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Original Article

Compliance and knowledge of health professionals regarding airborne precautions

Adesão e conhecimento de profissionais da saúde em relação às precauções para aerossóis

Adhesión y conocimiento de profesionales de la salud en relación a las precauciones para aerosoles

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Objective: to assess compliance to measures regarding airborne precautions, as well as knowledge about the application of these measures among health professionals of a service specialized in the care of patients with tuberculosis. **Methods:** an observational cross-sectional study, which evaluated compliance opportunities through observation (n=143) and knowledge through a questionnaire (76). **Results:** the door of the isolation areas remained open at 13.3%. The wards had high filtration filter, but in 60.9% of observations this was off. As for the mask, 99.3% of health professionals used it before entering the isolation area and 58.7% kept the same mask after leaving. Responses from professionals about airborne precautions characterized little knowledge about these measures. **Conclusion:** continuing education campaigns to raise awareness can be adopted to increase the compliance to airborne precautions and reduce the risk of occupational exposure.
Descriptors: Aerosols; Tuberculosis; Health Knowledge, Attitudes, Practice; Health Personnel.

Objetivo: avaliar a adesão às medidas de precauções para aerossóis, bem como o conhecimento a respeito da aplicação dessas medidas entre os profissionais de saúde de um serviço especializado no atendimento a pacientes com tuberculose. **Métodos:** estudo transversal observacional, que avaliou as oportunidades de adesão por meio da observação (n=143) e o conhecimento por um questionário (76). **Resultados:** a porta dos isolamentos permaneceu aberta em 13,3%. As enfermarias possuíam filtro de alta filtragem, porém em 60,9% das observações este estava desligado. Quanto à máscara, 99,3% dos profissionais de saúde a utilizaram antes de entrar no isolamento e 58,7% permaneceram com a mesma após saírem. As respostas dos profissionais sobre as precauções para aerossóis caracterizaram pouco conhecimento sobre essas medidas. **Conclusão:** campanhas de educação permanente para sensibilizar podem ser adotadas para aumentar a adesão às precauções para aerossóis e reduzir os riscos de exposição ocupacional.
Descritores: Aerossóis; Tuberculose; Conhecimentos, Atitudes e Prática em Saúde; Pessoal de Saúde.

Objetivo: evaluar la adherencia a medidas de precauciones para aerosoles y los conocimientos acerca de la aplicación de estas medidas entre profesionales de la salud de un servicio especializado en la atención a pacientes con tuberculosis. **Métodos**: estudio transversal observacional, que evaluó oportunidades de adhesión a través de la observación (n=143) y conocimiento de cuestionario (76). **Resultados**: puerta de aislados permaneció abierta en 13,3%. Enfermarías con filtro de alta filtración, pero en 60,9% de las observaciones, éste fue desligado. Cuanto a la máscara, 99,3% de los profesionales de la salud han utilizado antes de entrar en el aislamiento y 58,7% mantuvieron la misma después de salir. Las respuestas de los profesionales sobre las precauciones para aerosoles caracterizaron poco conocimiento acerca de estas medidas. **Conclusión**: campañas de educación para concienciar pueden adoptarse para aumentar la adhesión a las precauciones para aerosoles y reducir riesgos de exposición ocupacional.
Descriptores: Aerosoles; Tuberculosis; Conocimientos, Actitudes y Práctica en Salud; Personal de Salud.

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Introduction

The risk of infection and/or illness caused by *Mycobacterium tuberculosis* remains a global public health problem[1-2]. With the emergence of multidrug-resistant strains and infection by the human immunodeficiency virus there was change in the profile of hospitalized patients, increasing the risk of nosocomial transmission of tuberculosis[3-5]. Despite both the national and international biosafety policies against tuberculosis recommend the implementation of administrative, preventive, environmental and individual measures, the in-hospital transmission of tuberculosis is still occurring, even in developed countries[6-7].

The permanence of this risk in health institutions demonstrates that only the existence of a program of prevention and control of in-hospital transmission of tuberculosis is not enough, it is especially helpful the compliance of professionals to these measures. Compliance to airborne precautions was evaluated in a university hospital of North Carolina, in the United States of American, and failures to comply with these measures were evidenced in 39% of observations[8].

On the other hand, compliance to airborne precautions occurs if the professional has knowledge about them. Lack of knowledge was found among radiology technicians in a hospital of care to patients with tuberculosis in Italy[9]. These data suggest that low adherence to standard airborne precautions may be related to lack of knowledge by health professionals, which can help to increase the rate of infection and illness in this group.

The scientific literature on the compliance and/or knowledge of health professionals regarding the airborne precautions is scarce, both at international and national levels, and most of it has over five years of publication. The same is true at the national level, as evidenced in a literature review study on the production of knowledge in Brazil about occupational tuberculosis and occupational risk, where it is found that most publications were focused on the research of latent infection among health professionals. In addition, the authors highlighted the need for studies to assess the prevention and control policies within the health institutions[10].

Based on these, the following research question was elaborated: do the health professionals who work in a hospital specialized in the care of communicable diseases demonstrate knowledge and adherence to airborne precautions?

Thus, the objective of this study was to evaluate the adherence to airborne precautions, as well as knowledge about the application of these measures among health professionals of a service specialized in the care of patients with tuberculosis. In this sense, it is expected the contribution of this study, signaling the situation of compliance and knowledge about these preventive measures, a diagnosis that can contribute to underlie educational activities.

Method

This is an observational cross-sectional study conducted in a public reference hospital for treatment of infectious diseases, with 126 beds, in the Brazilian Midwest. The research subjects were professionals who worked in the wards with patients in airborne infection, with suspected or confirmed tuberculosis. Inclusion criteria were: being health professional or hospital cleaners and working inside the isolation area for patients in airborne infection. Physicians, nurses, nursing technicians, nutritionists, psychologists, laboratory technicians and hospital cleaners participated in the study.

This article is the product of a main project entitled: Evaluation of occupational exposure to *Mycobacterium tuberculosis* in professionals at a hospital of infectious diseases, which was developed over four years. This study was conducted in two stages: the first to assess the adherence to airborne precautions, which was held from August 2009 to February 2010, and the second to assess the knowledge of professionals regarding the biosafety behavior in tuberculosis,

held from January to July 2011.

The first step was conducted using a check-list, drawn from the recommendations of international and national guides and manuals[6,11]. Following the inclusion criteria, sampling was of random type, which was calculated by the number of health professionals and the hospital cleaners that worked in the wards under observation, considering sampling error of 5% and confidence level of 95%.

Data were collected through direct observation of opportunities to adhere the airborne precautions in three shifts, once a week, at every turn. On each day of observation two wards with patients subject to airborne precautions were chosen to perform data collection. The researcher was positioned in the corridor of the wards and when the professional entered in the ward, the researcher would accompany them until they leave, 143 professionals were observed at this stage.

The number of compliance opportunities for airborne precautions was determined by professionals' exposure to situations that required the application of airborne precautions. The variables were: putting mask before entering the ward, closing the door after entering, High Efficiency Particulate Air (HEPA) filter in operation, use of N95 mask by the companion, maintaining the door closed, removing the mask after leaving the ward, keeping the mask in suitable packaging and hand hygiene before and after patient care.

In the second stage the data were collected using a structured self-applicable questionnaire with open and closed questions, to assess the knowledge on diagnosis and transmission of tuberculosis, and airborne precautions. Professionals were asked to answer the instrument in their workplace, and they were collected immediately after its completion. All eligible professionals who were actively working in the period of data collection were invited to participate in this step, but only 76 (53%) agreed to participate.

Both instruments used in data collection were assessed for content and form by three professionals with experience in hospital infection control. The suggested adjustments were made, and then the instruments were submitted to a pilot test at a communicable disease clinic of another university hospital with 10 health professionals, to assess their applicability, which were found suitable to reach the proposed goals. The results of the pilot tests were not included in the study sample.

Data were analyzed using descriptive statistics through the Statistical Package for Social Sciences 18.0 program. The results were expressed in absolute and relative frequencies with a confidence interval of 95%.

All ethical aspects established in Resolution 196/96, in force in the period of data collection, were followed. The project was approved by the Research Ethics Committee of the Hospital for Tropical Diseases/ Dr. Anuar Auad under the Protocol No. 014/2009. All participants signed the Informed Consent Form.

Results

In the first stage of the study 143 professionals from different categories participated, as presented in Table 1.

Table 1 - Professional categories of the subjects observed regarding the compliance to airborne precautions

Profissional category	n (%)
Physical Therapist	5 (3.5)
Psychologist	5 (3.5)
Laboratory Technician	5 (3.5)
Doctor	8 (5.6)
Nurse	9 (6.2)
Nutritionist	10 (7.0)
Hospital Cleaner	32 (22.4)
Nursing Technician	69 (48.3)
Total	143 (100.0)

All wards with patients with tuberculosis or under suspicion of it, were marked with the sign of

airborne infection and had HEPA filter in working condition.

A total of 143 professionals that entered into the wards with airborne precautions were observed, and it was possible to observe all the variables proposed to everyone, except for the use of N95 masks by the companions, which was subject to observation in 101 opportunities, of which the N95 mask was not used in 15% (21/101) of the observations, and on these occasions any of the professionals questioned or advised the use thereof.

Table 2 shows the adherence of professionals in the care of patients in airborne precautions.

Table 2 - Distribution of adherence to aerosol precautions measures adopted by health professionals (n = 143) in serving patients in isolation

Observation variables	n (%)	CI 95%*
Closing the door after entering or leaving the ward		
Yes	124(86.7)	80.1 – 91.3
No	19 (13.3)	8.6 – 19.8
Use of N95 mask by the professional in entering the isolation room for aerosols		
Yes	142 (99.3)	96.1 – 99.8
No	1 (0.7)	0.1 – 3.8
Withdrawal of N95 mask by professional after leaving isolation area		
Yes	59 (41.3)	33.5 – 49.5
No	84 (58.7)	50.5 – 66.4
Storage container of N95 mask after the professional leaves the airborne infection ward		
Pocket	87 (60.9)	52.6 – 68.4
Envelope	43 (30.0)	23.1 – 38.0
Others**	13 (9.1)	5.3 – 14.9
HEPA filter connected in the isolation room		
Yes	56 (39.1)	31.5 – 47.3
No	87 (60.9)	52.6 – 68.4
Hands hygiene before contact with the patient		
Yes	28 (19.6)	13.9 – 26.8
No	115 (80.4)	73.1 – 86.0
Hand hygiene after contact with the patient		
Yes	51 (35.7)	51 (35.7)
No	92 (64.3)	92 (64.3)

*Confidence interval 95%;** Plastic bag, elastic file, purse

In the total, of 76 health professionals participated in the evaluation of knowledge about tuberculosis and precaution measures to aerosols, with a predominance of nursing staff (nurses, nursing technicians and assistants, 86.8%). About 72 (94.7%) professionals reported having received training on biosafety before the start of their professional activities in that hospital.

Precaution measures to aerosols described by most professionals were using the N95 mask (60/79%) and use of surgical mask by the patient to come out of isolation (9/11.8%). Environmental measures such as maintaining the door closed and use of HEPA filter were rarely mentioned (Table 3).

Table 3 - Prevention measures against nosocomial transmission of tuberculosis cited by employees of a reference hospital for infectious diseases (n=76)

Measures	n(%)	CI 95%*
Keeping isolation door close	3 (3.9)	1.3 – 10.9
Use of N95 mask by companions and visitors	5 (6.6)	2.8 - 14.0
Use of HEPA filters	6 (7.9)	3.6 – 16.1
Institution of isolation	7 (9.2)	4.5 – 17.8
Use of surgical mask by the patient to come out of isolation	9 (11.8)	6.3 – 21.0
Use of N95 mask	60 (78.9)	68.5 – 86.6

*Confidence interval 95%

The containers referred to by professionals for storing N95 mask were envelope (68.4%) and plastic bag (5.3%). The others (26.3%) did not answer the question. When asked about the time required for the replacement of N95 mask, there was no consensus among professionals, ranging from daily to semiannual exchanges. However, there was unanimity on the answers stating that moisture and loss of mask integrity require replacement. Regarding the disposal of N95 mask, 23 (30.2%) professionals reported disposing it in ordinary garbage and others in infectious garbage (69.8%).

As for respiratory protection when the patient leaves the airborne infection isolation, 66 (86.8%) professionals considered the surgical mask recommended for patients, five (6.6%) indicated the need for N95 mask and five (6 6%) did not answer.

Symptoms of tuberculosis were listed correctly by most professionals (92.0%). As for the suspension of aerosol precautions to patients suspected of tuberculosis, 29 (38.1%) professionals stated interrupting it after two or three negative samples of Bacilos Álcool-Ácido Resistentes and 10 (13.1%) did not answer the question. The others replied that it was necessary antibiotics or isolation ranging from two weeks to forty days.

Regarding suspension of patient isolation with confirmed tuberculosis, 32 (42.0%) subjects indicated 15 days after initiation of treatment with tuberculostatics associated with at least two negative smears and 51 (67.0%) subjects reported the need of only one negative smear.

Discussion

Control measures for nosocomial tuberculosis, in order of priority, are: administrative, environmental and personal respiratory protection[6,11]. In the assessment conducted in this study that considered some of the environmental and personal respiratory protection measures, the environmental measures showed less adherence and greater ignorance on the part of health professionals.

The environmental measures assessed were: aeration of the private room promoted by maintaining the door and windows closed as well as air filtration through HEPA filter. Failure to comply with these measures compromise the environmental safety and contribute to the exposure of workers and other people moving within the unit[7,12].

Maintaining the door closed is required to maintain the negative pressure inside the isolation room, as well as to prevent the spread of *Mycobacterium tuberculosis* to the hall[6,11]. It was evidenced in 13.3% of observations that the doors remained open. A similar result was found in North Carolina hospitals, in the United States of American, showing that in 15.4% of the observations the door remained open after patient care in airborne precaution areas[8], showing similar failure in a developed country.

As for the continued use of negative pressure, studies conducted in the United States of American showed that this item was not used in 16.7%[8] and 11%[13] of observations, contrasting with our results, which, despite the presence of the filter in all wards, they were not used in 60.9% of observations. In almost all observations, the windows were open, thus reducing the ability to maintain negative pressure in isolation rooms with HEPA filter in operation. Although this occasional event had contributed to the exchange of air in those areas in which the filters were turned off. These events feature inappropriate use of the ventilation system adopted within the institution.

Study showed a higher detection of *Mycobacterium tuberculosis* in air samples collected from within the halls than from the isolation rooms with active tuberculosis patients, from the laboratory for diagnosis of tuberculosis and from the sputum induction room. Only the sputum induction room had negative pressure system with six air changes per hour[12]. This evidence reinforces the need for adherence to the maintenance of the door closed, and for the appropriate use of the ventilation system, as *Mycobacterium tuberculosis* particles are dispersed for halls who do not have a proper ventilation system, and there is no recommendation to use individual respiratory protection in these areas.

Few studies have evaluated the knowledge about the airborne precautions among health professionals. It was evidenced lack of knowledge among professionals of five units of care to tuberculosis patients in Russia, especially in relation to biosafety measures on tuberculosis[14]. Knowledge, attitude and practice of dental professionals in relation to tuberculosis control measures were checked in an institution in India and it was shown that only 62.1% of the respondents reported knowledge on the need to keep the door closed to patients in airborne precautions and the observation in practice showed that 57.2% performed it[15]. Although the measure of keeping the door closed has been cited by only

three (3.9%) professionals in our study, the results showed that this measure was carried out by most of them in practice (86.7%). A recent study assessed the knowledge of nursing assistants of the Family Health Strategy in the city of São Carlos, São Paulo, on tuberculosis and highlighted several shortcomings, mainly regarding treatment, symptoms, transmission and vaccination with Bacillus Calmette Guerin[16]. This evidence points to the need for investment in education of professionals from both the primary and hospital care.

In our study, a high adherence to the N95 mask was evidenced, as well as extensive knowledge of the necessity of its use for care to patients in aerosol precautions. These findings may reflect the importance given to the individual respiratory protection of the professional. Similar data was shown in North Carolina hospitals in the United States that evidenced high adherence to the use of N95 mask (92.3%)[8]. In contrast, in hospitals in the urban district of Mozambique, in Africa, 75% of professionals had the mask, but only 36.0% used it properly[17]. An interesting finding about the use of N95 mask in our study was that most professionals kept the same after leaving the ward. This may suggest insecurity from professionals about the effectiveness of environmental and administrative measures adopted in the institution.

Despite the high increase in the use of N95 mask, there was lack of consensus among professionals regarding the time of use of it (ranging from daily to semiannual exchange). According to the recommendations of the Centers for Disease Control and Prevention[6] replacement of the N95 mask should follow the manufacturer's guidelines. However, the Brazilian Ministry of Health recommends that the Hospital Infection Control Service and the Specialized Service in Occupational Health of each institution draw up the Standard Operating Procedure, guiding how to use, reuse time, where and how to guard this personal protective equipment, since its integrity is kept (no threadbare, elastic in perfect use conditions), as well as the absence of moisture and its cleaning. It is still recommended the immediate disposal thereof after use in care for patients with contact precautions added to airborne precautions[18]. It is noteworthy the uniformity in professionals' responses in this study, who indicated the moisture and the loss of mask integrity as reasons for discarding it.

Despite the reuse recommendation of N95 masks in Brazil, some authors discuss the possibility of contamination of this respirator by the professional themselves, while handling or due to improper storage[19].

It was hoped to find high adherence to hand hygiene, given that professionals were exposed to isolation situation. However, adherence to hands hygiene during patient care in airborne precaution was low, similar to other studies involving assistance to patients requiring standard precautions[20], which shows that adherence to this practice remains a major challenge for nosocomial infection control.

It is noteworthy that the low adherence to hand hygiene in care for patients in airborne precaution can result in cross-contamination between patients and professionals, and also contamination of N95 masks, since there are specific recommendations for hands hygiene before putting or removing the mask[18].

This study showed deficiencies in knowledge of health professionals regarding the isolation time in case of suspected and confirmed tuberculosis, which can lead to failures in the management of these patients, thus increasing the occupational hazards[6].

Final considerations

This study showed that there is still compliance failures and lack of knowledge on measures of airborne precaution, which may contribute to the increased exposure of professionals and users moving within the institution to the *Mycobacterium tuberculosis*.

Although biosafety policies on tuberculosis are implemented in the institution, it is important to

periodically perform a diagnosis of reality in order to detect weaknesses of the biosafety policy on tuberculosis adopted in the institution to improve safety therein.

Permanent education campaigns can be adopted in order to raise awareness among professionals, to supervise the practice, to increase the adherence to airborne precautions and also to reduce the risk of occupational exposure.

The difference in the number of participants by professional category, predominantly observing members of the nursing staff, the refusal of professionals to participate in the evaluation of knowledge on biosafety in tuberculosis, and the time elapsed between the first and the second data collection steps consisted the limitations of this study.

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Collaborations

Galdino Júnior H and Lopes LKO contributed to the design, data interpretation and writing of the article. Araújo ML and Santos LV contributed to the data collection and analysis. Tipple AFV contributed to the design and writing of the manuscript and final version to be published.

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