Peru.
Objectives: To evaluate the effect of universal access to the microscopic-observation drug susceptibility (MODS) assay on treatment outcomes in new and primary multidrug-resistant tuberculosis (MDR-TB) patients and on the process of drug susceptibility testing (DST).
Design: Retrospective review of tuberculosis (TB) registers and clinical records before (2007) and after (2009) the introduction of MODS in 2008.
Results: There were 281 patients in each cohort. Favourable treatment outcomes for 2007 (81%) and 2009 (77%) cohorts were similar. There was an increase in loss to follow-up (from 6% to 10%, $P = 0.04$) and a reduction in failure rates (from 4% to 0.4%, $P = 0.01$) in the 2009 compared with the 2007 cohort. In new MDR-TB cases ($n = 22$), a favourable treatment outcome was improved (from 46% to 82%, $P = 0.183$) in the 2009 cohort. DST coverage improved (from 24% to 74%, $P < 0.001$), and a significant reduction in time to diagnosis of drug-susceptible (from 118 to 33 days, $P < 0.001$) and MDR-TB (from 158 to 52 days, $P = 0.003$) was observed in the 2009 cohort.
Conclusion: Universal access to MODS increased DST coverage, reduced the time required to obtain DST results and was associated with reduced failure rates. MODS can make an important contribution to TB management and control in Peru.

Peru has a high burden of drug-resistant tuberculosis (TB): of an estimated 34000 TB cases per annum, 2600 new multidrug-resistant TB (MDR-TB, resistant to at least isoniazid [INH] and rifampicin [RMP]) cases and around 120 new extensively drug-resistant TB (XDR-TB) cases are estimated to occur annually.[1–3] The most recent national survey in Peru showed that 5.3% of TB patients in the country and 8.6% in the Lima and Callao regions have primary MDR-TB.[3] To reduce the failure and relapse rates of the empiric short regimens proposed by the World Health Organization (WHO) and accelerate the early diagnosis of MDR-TB, it has been recommended that in settings where the MDR-TB rate among new cases is over 3%, drug susceptibility testing (DST) should be performed for all patients as soon as TB is diagnosed.[4,5]

The MODS (microscopic observation drug susceptibility) assay was developed in Peru in 2000 as a rapid test to diagnose *Mycobacterium tuberculosis* and assess susceptibility to INH and RMP simultaneously using a liquid culture set and inverted microscopy.[6,7] Based on its good performance, including rapid diagnosis usually in 1–3 weeks, and low cost, the WHO recommended its implementation in developing countries.[8] In 2008, the National TB Programme (NTP) and the National Institute of Health started implementing universal access to the MODS assay in some regions in Lima and Callao.[9] Universal access means that MODS is used for every patient (new and previously treated, smear-positive and smear-negative) about to start anti-tuberculosis treatment. However, the NTP has not yet evaluated the impact of this intervention and whether it is associated with improved TB treatment management, processes and outcomes.

To our knowledge, MODS has not been implemented within the public health system in any other country, and there is no published information about whether or not this intervention is beneficial for patient management and outcomes under routine conditions. Our hypothesis is that MODS reduces the delay in diagnosing drug-susceptible and MDR-TB, accelerates the administration of correct treatment and improves anti-tuberculosis treatment outcomes.

The primary objective was to determine whether treatment outcomes among new smear-positive or smear-negative/culture-positive pulmonary TB (PTB) patients starting first-line anti-tuberculosis treatment (termed Regimen I) improved following the introduction of MODS. Secondary objectives were to compare, before and after the introduction of MODS: 1) DST coverage, MDR-TB case detection and time taken to diagnose drug-susceptible, INH-resistant and MDR-TB, and 2) the treatment outcomes of MDR-TB patients diagnosed in the Callao region.

METHODS

Study design

This was a retrospective cross-sectional study assessing two cohorts of adults with newly diagnosed smear- or culture-positive PTB.

Setting

General

Peru (population: 29 million) is a large country in Latin America with a gross domestic product of US$8825 per capita. Peru began its DOTS-based TB Control Programme in 1991, and managed to meet WHO targets for case detection and cure for smear-positive PTB.[10] Despite these successes, MDR- and XDR-TB have emerged as significant public health problems for the NTP to address. Patients with suspected TB are diagnosed and registered according to national TB guidelines.[11] Patients

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KEY WORDS
Peru; MODS; MDR-TB; drug-resistant TB; rapid test; operational research

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are treated with national first-line and retreatment regimens according to category of TB and risk factors for drug-resistant TB. New patients receive the 6-month Regimen I, which consists of a 2-month initial phase of daily INH, RMP, pyrazinamide and ethambutol, followed by a 4-month continuation phase of twice-weekly RMP and INH. Those at high risk of MDR-TB are treated with a standardised MDR-TB regimen, followed by individualised regimens once culture and DST results are available. MDR-TB treatment lasts 18–24 months, depending on culture results during treatment.

Management of patients starting Regimen I before and after introduction of MODS

Protocols for managing patients starting Regimen I before and after the introduction of MODS are shown in Table 1.[11,12]

Study site

The Dirección Regional de Salud Callao was selected, as MODS was implemented in the Regional TB Laboratory in August 2008; DST was previously performed only at the National TB Laboratory in Lima. MODS is currently offered to smear-positive and -negative PTB patients before treatment initiation. MODS results are obtained via internet through the NETLAB system (Instituto Nacional de Salud, Lima, Peru) 7–21 days after sputum submission. NETLAB's database includes all persons tested in Peru's regional and national TB laboratories.

The Callao region (population: 941 268) has the same metropolitan area as Lima, the capital city, a TB case notification rate of 127 cases per 100 000 population, a smear-positive TB case notification rate of 72 cases/100 000 and an MDR-TB rate among new patients of approximately 6%. Most TB patients are treated in the public sector, with <5% treated in the private sector.[13] Callao has 45 primary health care centres organised in three health networks: BEPECA (Bellavista, La Perla and Carmen de la Legua Districts), Bonilla and Ventanilla, two district hospitals and one central hospital, all with a TB out-patient clinic. Human immunodeficiency virus (HIV) prevalence in TB patients is low, at 1–3%, similar to the rest of the country.[14]

This study focused on TB out-patient clinics from the BEPECA and Bonilla Health Networks, with 15 and 17 TB clinics, respectively. As the MODS assay had been validated in Ventanilla since 2005, it was excluded from this evaluation.

TABLE 1 Management of patients starting Regimen I before and after the introduction of MODS

Management of patients starting Regimen I before the introduction of MODS
Smear-positive pulmonary TB patients starting Regimen I treatment are first assessed for high risk of MDR-TB according to national guidelines.[10] If they are at high risk, sputum culture in Ogawa and Löwenstein-Jensen media and DST (proportion by Canetti method) are carried out. If DST shows the presence of MDR-TB, patients are taken off Regimen I treatment and started on MDR-TB treatment. All other patients have sputum smear examinations performed at Month 2. If patients are smear-negative, they continue on the initial treatment regimen and sputum smears are examined at 4 and 6 months. If patients are smear-positive at 2 months, they are evaluated by a local TB consultant and a decision is made to continue Regimen I or to declare the patient a 'drug-resistant TB suspect' according to clinical and epidemiological criteria: in both cases, sputum is obtained for culture and DST. Patients suspected of having drug-resistant TB are started on empirical standardised MDR-TB treatment. This is changed to individualised MDR-TB treatment or back again to Regimen I based on DST results. Patients in Regimen I with positive smears at 4 and 6 months are declared failures, sputum is obtained for culture and DST, and patients are started on empirical standardised MDR-TB treatment, followed by individualised treatment based on DST results
Management of patients starting Regimen I after the introduction of MODS
Before starting Regimen I, all pulmonary TB patients (smear-positive, smear-negative, never treated and previously treated) submit sputum specimens for MODS examination. If the MODS test shows MDR-TB, the patients are taken off Regimen I treatment and started on MDR-TB treatment. If the MODS test shows no resistance to isoniazid and rifampicin, the patients stay on the initial Regimen I treatment. If the MODS test shows drug resistance patterns different to MDR-TB, treatment may be modified according national guidelines[11]

MODS = microscopic observation drug susceptibility test; TB = tuberculosis; MDR-TB = multidrug-resistant TB (i.e., *Mycobacterium tuberculosis* with resistance to at least isoniazid and rifampicin); DST = drug susceptibility testing.

Study population

We included all patients from two cohorts: 1) adults (aged ⩾15 years) with new smear-positive or smear-negative/culture-positive PTB registered in 2007 in the BEPECA and Bonilla Networks before the introduction of MODS, and 2) adults (aged ⩾15 years) with new smear-positive or smear-negative/culture-positive PTB registered in 2009 in the BEPECA and Bonilla Networks, after the introduction of MODS in 2008.

Data variables, sources and collection

A trained team collected data directly from the TB patient registers in each TB clinic using a structured questionnaire (January–April 2012). The clinical records and TB cards of patients that met the inclusion criteria in each cohort were reviewed. Variables included TB registration number, age, sex, date of TB diagnosis and treatment initiation, smear microscopy results, whether there was irregular treatment in the initial or continuation phases of treatment (at least one dose not taken on the correct date), final treatment outcomes on Regimen I, INH and RMP susceptibility profile, number of patients diagnosed with MDR-TB while on Regimen I, number of patients started on MDR-TB treatment (defined as empirical standardised MDR-TB treatment), final outcome of MDR-TB patients, and dates of diagnosis and treatment processes for drug-susceptible and drug-resistant TB.

Regarding the final treatment outcomes on Regimen I, we included an outcome category 'initial TB treatment not completed' to include patients whose Regimen I treatment was stopped due to adverse reactions or diagnosis or suspicion of drug-resistant TB, as described above. Data on DST (MODS and conventional proportion method) were obtained from patient clinical files and from NETLAB.

Analysis and statistics

Data were double-entered into EpiData 3.1 (EpiData Association, Odense, Denmark), and then transferred to STATA 10 (Stata Corp, College Station, TX, USA). We compared the two cohorts in relation to 1) general characteristics; 2) diagnosis of MDR-TB; 3) final treatment outcomes, including the category 'initial TB treatment not completed'; and 4) time to diagnosis and the various decisions about treatment options for drug-susceptible and drug-resistant TB. Continuous variables were compared between the two cohorts using the Mann-Whitney test. Categorical variables were compared using the χ^2 test or Fisher's exact test if at least one value was <5. Significance levels were set at 5%.

Ethics approval

The protocol was approved by the Ethics Committees of the International Union Against Tuberculosis and Lung Disease in Paris,

France, and the Instituto de Medicina Tropical of the Universidad Nacional Mayor de San Marcos in Lima, Peru.

RESULTS

Baseline characteristics of patients

Of 680 eligible patients, 562 (83%) were included in the study. Each cohort had 281 patients, equally distributed between the health networks (Figure). The demographic and clinical characteristics of the two cohorts are shown in Table 2. There were no differences in age or sex. HIV status was evaluated more frequently in the 2009 cohort, but the proportion of HIV-positive patients was similar, at <3%. There was a higher proportion of smear-negative, culture-positive TB patients and a lower proportion of patients with grade 3+ positive smears in the 2009 cohort.

Treatment outcomes of patients on Regimen I

Treatment outcomes are shown in Table 3. No difference in favourable outcomes (cure or treatment completed) between the 2007 and 2009 cohorts on Regimen I was observed. There was a significant reduction in treatment failure ($P = 0.011$); however, loss to follow-up increased significantly in the 2009 compared with the 2007 cohort ($P = 0.04$). Treatment regularity was assessed: 23% of each cohort had a record of at least one dose of medication missed in the initial phase of treatment, and respectively 40% and 35% of the 2007 and 2009 cohort had a record of at least one dose of medication missed in the continuation phase of treatment; these differences were not significant.

Drug susceptibility testing and MDR-TB case detection

DST results are shown in Table 4. DST coverage was higher in the 2009 group (24% vs. 74%, $P < 0.001$), but the proportion of patients ultimately diagnosed with MDR-TB was similar in both cohorts. Time taken from diagnosis of TB to diagnosis of drug-susceptible, INH-resistant or MDR-TB is shown in Table 5. For drug-susceptible and drug-resistant TB, there was a significant reduction in the number of days to diagnosis in the 2009 compared with the 2007 cohort. For MDR-TB, the time between TB diagnosis and MDR-TB treatment initiation was 2.5 months (interquartile range [IQR] 1.3–3.0) in the 2009 cohort, significantly shorter than the 5.7 months (IQR 4.3–7.9) in the 2007 cohort ($P < 0.001$).

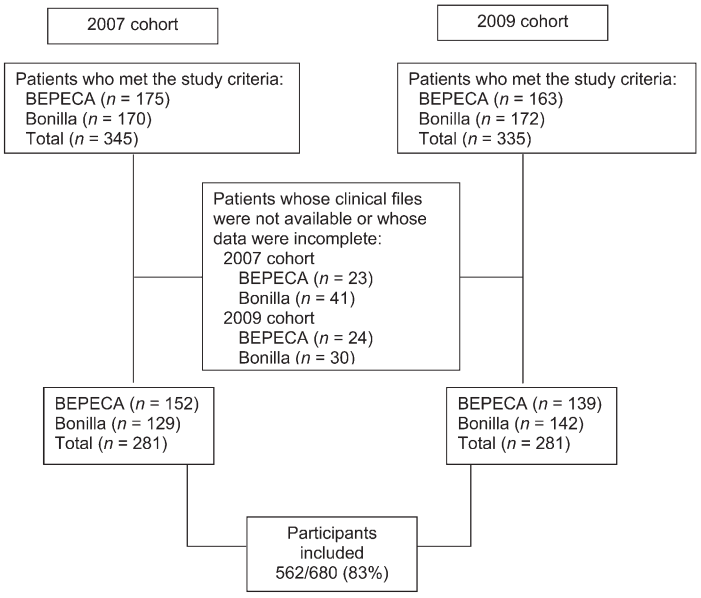

FIGURE Flow diagram of participants included in cohort before (2007) and after (2009) the introduction of the MODS assay, Callao, Peru. BEPECA network = Bellavista, La Perla and Carmen de la Legua Districts; Bonilla network = Callao and La Punta Districts; MODS = microscopic observation drug susceptibility.

TABLE 2 Demographic and clinical characteristics of TB patients before (2007) and after (2009) the introduction of the MODS assay, Callao, Peru

Characteristic	2007 ($n = 281$) n (%)	2009 ($n = 281$) n (%)	P value*
Age, years, median [1st and 3rd quartiles]	33.7 [21, 42]	34.5 [21, 45]	0.55
15–30	164 (58)	152 (54)	0.39
31–45	59 (21)	59 (21)	
46–60	33 (12)	47 (17)	
>60	25 (9)	23 (8)	
Female sex	115 (41)	111 (40)	0.73
HIV status			
Evaluated	184 (66)	226 (80)	<0.001
Positive	3 (1.6)	8 (3.5)	0.23
Result of smear microscopy			
Negative (culture +)	3 (1)	38 (14)	<0.001
Positive +	93 (33)	91 (32)	0.86
Positive ++	99 (35)	94 (34)	0.66
Positive +++	85 (30)	54 (19)	0.002
Scanty	1 (0.4)	4 (1)	0.37

*Mann-Whitney test.
TB = tuberculosis; MODS = microscopic observation drug susceptibility; HIV = human immunodeficiency virus.

TABLE 3 Final treatment outcomes of Regimen I in TB patients before (2007) and after (2009) the introduction of the MODS assay, Callao, Peru

Outcome	2007 ($n = 281$) n (%)	2009 ($n = 281$) n (%)	P value*
Favourable outcome	227 (81)	216 (77)	0.258
Cure	214 (76)	207 (74)	
Treatment completed	13 (5)	9 (3)	
Poor outcome	29 (10)	32 (11)	0.684
Failure	10 (4)	1 (0.4)	0.011*
Died	3 (1)	2 (1)	1.00
Loss to follow-up (default)	16 (6)	29 (10)	0.043
Other outcomes	25 (9)	33 (12)	
Transfer out	8 (3)	9 (3)	0.805
Initial TB treatment not completed	17 (6)	24 (9)	0.256
Reasons for initial TB treatment not being completed†			
Adverse drug reactions	3 (1.1)	1 (0.4)	
MDR-TB diagnosis	4 (1.4)	8 (2.9)	
INH- or RMP-resistant/TB diagnosis	2 (0.8)	9 (3.2)	
Drug-resistant TB suspect	8 (2.8)	6 (2.1)	

*Fisher's exact test.
†Respectively seven and five cases were confirmed as MDR-TB in the 2007 and 2009 cohorts.
TB = tuberculosis; MODS = microscopic observation drug susceptibility; MDR-TB = multidrug-resistant TB; INH = isoniazid; RMP = rifampicin.

Treatment outcome of MDR-TB

Of cases discharged as 'drug-resistant TB suspect', seven in 2007 and five in 2009 were diagnosed with MDR-TB. There were a final 24 patients with MDR-TB, 11 in the 2007 cohort and 13 in the

TABLE 4 DST and MDR-TB case detection of TB patients before (2007) and after (2009) the introduction of the MODS assay, Callao, Peru

Characteristic	2007 (n = 281) n (%)	2009 (n = 281) n (%)	P value
DST	66 (24)	207 (74)	
MODS assay	0	169 (82)	
Proportion method	63 (95)	38 (18)	<0.001
Other (BACTEC™ 460)	3 (5)	0	
MDR-TB diagnosed	11 (4)	13 (5)	0.676

DST = drug susceptibility testing; MDR-TB = multidrug-resistant tuberculosis; MODS = microscopic observation drug susceptibility.

2009 cohort. Treatment outcomes are shown in Table 6. Two patients in the 2009 cohort were still on treatment during data collection and thus final treatment outcomes were unavailable. For the remaining 22 patients, a favourable outcome was more frequent in the 2009 cohort (46% vs. 82%, P = 0.183).

DISCUSSION

There have been no previous evaluations of the effect of universal access to the MODS assay in Peru since its implementation in 2008. This is the first study to assess its usefulness under routine conditions in the Callao region of Peru. We found that universal access to MODS contributed significantly to increasing DST coverage and reducing the time taken between the diagnosis of TB and receipt of DST results.

Although universal access to MODS failed to improve the overall final treatment outcomes of new patients with PTB on Regimen I or patients with MDR-TB diagnosed during Regimen I treatment, failure rates during Regimen I were significantly reduced by using MODS. This is an important advantage, as it allows such patients to be changed much earlier to an appropriate regimen. However, despite the policy of universal access to MODS, only 60% of the 2009 cohort accessed it. The main reasons for this deficiency were 1) difficulties in local transportation of samples; 2) poor quantity and quality of sputum specimens; and 3) failure of health care staff to comply with guidelines due to high staff turnover.

The impact of any new diagnostic test depends entirely on the effective functioning of the overall programme. Unfortunately, the 2009 cohort with MODS had a high loss to follow-up, which

TABLE 5 Time taken from the diagnosis of TB to the diagnosis of drug-susceptible, INH-resistant or MDR-TB before (2007) and after (2009) the introduction of the MODS assay, Callao, Peru

Type of TB	2007 n (%) or median [IQR]*	2009 n (%) or median [IQR]*	P value
Drug-susceptible TB	43 (15)	174 (62)	<0.001
Time to diagnose drug-susceptible TB, days	118 [101–131]	33 [16–27]	<0.001
INH-resistant TB (non-MDR-TB)	9 (3)	18 (6)	0.073
Time to diagnose INH-resistant TB, days	92.7 [86–107]	49.4 [20–69]	0.006
MDR-TB	11 (4)	13 (5)	0.663
Time to diagnose MDR-TB, days	157.5 [93–211]	51.6 [13–80]	0.003

*Data are median and [first and third quartiles] unless stated otherwise.
TB = tuberculosis; INH = isoniazid; MDR-TB = multidrug-resistant TB; MODS = microscopic observation drug susceptibility; IQR = interquartile range.

TABLE 6 Final treatment outcomes of MDR-TB patients before (2007) and after (2009) the introduction of the MODS assay, Callao, Peru

Outcome	2007 (n = 11) n (%)	2009 (n = 11) n (%)	P value
Favourable outcome	5 (46)	9 (82)	0.183*
Cure	5 (46)	7 (64)	
Treatment completed	0	2 (18)	
Poor outcome	6 (55)	2 (18)	
Treatment failure	0	0	
Died	1 (9.0)	0	
Default	5 (46)	2 (18)	

*Comparison between 2007 and 2009.
MDR-TB = multidrug-resistant tuberculosis; MODS = microscopic observation drug susceptibility.

reduced the group's overall treatment success. This increased loss to follow-up is not limited to patients in this study; it is a general phenomenon recorded in the TB programme in Callao. Reasons include 1) increasing rates of drug-resistant TB in patients being treated in primary health care centres that do not have sufficient health care workers, 2) high proportions of drug and alcohol use in the region, and 3) anti-social behaviour of patients, leading to imprisonment or disappearance from the health system.[15]

Another important issue evaluated was the high proportion of patients with poor treatment adherence in both cohorts, which is a precursor to patients being declared lost to follow-up. We believe that there is a need for an international operational definition of 'irregular treatment' so that these events can be closely monitored and interventions to prevent loss to follow-up may be implemented. Peru's NTP will need to address this significant nationwide problem. This is especially important in Peru as the continuation phase includes medication given only twice weekly, which means that loss of a single dose can lead to subtherapeutic drug concentrations and thus an increased risk of drug resistance.

Study strengths include the large number of patients in each group, evaluations performed within the routine system, and study conduct and write-up per STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines.[16] Limitations are those of any retrospective study, and the fact that 17% of patients could not be assessed due to absent or poorly completed medical records.

The study had small numbers of MDR-TB patients, and despite the better outcomes in the 2009 cohort, there was limited power to show any significant differences compared with the 2007 cohort. This finding should be evaluated taking into account all MDR-TB cases in both cohorts, and not only newly detected cases.

There is no previous literature about the use of MODS by routine health systems. The WHO currently recommends the use of Xpert® MTB/RIF (Cepheid, Sunnyvale, CA, USA) for patients with suspected HIV-associated TB or MDR-TB.[17,18] While Xpert is an important and revolutionary new diagnostic test that requires minimal laboratory expertise and produces results for TB diagnosis and RMP resistance within 2 h, and despite the subsidised cost of less than US$10 per cartridge,[19] the main challenge for Peru is the necessity to confirm INH susceptibility in Xpert RMP-susceptible cases.[20] In Lima and Callao, the prevalence of primary resistance to INH is 16.4%, while only 8.1% of samples are also resistant to RMP (MDR-TB).[3] Xpert is also recommended in high HIV prevalence settings, but fortunately, and unlike the situation in many African countries, the prevalence of co-infection of HIV among persons with TB is <3% in Peru.[14] Instead of using Xpert,

Peru is the first country in Latin America to implement Genotype® MTBDR*plus* (Hain Lifesciences, Nehren, Germany) as part of its public health policy at the National Laboratory of Mycobacteria in combination with the MODS assay implemented in several regions.[21] Both tests address the issue of INH and RMP susceptibility; MODS can be used for patients with smear-negative TB and in HIV-infected patients. In Peru, the cost of one test using MODS is approximately US$5,[22] and an inverted microscope costing less than US$1000 is required.

In conclusion, this study shows the feasibility and advantage of using the MODS assay in all new patients at treatment initiation. Although final treatment outcomes were not significantly modified with MODS, this test makes a contribution to earlier detection, better management and prevention of drug-resistant TB transmission in the country. It is critical that the Peruvian NTP implement interventions to address poor drug adherence and loss to follow-up as fundamental measures for the prevention and control of drug-resistant TB, irrespective of which rapid test is implemented.

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Contexte : Les centres primaires de soins de santé à Callao, Pérou.
Objectifs : Evaluer l'effet d'un accès général au test d'observation microscopique de la sensibilité aux médicaments (MODS) sur les résultats du traitement chez les nouveaux patients et dans les cas de tuberculose où existe une multirésistance TB primaire ainsi que sur le processus des tests de sensibilité aux médicaments.
Schéma : Revue rétrospective des registres TB et des dossiers cliniques avant l'introduction du MODS en 2008, en l'occurrence en 2007 et après celle-ci, en l'occurrence en 2009.
Résultats : Chaque cohorte comportait 281 patients. Les résultats favorables du traitement ont été similaires en 2007 (81%) et en 2009 (77%). On a noté une augmentation des pertes de suivi (passant de 6% à 10% ; $P = 0,04$) et une diminution des échecs (passant de 4% à 0,4% ; $P = 0,01$) dans la cohorte de 2009 par comparaison à celle de 2007. Parmi les 22 nouveaux cas de TB-MDR, le résultat favorable du traitement a été plus fréquent (passant de 46% à 82% ; $P = 0,183$) dans la cohorte de 2009. Dans la cohorte de 2009, on a noté une meilleure couverture par les tests de sensibilité aux médicaments (passant de 24% à 74% ; $P < 0,001$) ainsi qu'une réduction significative de la durée précédant le diagnostic chez les patients sensibles aux médicaments (passant de 118 à 33 jours ; $P < 0,001$) et chez les patients atteints de TB-MDR (passant de 158 à 52 jours ; $P = 0,003$).
Conclusion : Un accès général au MODS augmente la couverture en matière de tests de sensibilité, réduit la durée avant l'obtention des résultats de la sensibilité et est en association avec une décroissance des taux d'échec. Le MODS peut constituer une contribution importante à la prise en charge et à la lutte contre la TB au Pérou.

Marco de referencia: Los centros de atención primaria de salud en Callao, Perú.
Objetivos: Evaluar la repercusión del acceso universal a la prueba de observación microscópica de la sensibilidad a los medicamentos (MODS) en el desenlace de los casos nuevos de tuberculosis multidrogorresistente (TB-MDR) primaria y en el procedimiento de evaluación de la sensibilidad.
Método: Se llevó a cabo un examen retrospectivo de los registros de

TB y de las historias clínicas en el 2007 antes de la introducción de la técnica MODS, que tuvo lugar en el 2008 y después de la misma (2009).

Resultados: Cada cohorte constó de 281 pacientes. Los desenlaces terapéuticos favorables fueron equivalentes en las cohortes del 2007 (81%) y el 2009 (77%). Se observó un aumento en la pérdida de casos durante el seguimiento (de 6% a 10%; $P = 0,04$) y una disminución de los fracasos terapéuticos (de 4% a 0,4%; $P = 0,01$) en la cohorte del 2009, comparada con la cohorte del 2007. En 22 casos nuevos de TB-MDR se mejoró el desenlace terapéutico en la cohorte del 2009 (de 46% a 82%; $P = 0,183$). En la cohorte del 2009, se logró una mejor cobertura con las pruebas de sensibilidad a los medicamentos (de 24% a 74%; $P < 0,001$) y una disminución significativa del lapso hasta la obtención del diagnóstico de TB farmacosensible (de 118 a 33 días; $P < 0,001$) y de TB-MDR (de 158 a 52 días; $P = 0,003$).

Conclusión: El acceso universal a la técnica MODS amplía la cobertura de evaluación de la sensibilidad a los medicamentos, disminuye el lapso hasta la obtención de los resultados de la prueba y se asocia con una disminución de las tasas de fracaso terapéutico. La prueba MODS puede contribuir de manera considerable al tratamiento y al control de la TB en el Perú.

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