BACTERIOLOGICAL PROFILE OF LOWER RESPIRATORY TRACT INFECTIONS IN PATIENTS ADMITTED TO THE PULMONOLOGY WARD AT A TERTIARY HOSPITAL REFERENCE IN LUNG DISEASES IN THE STATE OF PERNAMBUCO

PERFIL BACTERIOLÓGICO DAS INFECÇÕES DO TRATO RESPIRATÓRIO INFERIOR EM PACIENTES INTERNADOS NA ENFERMARIA DE PNEUMOLOGIA EM HOSPITAL TERCIÁRIO DE REFERÊNCIA EM DOENÇAS PULMONARES NO ESTADO DE PERNAMBUCO

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ABSTRACT

Introduction: Respiratory tract infection is responsible for high morbidity and mortality, and frequent use of antibiotics. It is important to understand the bacteriological profile according to the evaluated location and condition of the patient since, on many occasions, the treatment of these infections is initiated empirically. **Objective:** The aim was to identify the bacteriological profile of cultures of sputum and bronchoalveolar lavage and verify the underlying lung disease of patients hospitalized in the pulmonology ward of the reference hospital in lung diseases of the state of Pernambuco. **Methods:** In this retrospective study, cultures of sputum, bronchoalveolar lavage, or both of 70 patients were analyzed. **Results:** The most prevalent bacteria in sputum cultures were *Pseudomonas sp*. (24%) *and Klebsiella sp.* (21%). Any pathogen was predominant in the cultures of bronchoalveolar lavage. Bronchiectasis was the most prevalent pulmonary disease with pulmonary tuberculosis after-effects, and a significant relationship between their presence and the infection by *Pseudomonas sp.* ($p < 0.05$) was found. **Conclusion:** The finding of *Pseudomonas sp.* as the most common bacteria, particularly in patients with bronchiectasis by pulmonary tuberculosis after-effects and *Klebsiella sp.* as the second most common, although not associated with any underlying lung disease, may assist in selecting empirical therapy of patients admitted to the pulmonology ward.

Keywords: Bacteria; Culture media; Bronchiectasis; Chronic Obstructive Pulmonary Disease. Pneumonia

RESUMO

Introdução: A infecção do trato respiratório é responsável por elevada morbimortalidade, além de levar ao uso frequente de antibióticos. É importante o conhecimento do perfil bacteriológico de acordo com o local avaliado e a doença de base do paciente, uma vez que, em muitas ocasiões, o tratamento dessas infecções é iniciado empiricamente. Objetivo: Identificar o perfil bacteriológico das culturas de escarro e dos lavados broncoalveolares e verificar a doença pulmonar de base dos pacientes internados na enfermaria de Pneumologia de um Hospital Terciário referência em doenças pulmonares do estado de Pernambuco. **Métodos:** O estudo consistiu de uma série de casos retrospectiva, onde foram analisadas as culturas de escarro e/ou do lavado broncoalveolar de 70 pacientes. **Resultados:** Os patógenos mais prevalentes nas culturas de escarro foram a *Pseudomonas sp.* e a *Klebsiella sp.*, presentes, respectivamente, em 17 (24%) e 15 (21%) pacientes. Não houve predomínio de qualquer patógeno nas culturas dos lavados broncoalveolares. A doença pulmonar de base mais prevalente foi a bronquiectasia por sequela de tuberculose pulmonar, havendo relação significativa entre a sua presença e a infecção por *Pseudomonas sp.* ($P < 0{,}05$). **Conclusão:** O encontro de *Pseudomonas sp.* como a bactéria mais prevalente, principalmente em pacientes que apresentam bronquiectasia por sequela de tuberculose pulmonar, assim como o achado de *Klebsiella sp.* como o segundo patógeno mais frequente, ainda que não associado a alguma doença pulmonar de base, poderão auxiliar na escolha da terapia empírica de pacientes internados na enfermaria de Pneumologia de um Hospital Terciário de Referência em doenças pulmonares.

Palavras-chave: Bactéria. Meios de cultura. Bronquiesctasia. Doença Pulmonar Obstrutiva Crônica. Pneumonia

IINTRODUCTION

Acute respiratory tract infections highly increase morbidity and mortality rates, leading to frequent antibiotic use.[1]

Due to diverse etiologies and the time required for bacteriological diagnosis, the treatment is often initiated empirically.[2]

Knowing the local bacteriological profile is essential since the prevalent bacterial flora and the pattern of antimicrobial resistance may vary according to the geographic region [1] and of the patient underlying disease.

The bacteriological predominance described in the literature, according to the underlying pulmonary pathology, shows that the most frequently isolated bacteria in patients with exacerbations of chronic obstructive pulmonary disease (COPD) are non-typable *Haemophilus influenzae*, *Moraxella catarrhalis*, and *Streptococcus pneumoniae*[3]. *Pseudomonas aeruginosa* and *Enterobacteria* are also commonly isolated, particularly in patients with severe COPD[3,4]. In patients with bronchiectasis, the most frequently bacteria include *H. influenzae*, *M. catarrhalis*, *Staphylococcus aureus*, *P. aeruginosa* (especially the mucoid type), and, to a lesser extent, *S. pneumoniae*[5]. Approximately one-third of these patients are chronically colonized by *P. aeruginosa*[6]. In relation to community-acquired pneumonia (CAP), the most frequent are *S. pneumoniae*, followed by atypical bacteria such as *Mycoplasma pneumoniae* and *Chlamydophila pneumoniae*[7].

Few studies describe the bacteriological profile of patients admitted to pulmonary wards, considering the most prevalent diseases in these specific sectors. Also, many of these studies focus on patients with CAP[8-12]. The most comprehensive study on the bacteriological profile of lower respiratory tract diseases was conducted in Egypt, evaluating 360 patients with CAP, 318 with hospital-acquired pneumonia, and 376 with acute exacerbations of COPD.

While no studies have been published on the prevalence of underlying lung diseases among patients admitted to the pulmonology ward of tertiary hospital reference in lung disease in Pernambuco, hospitalizations due to exacerbations of COPD and bronchiectasis due to pulmonary sequelae of previous infections, mainly pulmonary tuberculosis, seem to predominate. The number of patients with CAP is lower in comparison to other etiologies. To date, no studies have examined the bacteriological profile in patients admitted to this ward. Therefore, this study aimed to identify the bacteriological profile of sputum cultures and bronchoalveolar lavage (BAL) in patients admitted to the pulmonology ward of a tertiary hospital reference in lung diseases and to evaluate the underlying lung diseases in these patients.

METHODS

A retrospective case series study was conducted in the pulmonology ward of a tertiary hospital reference in lung diseases in the state of Pernambuco, Brazil. The results of the sputum and BAL cultures of the patients were analyzed.

The inclusion criteria comprised patients with available results of sputum and BAL culture, or both, and complete medical records. Patients whose culture results were available but whose medical records were inaccessible, or incomplete, were excluded.

The study was conducted in four stages. In the first, results of sputum and BAL culture were retrieved from the bacteriology laboratory. Next, the electronic medical records of the patients identified in the first stage were retrieved. For those whose electronic records could not be located, printed medical records were requested in the third stage. Finally, in the fourth stage, data on age, underlying pulmonary disease, and comorbidities were collected based on the information obtained in the previous stages.

A standardized form was created for each bacteriological result and its corresponding patient, including the variables of interest: underlying pulmonary disease, comorbidities, number of hospitalizations, results of sputum, and BAL culture for nonspecific bacteria and fungi.

Descriptive analysis was performed using absolute and relative frequencies for qualitative variables. The measure of association used was the odds ratio (OR), with a 95% confidence interval (CI).

For quantitative variables, the mean and standard deviation were calculated, and Student's *t*-test was applied. The software Epi Info version 7 was used for analysis.

RESULTS

A total of 110 cultures, including sputum and BAL, were performed in 73 patients in the pulmonology ward. Of these, two were excluded due to the unavailability of electronic or printed medical records and one due to a mismatch between the name and the information provided by the microbiology laboratory. Therefore, 70 patients were included in the final analysis, of whom 58 were men (83%). The mean age was 54.8 ± 13.6 years, ranging from 18 to 87 years. Most patients (80%) had only one underlying pulmonary disease, with bronchiectasis secondary to tuberculosis sequelae being the most frequent (47%), followed by COPD (11%). Regarding comorbidities, 41% of patients had one comorbidity, while 39% had two or more.

Of sputum cultures, 69% were positive for pathogenic bacteria and 20% for fungi. BAL culture was performed in 23 patients (33%), with nonspecific bacterial growth in 21 samples (30%) and fungal growth in 3 samples (4%).

The most frequently isolated bacteria in sputum cultures belonged to the genera *Pseudomonas* (24%) and *Klebsiella* (21%) (Table 1). Within the *Pseudomonas* genus, the predominant species was *Pseudomonas aeruginosa*, while *Klebsiella pneumoniae ssp. pneumoniae* was the main species within the *Klebsiella* genus. All fungal isolates from sputum cultures were identified as *Candida albicans*.

In BAL cultures, due to the smaller number of samples, no predominant nonspecific bacteria were identified. *P. aeruginosa* and *Klebsiella* sp. were each isolated in four patients. Among the three BAL cultures positive for fungi, two isolates were *C. albicans*, and one was *Candida dubliniensis*.

Among patients whose sputum cultures were positive for *Pseudomonas* sp., 14 (82%) were male, with a mean age of 53.3 ± 16.5 years. Fourteen patients (82%) had one underling pulmonary disease, and three (18%) had two or more.

The *Pseudomonas* genus was significantly more frequent in patients with bronchiectasis (36%) ($p < 0.05$). No significant associations were observed between the presence of *Pseudomonas* sp. and the other variables analyzed (Table 2).

Table 1. Clinical parameters in patients hospitalized in the pneumology ward who underwent sputum or BAL culture.

Variables	n (%)
Age (years)	**54.8± 13.6**
Sex	
Male	58 (83)
Female	12 (17)
Number of PD[1]	
1	56 (80)
≥ 2	14 (20)
PD	
Abscess	07 (10)
Bronchiectasis	33 (47)
COPD	11 (16)
Neoplasia	10 (14)
Pneumonia	04 (6)
Active pulmonary tuberculosis	02 (3)
Others	15 (21)
Comorbidities	
0	12 (17)
1	29 (41)
2	27 (39)
3	02 (3)
Sputum (pyogenic)	
Positive	48 (69)
Negative	22 (31)
Sputum (fungi)	
Positive	14 (20)
Negative	56 (80)
BAL (pyogenic)	
Positive	21 (30)
Negative	02 (3)
Unrealized	47 (67)
LBA (fungi)	
Positive	03 (4)
Negative	20 (29)
Unrealized	47 (67)
Positive sputum	
Pseudomonas sp.	17 (24)
Klebsiella sp.	15 (21)

* Mean± standard deviation
1 DPB = underlying lung disease
PD = pulmonary disease
COPD = chronic obstructive pulmonary disease

Table 2. Clinical parameters in patients admitted to the pulmonology ward with positive sputum culture for the genus *Pseudomonas sp.*

Variables	*Pseudomonas sp.* Positive n (%)	*Pseudomonas sp.* Negative n (%)
Age (years)*	53.3 ±16.5	55.3 ±12.7
Sex		
Male	14 (24)	44 (76)
Female	03 (25)	09 (75)
Number of PD[1]		
1	14 (25)	42 (75)
≥ 2	03 (21)	11 (79)
PD[1]		
Abscess	01 (14)	06 (86)
Bronchiectasis		
Yes	12 (36)	21 (64)[a]
No	05 (14)	32 (86)
COPD	03 (27)	08 (73)
Neoplasia	01 (10)	09 (90)
Pneumonia	01 (25)	03 (75)
Others	01 (7)	14 (93)
Number of comorbidities		
0	03 (25)	09 (75)
1	07 (24)	22 (76)
2	07 (26)	20 (74)
3	0 (0)	02 (100)
Comorbidities		
Alcoholism	05 (28)	13 (72)
Diabetes mellitus	03 (30)	07 (70)
HIV2 / AIDS	0 (0)	03 (100)
Smoking	07 (19)	30 (81)

* Mean ± standard deviation
PD = pulmonary disease
1 COPD = chronic obstructive pulmonary disease
2 HIV = human immunodeficiency virus
3 AIDS = acquired immunodeficiency syndrome
*p-value < 0.05

Table 3. Clinical parameters in patients hospitalized in the pneumology ward with sputum culture positive for the genus *Klebsiella sp.*

Variables	*Klebsiella sp.* Positive n (%)	*Klebsiella sp.* Negative n (%)
Age (years)*	51.8 ± 16.1	55.7 ± 12.9
Sex		
Male	14 (24)	44 (76)
Female	01 (8)	11 (92)
Number of PD [1]		
1	11 (20)	45 (80)
2		
PD[1]	04 (29)	10 (71)
Abscess	03 (43)	04 (57)
Bronchiectasis	05 (15)	28 (85)
COPD	03 (27)	08 (73)
Neoplasia	03 (30)	07 (70)
Pneumonia	0 (0)	04 (100)
Others	04 (27)	11 (73)
Number of comorbidities		
0	06 (50)	06 (50)
1	01 (3)	28 (9 7)
2	08 (30)	19 (70)
3	0 (0)	02 (100)
Comorbidities		
Alcoholism	04 (22)	14 (78)
Diabetes mellitus	0 (0)	10 (100)
HIV2 / AIDS	01 (33)	02 (67)
Smoking	09 (24)	28 (76)

* Mean ± standard deviation
PD = pulmonary disease
1 COPD = chronic obstructive pulmonary disease
2 HIV = human immunodeficiency virus
3 AIDS = acquired immunodeficiency syndrome

Table 4. Clinical parameters in patients admitted to the pneumology ward with sputum culture positive for fungi.

Variables	Fungi	
	Positive	Negative
	n (%)	n (%)
Age (years)*	52.0± 9.7	55.5 ± 144
Sex		
Male	14 (24)	44 (76)
Female	0 (0)	12 (100)
N º de PD1		
1	10 (18)	46 (82)
≥ 2	04 (29)	10 (71)
PD¹		
Abscess	02 (29)	05 (71)
Bronchiectasis	07 (21)	26 (79)
COPD	02 (18)	09 (82)
Neoplasia	03 (30)	07 (70)
Pneumonia	01 (25)	03 (75)
Others	01 (7)	14 (93)
Number of comorbidities		
0	03 (25)	09 (75)
1	05 (17)	24 (83)
2	06 (22)	21 (78)
3	0 (0)	02 (100)
Comorbidities		
Alcoholism	04 (22)	14 (78)
Diabetes mellitus	0 (0)	10 (100)
HIV2 /SIDA3	0 (0)	03 (100)
Smoking	08 (22)	29 (78)

* Mean ± standard deviation
PD = pulmonary disease
‘COPD = chronic obstructive pulmonary disease
2 HIV = human immunodeficiency virus
3AIDS = acquired immunodeficiency syndrome
p-value < 0.05

Among the patients with sputum cultures positive for *Klebsiella sp.*, 14 (93%) were male, with a mean age of 51.8 ± 16.1 years (Table 3). No statistically significant differences were observed in the analyzed variables in relation to the presence of *Klebsiella sp*.

All cases of positive sputum cultures for fungi occurred in male patients (100%), with a mean age of 52 ± 9.7 years. However, no significant differences were identified between the groups with and without positive fungi cultures (Table 4).

DISCUSSION

This case series revealed two main findings. First, the most prevalent bacterial genera were *Pseudomonas sp.* and *Klebsiella sp* respectively. Second, the most common underlying pulmonary disease was bronchiectasis resulting from pulmonary tuberculosis sequelae.

Within the *Pseudomonas* genus, *P. aeruginosa* was the predominant species, especially in patients with bronchiectasis. This observation aligns with previous studies involving patients with bronchiectasis, in which *P. aeruginosa* was found in approximately one-third of cases. Also, *Haemophilus influenzae* is a frequently reported pathogen in patients with bronchiectasis, according to other studies. However, in the microbiology laboratory where the present study was conducted, *H. influenzae* was not considered pathogenic and was not included in the data, limiting comparative analysis.

Klebsiella sp., the second most frequently isolated genus, is a nosocomial pathogen capable of causing pulmonary infections, particularly hospital-acquired pneumonia. Also, it is associated with other respiratory conditions, such as lung abscesses, and is more common in immunocompromised individuals, including those with diabetes mellitus and malignancies. Nevertheless, in this study, no statistically significant association was observed between the presence of *Klebsiella* sp. and any specific underlying pulmonary disease or comorbidities.

Regarding the fungal profile, all positive cultures involved *Candida* species, primarily *C. albicans*, except for one instance of *C. dubliniensis*. Airway colonization or contamination of respiratory secretions with *Candida* from the oropharynx is a frequent finding. Moreover, previous studies have demonstrated that the growth of *Candida* species in respiratory specimens, including BAL, has limited predictive value for diagnosing lower respiratory tract infections. In fact, fungal diseases of the lungs, such as pneumonia or abscesses caused by *Candida*, are rare and typically occur through hematogenous dissemination rather than through aspiration of contaminated secretions.

The second notable finding of this study was the high prevalence (47%) of bronchiectasis among hospitalized patients. While previous studies in the United Kingdom and Spain reported that the most frequent etiology of bronchiectasis is post-infectious, often originating in childhood and more commonly affecting women, the present study diverged in two aspects. First, bronchiectasis was more com-

mon among men, and second, its etiology was predominantly linked to sequelae of *Mycobacterium tuberculosis* infection rather than childhood infections. Except for three patients whose bronchiectasis had undefined causes, all others presented traction bronchiectasis as a post-tuberculosis complication. Consistent with this, pulmonary tuberculosis is a serious public health problem in Brazil, considered one of the 22 countries responsible for 80% of all cases in the world. Pernambuco is one of the Brazilian states with the highest incidence and the second highest mortality rate. Thus, many patients develop lasting pulmonary structural damage, including bronchiectasis.

The second most frequent disease reported was COPD (16%), often in combination with other respiratory diseases. In these cases, no predominant microorganism was identified, diverging from other studies.

CAP affected 6% of patients in this study, in contrast to other studies where *Streptococcus pneumoniae* was the primary bacteria in these patients . The current study found *Pseudomonas aeruginosa* in two of the four patients with CAP, and no microbial growth was observed in the remaining two. These findings are inconsistent with prior research that has frequently associated CAP with *S. pneumoniae* and atypical pathogens in patients outside the intensive unit care.

Furthermore, the bacteriology laboratory does not consider common flora bacteria as pathogenic, even when the growth is predominant, not being possible to properly evaluate the most involved bacteria. Furthermore, the laboratory does not perform serological testing for atypical pathogens such as *Mycoplasma pneumoniae*, a method used in other studies to characterize the bacteriological profile of CAP. Additional limitations include the lack of blood cultures and urinary antigen testing. The retrospective design, based on the review of medical records, also represents an inherent limitation. Finally, it is worth mentioning that cultures were analyzed qualitatively since colony counts were not reported.

CONCLUSION

This retrospective study evaluated the bacteriological profile of lower respiratory tract infections in hospitalized patients. *Pseudomonas aeruginosa* was the most frequent bacteria, particularly among patients with bronchiectasis, a condition predominant in adult men.

Klebsiella sp. was the second most prevalent bacterium, corroborating with other studies, although no significant association was found with any specific pulmonary disease or comorbidity.

Among the underlying pulmonary diseases, tuberculosis emerged as a significant public health concern in Brazil. Pernambuco, specifically, presents one of the highest incidence rates and the second-highest mortality rate. COPD was the second most frequent disease, with no clear association with any predominant microorganism.

Thus, knowing the bacteriological profile of the various health services, such as the pneumology ward, facilitates developing more directed empirical therapies. Consequently, this approach may contribute to reducing therapeutic failures and shortening hospital stays, ultimately improving patient outcomes.

REFERENCES

1. Agmy G, Mohamed S, Gad Y, Farghally E, Mohammedin H, Rashed, H. Bacterial profile, antibiotic sensitivity and resistance of lower respiratory tract infections in upper Egypt. Med J Of hematol infect Dis. 2013; 5(1).
2. Mendes C, Hsiung A, Dencer C, Felmingham D, Rossi F, Segura AJA, et al. Respiratory Tract Infections: Main Bacterial Agents and Resistance Patterns. Brazilian Data from the International PROTEKT Study. Internato Arch Ootorhinol. 2003; 7(2), 227.
3. Bartlett J, Sethi S. Management of infection in exacerbations of chronic obstructive pulmonary disease. UpToDate 2015.
4. Pauwels RA, Buist AS, Calverley PMA, Jenkins CR, Hurd S. Gold: Global Initiative for Chronic Obstructive Lung Disease. National Institutes of Health. National Heart, Lung, and Blood Institute.Am J Respir Crit Care Med.2001;163,43-4.
5. Barker AF, Stoller JK. Treatment of bronchiectasis in adults. UpToDate 2015.
6. O'Donnell, AE. Bronchiectasis. Chest J. 2008;134(4):815-23.
7. Corrêa RDA, Lundgren FLC, Pereira-Silva JL, Silva RLF, Cardoso AP, Lemos ACM, et al. Brazilian guidelines for community-acquired pneumonia in immunocompetent adults-2009. J Bras Pneumol. 2009; 35(6), 574-601.
8. Angrill J, Agusti C, De Celis R, Rano A, Sole T, et al. Bacterial colonization in patients with bronchiectasis: microbiological patternandriskfactors.Thorax2002;57(1):15-9.
9. Groenewegen KH, Wouters EF. Bacterial infections in patients requiring admission for an acute exacerbation of COPD; a 1-year prospective study. Respiratory medicine 2003; 97(7), 770-7.
10. Bansal S, Kashyap S, Pal LS, Goel A. Clinical and bacteriological profile of community acquired pneumonia in

Shimla, Himachal Pradesh. Indian Journal of Chest Diseases and Allied Sciences 2004;46(1):17-22.

11. Oberoi A, Aggarwal A. Bacteriological profile, serology and antibiotic sensitivity pattern of microorganisms from community acquired pneumonia. JK Sci 2006:8:79-82.
12. Donalisio MR, Arca CHM, Madureira P. Clinical, epidemiological and etiological profile of patients with community-acquired pneumonia admitted to a general hospital in the microregion of Sumaré, SP. JBrasPneu. 2011;37(2):200-8.Laboratory Procedures: from Examination Request to Microbiological Analysis. National Health Surveillance Agency.
13. 14.13. Islam S, Mathur PN. Flexible bronchoscopy: Equipment, procedure, and complications. UpToDate. 2015. Fried LP, Ferrucci L, Darer J, Williamson JD, Anderson G. Untangling the concepts of disability, frailty, and comorbidity: implications for improved targeting and care. J Gerontol Series A:BiolSciMedSciences.2004:59(3):M-255-M63.
14. Yu WL, Chuang YC. Clinical features, diagnosis, and treatment of Klebsiella pneumoniae infection. UpToDate. 2015.
15. Zhoy YJ, Li GH. Clinical practice guidelines for the management of candidiasis: 2009 Update by the Infectious Diseases Society of America. Chi J Inf Chemo. 2009; 3, 004.
16. Wood GC, Mueller EW, Croce MA, Boucher BA, Fabian TC. Candida sp. isolated from bronchoalveolar lavage: clinical significance in critically ill trauma patients. Int Care Med. 2006; 32:599-603.
17. Shoemark A, Ozerovitch L. Aetiology in adult patients with bronchiectasis.RespMed.2007;101(6):1163-70.
18. Historical Series of Tuberculosis Mortality Rate. Brazil, Regions and Federative Units of residence by year of diagnosis (1990 to 2004). Available at: http://portal saude.saude.gov.br/index.php/oministerio/principal/leiamais-o-ministerio/741-secretaria-svs/vigilancia-de-a-a-z/tuberculosis/11485-situacao-epidemilogica-dados.