Compliance with infection control practices in sputum microscopy centres: a study from Kerala, India

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Background: One of the strategies of the Revised National Tuberculosis Control Programme in India to achieve tuberculosis control is by increasing case detection through a nationwide network of designated microscopy centres (DMC). Practice of standard precautions for infection control in these DMCs is very important to prevent transmission of infection not only to the laboratory personnel, but also to the general population. However, in India this has not been evaluated by an external agency.

Method: A cross-sectional study was carried out to assess knowledge, facilities and compliance regarding infection control practices (ICP) in all 38 DMCs in Kannur district, Kerala, India, in 2015. Using observations and interviews, the investigators collected data in a structured format.

Results: Overall knowledge about infection control was found to be satisfactory among 29% of laboratory technicians. Overall facilities for infection control were satisfactory in 61% of the DMCs, while adherence to ICP was satisfactory in 45% of the DMCs. Knowledge regarding ICP was better in government DMCs, whereas facilities for ICP and adherence to biomedical waste management guidelines were better in private DMCs.

Conclusion: Given the higher risk of infection among laboratory technicians, there is an urgent need to address the shortcomings in infection control practices.

Tuberculosis (TB) is still a major public health problem in developing countries such as India, which contributes a quarter of the global TB burden, with an estimated annual incidence of 171 per 100 000 population.¹ One of the strategies of the Revised National Tuberculosis Control Programme (RNTCP) to achieve control is by increasing the case detection rate through a nationwide network of laboratories, known as designated microscopy centres (DMC), which perform sputum microscopy for acid-fast bacilli (AFB).

Recent studies have shown that the prevalence of latent tuberculous infection is high among health care workers.^{2,3} Multidrug resistance is seen in 2.2% of newly diagnosed TB cases and 15% of retreatment cases in India.¹ In addition to airborne transmission, the sputum collected for laboratory investigations can also be a potential source of infection if not properly disinfected and disposed of.⁴ In many institutions, the DMC is not isolated but is a part of the hospital clinical laboratory. A presumptive TB patient may have to visit a DMC multiple times during the process

of diagnosis—twice for sample collection and once for collecting the results. In the absence of proper infection control practices (ICP), there is a risk of transmission to other patients visiting the laboratory. Moreover, the current guidelines for TB control in India require that all TB patients be screened for diabetes by blood sugar examination.⁵ Under these circumstances, laboratory technicians may have to handle specimens such as blood and other bodily fluids in addition to sputum.

The practice of taking standard precautions for infection control in DMCs is important to prevent the transmission of sputum and blood borne infections not only to the laboratory personnel but also to the general population. Standard precautions include hand washing, the use of personal protective equipment, the prevention of injury with sharps, environmental cleaning and spill management and appropriate handling of waste.⁶ The RNTCP guidelines for the prevention of airborne infections, standard precaution and biomedical waste management to prevent the transmission of infection in DMCs are provided in the environment and biomedical waste management plan (2005).⁷

Studies from developing countries have shown that laboratory conditions and ICP in sputum microscopy centres are often unsatisfactory.^{8–11} Internal evaluations of the laboratory environment and biomedical waste management by the RNTCP, conducted in 40 laboratories across 10 districts in India, showed 50–70% compliance in different aspects of ICP.¹² However, to the best of our knowledge, no external evaluation of the knowledge of laboratory technicians or facility assessment and ICP in the DMCs has ever been conducted. This study was therefore conducted to assess knowledge and compliance with regard to infection control at DMCs. The specific objectives of the study were to determine, in Kannur district, Kerala, India, in 2015: 1) the number (proportion) of laboratory technicians with satisfactory knowledge about ICP, 2) the number (proportion) of DMCs with satisfactory facilities for infection control, and 3) the number (proportion) of DMCs adhering to standard ICP.

MATERIALS AND METHODS

Study design

This was a cross-sectional study conducted in all the designated DMCs in Kannur district, Kerala, India, from May to July 2015.

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Study setting

Kannur is a coastal district in Kerala state on the western coast of southern India. The district has a population of 2.5 million persons.¹³ Under the RNTCP, there is one district TB centre and six TB units (TU, a sub-district programme management unit for every 0.5 million population). There are 38 DMCs, of which 23 are in the government sector and 15 in the private sector. Each DMC caters for a population of 0.1 million, and is manned by one laboratory technician.¹⁴ The laboratory technicians are qualified in laboratory technology (diploma or degree) and receive training through the RNTCP on sputum AFB staining and ICP per RNTCP guidelines. The DMCs are located in public health institutions at primary, secondary and tertiary levels. In addition, some laboratories in private hospitals and stand-alone private laboratories have been accredited by the RNTCP to perform sputum AFB microscopy. All DMCs should have facilities for hand washing, personal protection, disinfection and waste segregation as per the guidelines delineated in the RNTCP's environment and biomedical waste management plan.⁷ ICP in the DMCs are required to be monitored by a senior TB laboratory supervisor (STLS) during supervisory visits.

Study population

The study population included the laboratory technicians employed in all 38 DMCs in Kannur district. Each DMC was manned by one laboratory technician.

Data collection, variables and sources of data

All of the 38 DMCs in Kannur district and their laboratory technicians were listed. Uninformed visits were conducted by the investigator (OPA) and co-investigator (NPU) to each of the DMCs. If the laboratory technician was absent during the initial visit, a repeat visit was made. A structured tool was used to collect and record information obtained by interviewing the laboratory technicians and observing the facilities. Details of the DMC, such as the type of DMC (government or private), the number of slides examined per month, the existence of a biomedical waste management committee in the institution, links to the central treatment facility for waste management and the frequency of supervisory visits were collected. The laboratory technicians were assessed through structured interviews on their knowledge about the transmission of infection, hand washing, personal protection, management of sharps, management of spills, vaccination status and biomedical waste management. Practices related to hand washing, use of personal protection and management of spills were assessed by interviewing the laboratory technicians regarding the frequency of such practices in different situations. The practices related to the management of sharps and biomedical waste management were assessed by observation using a check list. Facilities for hand washing, management of sharps, waste segregation, disinfection and biomedical waste disposal were assessed by observation using a checklist.

ICPs were assessed under three domains: knowledge, facility assessment and compliance, and itemised. The operational definitions are summarised in Table 1.

Data management and statistical analysis

Quantitative data were collected in a structured format and double-entered, validated and analysed using Epi-Data (version 3.1 for entry and version 2.2.2.182 for analysis, EpiData Association, Odense, Denmark). Frequencies and percentages were used to summarise knowledge, facility assessment and compliance, with ICP. Knowledge, facility assessment and compliance with ICP were compared between the public and private DMCs and the statistical significance of difference was tested using the χ^2 test. $P < 0.05$ was considered significant. The explanatory variables for compliance with ICP were tested by χ^2 and those variables with a univariate $P < 0.2$ were subjected to logistic regression analysis (enter model) using Epi Info 7.1.1.14 (US Centers for Disease Control and Prevention, Atlanta, GA, USA). The DMC/laboratory technician was the unit of analysis.

Ethical considerations

Ethical approval for the study was obtained from the Institute Ethics Committee of the Academy of Medical Sciences (ACME) and the Ethics Advisory Group of the International Union Against Tuberculosis and Lung Disease, Paris, France. Permission to conduct the study was obtained from the State Tuberculosis Office, Kerala. A participant information sheet was provided to all laboratory technicians in DMCs, and written informed consent was obtained from the technicians before starting data collection. The informed consent process was approved by the ethics committees.

RESULTS

Baseline characteristics

Of the 38 DMCs in the district (100%) assessed, 23 were government DMCs and 15 private DMCs. All 38 laboratory technicians working in the DMCs were assessed for their knowledge and practices related to ICP. Among the 23 government DMCs, four (17%) were located in primary level health facilities and 19 (83%) in secondary/tertiary level health facilities. Biomedical waste management was outsourced to a central treatment facility in 25 (66%) of the DMCs: 11 (48%) government and 14 (93%) private. Fifteen DMCs, all in the private sector, reported that they had clearance from the state pollution control board. Supervisory visits were conducted every month in all the DMCs. Among the laboratory technicians, 25 (66%) had >5 years' experience and 35 (92%) had received orientation training on ICP. Those who had not received orientation training had been recruited recently. The baseline characteristics of the DMCs and the laboratory technicians in each DMC are described in Table 2. Knowledge, facility assessment and compliance related to ICP in the DMCs are summarised in Table 3.

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TABLE 1 Operational definitions used for knowledge, facility assessment and compliance with ICP in the DMCs of Kannur district, Kerala, India, 2015

Serial no	Variable	Operational definitions
1	Knowledge	
	1.1 Hand washing	Considered adequate when correct responses were obtained for different situations of washing hands with soap, such as after accidental contamination, after removing gloves, before eating/drinking, as well as duration (>15 s) and steps of hand washing
	1.2 Personal protection using gloves	Considered adequate when correct responses were obtained for situations involving wearing gloves, such as handling sputum samples, blood samples and biomedical waste
	1.3 Management of sharps	Considered adequate if the response was 'use of needle burner and collection in puncture proof container containing disinfectant solution'
	1.4 Management of spills	Considered adequate if the response was 'pouring disinfectant (phenol or sodium hypochlorite solution) followed by mopping'
	1.5 Disinfection of sputum cups	Considered adequate if participants answered 'completely immersing in 5% phenol solution overnight'
	1.6 Waste segregation	Considered adequate when correct responses were obtained for all the following: segregation of sputum cups (into red bin), cotton (into yellow bin) and sharps (into white puncture proof container)
2	Facility assessment	
	2.1 For hand washing	Considered adequate when the facility had sink, running tap water and soap for washing hands
	2.2 For management of sharps	Considered adequate when there was a working needle burner
	2.3 For personal protection	Considered adequate when no stockout for gloves was reported in the previous month
	2.4 For disinfection	Considered adequate when no stockout for phenol or sodium hypochlorite solution was reported in the previous month
	2.5 For waste segregation	Considered adequate when the facility had a red bin, a yellow bin and a white puncture proof container
	2.5 Overall facilities for ICP	Satisfactory: when all of 5 of the facilities listed above were adequate Unsatisfactory: when ≤ 4 of the facilities listed above were adequate
3	Adherence	
	3.1 Hand washing	Considered adequate when participant always washes hands with soap in circumstances such as accidental contamination, before eating or drinking and after removing gloves
	3.2 Personal protection using gloves	Considered adequate when participant wears gloves when handling sputum samples and handling biomedical waste
	3.3 Waste segregation	Considered adequate when the biomedical wastes are appropriately segregated into red, yellow and white colour-coded bins per biomedical waste management guidelines ¹⁵
	3.4 Waste disposal	Considered adequate when all sputum cups are disinfected with phenol/hypochlorite solution then subjected to deep burial AND sharps are put in sharp pits AND blood-stained cotton (yellow waste) is incinerated Or All segregated biomedical waste is taken to a central treatment facility
	3.5 Overall adherence to ICP	Satisfactory: when all of the 4 points listed above were adequate Unsatisfactory: when ≤ 3 were adequate

ICP = infection control practice; DMC = designated microscopy centre.

Knowledge about infection control practices

Overall knowledge about ICPs was satisfactory in 11 (29%) laboratory technicians: 10 were at government DMCs and one at a private DMC. All laboratory technicians had adequate knowledge about the mode of transmission of TB and the human immunodeficiency virus (HIV) (data not shown). The analysis of the individual items under the knowledge section revealed that the laboratory technicians fared better in knowledge about personal protection using gloves and the management of spills and sharps compared with knowledge about hand washing, the disinfection of sputum cups and waste segregation. Government laboratory technicians were more knowledgeable than private laboratory technicians in all aspects of infection control, except waste segregation.

Facility assessment for infection control practices

Twenty three (60%) DMCs were found to be satisfactory on the facility assessment for ICPs. Analysis of each item revealed that more than 90% of DMCs had adequate facilities for hand wash-

ing, personal protection (gloves), disinfection and management of sharps. Facilities for waste segregation were better in private than in government DMCs.

Compliance with infection control practices

Seventeen (45%) DMCs had satisfactory compliance with ICPs. Adequate compliance in personal protection with gloves, immunisation with hepatitis B vaccination, disinfection of sputum cups, waste segregation and waste disposal was not observed in more than 30% of the DMC. Item-wise analysis revealed significant differences between private and government DMCs for compliance with waste segregation and waste disposal. Waste segregation and waste disposal was adequate in respectively 84% and 100% of the DMCs that had outsourced it to a central treatment facility. These practices were inadequate in all DMCs that were not attached to a central treatment facility.

On univariate analysis, attachment to a central treatment facility, laboratory technicians aged ≥ 30 years, training received by laboratory technicians and satisfactory facility assessment as a

TABLE 2 Baseline characteristics of the DMCs and their laboratory technicians in Kannur district, Kerala, India, 2015 ($n = 38$)

Characteristics	Categories	<i>n</i> (%)
Characteristics of DMC		
Type of DMC	Government	23 (60.5)
	Private	15 (39.5)
Number of slides read in previous month	>50	27 (71.1)
	≤50	11 (28.9)
Performing diabetes screening for TB	Yes	38 (100)
	No	0
Existence of BMW committee	Yes	11 (28.9)
	No/Do not know	27 (71.1)
Clearance from state pollution control board	Yes	15 (39.5)
	No/Do not know	23 (60.5)
Frequency of supervisory visits	Once a month	21 (55.0)
	More than once a month	17 (45.0)
Waste management outsourced to central treatment facility	Yes	25 (66.0)
	No	13 (34.0)
Display of IEC material about ICP	Yes	24 (63.0)
	No	14 (37.0)
Characteristics of laboratory technician		
Age, years	<30	11 (29.0)
	≥30	27 (71.0)
Sex	Male	12 (32.0)
	Female	26 (69.0)
Qualification	Bachelor's or Master's degree in MLT	8 (21.0)
	Diploma in MLT	30 (79.0)
Experience, years	≤5	13 (34.0)
	>5	25 (66.0)
Training received	Yes	35 (92.0)
	No	3 (8.0)
Past history of TB	Yes	1 (3.0)
	No	37 (97.0)

DMC = designated microscopy centres; TB = tuberculosis; BMW = biomedical waste management; IEC = information, education, communication; ICP = infection control practices; MLT = medical laboratory technician course.

factor for compliance with ICP had a P value of <0.2 . However, multivariate analysis highlighted no significant relationship between these three variables and compliance with ICP.

DISCUSSION

The study showed that the majority of the study participants had adequate knowledge about personal protection, spill management, management of sharps and hand washing. However, less than 50% of participants had adequate knowledge about disinfection of sputum cups and waste segregation. Overall, facilities for infection control were not satisfactory in 40% of the DMCs. Practices to prevent environmental contamination, such as disinfection of sputum cups, waste segregation and waste disposal, were not properly respected in more than 50% of the DMCs. Practices for personal protection, such as the use of gloves and hepatitis B vaccination, were not reported by one third of the study participants.

The laboratory technicians in government DMCs performed better than those in private DMCs in terms of knowledge about infection control. This can be attributed to the training and retraining received through the RNTCP. However, practices related to infection control, such as waste segregation and disposal, were better in private DMCs. This may be due to the fact that most of the pri-

vate DMCs had outsourced their waste management, while less than half of the government DMCs had done so. Disinfection and disposal were not properly performed in most government DMCs that did not have a central treatment facility. This poses a risk for environmental contamination, and highlights the general lack of compliance with the biomedical waste management specifications of the RNTCP's environmental and biomedical action plan.⁷

The results of the ICP analysis in the study are similar to those of the internal evaluation, which reports that 50% of the institutions had adequate supplies of colour-coded bags and bins and had a contract with a central treatment facility.¹² Although the internal evaluation reported that 90% had adequate knowledge about ICP, in the present study just one third of the participants had satisfactory knowledge. However, in the internal evaluation, the knowledge level of the health personnel was determined as reported by the medical officer in charge, while in the present study the knowledge was measured objectively.

A study done in Malawi showed ICP results that were similar to those of our study.¹¹ In the Malawi study, practices such as hand washing or use of personal protective equipment were well adhered to ($>80\%$), while decontamination of sputum cups was less strictly adhered to (3%) than in our study. Similar findings regarding the disinfection of sputum cups were reported in Ethiopia, where only 10% of laboratory technicians did so.⁸

TABLE 3 Knowledge, facility assessment and compliance with ICP by type of DMC ($n = 38$)

	All DMCs n (%)	Government ($n = 23$) n (%)	Private ($n = 15$) n (%)	P value
Adequate knowledge				
Hand washing	12 (32)	11 (48)	1 (7)	0.008
Personal protection using gloves	29 (76)	19 (83)	10 (67)	0.3
Management of spills	32 (84)	22 (96)	10 (67)	0.02
Management of sharps	33 (87)	22 (96)	11 (73)	0.04
Disinfection of sputum cups	17 (45)	12 (52)	5 (33)	0.2
Waste segregation	16 (42)	7 (30)	9 (60)	0.07
Overall satisfactory knowledge about infection control*	11 (29)	10 (44)	1 (7)	0.02
Adequate facilities				
Hand washing	37 (97)	22 (96)	15 (100)	0.4
Handling sharps	35 (92)	23 (100)	12 (80)	0.03
Personal protection	37 (97)	23 (100)	14 (93.3)	0.2
Disinfection	35 (92)	20 (87)	15 (100)	0.2
Waste segregation	25 (66)	12 (52)	13 (87)	0.03
Overall satisfactory facilities for infection control†	23 (61)	12 (52)	11 (73)	0.2
Adequate adherence to ICP				
Sputum collection outside DMC in open area	33 (87)	21 (91)	12 (80)	0.3
Hand washing	37 (97)	22 (96)	15 (100)	0.4
Personal protection with gloves	23 (61)	16 (70)	7 (47)	0.2
Full immunisation with hepatitis B vaccine	25 (66)	14 (61)	11 (73)	0.4
Disinfection of sputum cups using phenol/sodium hypochlorite	19 (50)	10 (44)	9 (60)	0.9
Disinfection of work bench	33 (87)	19 (83)	14 (93)	0.34
Waste segregation	21 (55)	10 (44)	11 (73)	0.004
Waste disposal	25 (66)	11 (48)	14 (93)	0.004
Overall satisfactory compliance with ICP‡	17 (45)	9 (39)	8 (53)	0.4

*Adequate knowledge about hand washing, personal protection using gloves, management of sharps, management of spills and waste segregation.

†Adequate facilities for hand washing, personal protection, management of sharps, disinfection and waste segregation.

‡Adequate compliance with hand washing, personal protection, waste segregation and waste disposal.

ICP = infection control practice; DMC = designated microscopy centre.

The strength of this study is that this is the first external evaluation of ICP in DMCs in India. The study was carried out by visiting all the DMCs without prior notice, which helped to obtain an accurate assessment of knowledge, facility assessment and practices. However, as practices related to personal protection and hand washing were not assessed objectively in all situations, the reported practice may be influenced by social desirability. As the study covered only one district, the observations cannot be generalised to other states in the country. Also, the limited sample size prevented the assessment of factors related to compliance with ICP.

In conclusion, these study results confirm that ICP has to be improved in the DMCs and that this needs to be a focus during supervisory visits. The facilities for ICP, such as disinfection, waste segregation and disposal, need to be strengthened with the help of the hospital development/management committees using local resources.

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Contexte : Une des stratégies du Programme national révisé de lutte contre la tuberculose (RNTCP) en Inde consiste à lutter contre la tuberculose en augmentant la détection des cas à travers un réseau national de Centres de Diagnostic par Microscopie (DMC). La mise en oeuvre des précautions standard de lutte contre les infections dans ces DMC est très importante pour prévenir la transmission des infections, non seulement vis-à-vis du personnel de laboratoire, mais également vis-à-vis de la population générale. Cependant, en Inde, ceci n'a pas été évalué par une agence externe.

Méthode : Une étude transversale a été réalisée pour évaluer les connaissances, la structure et l'adhésion aux pratiques de lutte contre l'infection (ICP) dans les 38 DMC du district de Kannur, état du Kerala, Inde en 2015. Grâce à des observations et à des

entretiens, les investigateurs ont recueilli des données dans un format structuré.

Résultats : Les connaissances d'ensemble relatives à la lutte contre l'infection ont été jugées satisfaisantes pour 29% des techniciens de laboratoire. Le niveau d'ensemble des centres en matière de lutte contre l'infection a été satisfaisant dans 61% des DMC. L'adhésion aux pratiques de lutte contre l'infection a été satisfaisante dans 45% des DMC. Les connaissances relatives aux pratiques d'ICP ont été meilleures dans les DMC du gouvernement tandis que les installations et l'adhésion aux directives de gestion des déchets biomédicaux ont été meilleures dans les DMC privés.

Conclusion : Connaissant le risque très élevé d'infection parmi les techniciens de laboratoire, il y a un besoin urgent de corriger les déficiences des pratiques de lutte contre l'infection.

Marco de referencia: Una de las estrategias del Programa Nacional Revisado contra la Tuberculosis de la India consiste en controlar la enfermedad al aumentar la detección de casos por conducto de una red nacional de centros de microscopía diagnóstica (DMC). La práctica de las precauciones corrientes de control de las infecciones en estos centros es muy importante con el fin de evitar la transmisión no solo al personal de laboratorio, sino también a la población general. Sin embargo, ningún organismo externo ha evaluado estas prácticas en el país.

Método: Se llevó a cabo un estudio transversal con el fin de evaluar los conocimientos, la adecuación de los establecimientos y el cumplimiento de las prácticas en materia de control de las infecciones (ICP) en 38 DMC del distrito de Kannur en el estado de Kerala en la India en 2015. Los investigadores recogieron datos mediante observaciones y entrevistas estructuradas.

Resultados: En general, el 29% del personal auxiliar de laboratorio poseía un grado satisfactorio de conocimientos sobre el control de las infecciones; el 61% de los DMC contaba con dispositivos adecuados de ICP y en el 45% se observó el cumplimiento de las normas. El conocimiento de las ICP fue mayor en los DMC del sector público, pero los dispositivos de los establecimientos y el cumplimiento de las directrices de eliminación de los desechos biológicos fueron de mejor calidad en los DMC del sector privado.

Conclusión: Teniendo en cuenta el mayor riesgo de exposición a las infecciones que presenta el personal auxiliar de laboratorio, existe una necesidad urgente de abordar las deficiencias observadas en las prácticas de control de las infecciones.