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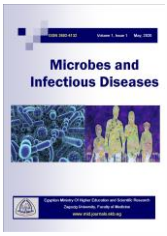

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Original article

Bacterial respiratory infection epidemiology and antibiogram profile in patients attending in regional hospital, Meknes, Morocco

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ABSTRACT

Objective: The main goal of this current study was to assess the prevalence of these infections in the outpatient setting as well as in hospitalized patients at Mohammed V hospital in Meknes, Morocco. **Method**: The epidemiological and microbiological characteristics of respiratory infections mentioned in the registers of the laboratory of microbiology at Mohammed V hospital, Meknes, were collected on pre-established exploitation sheets for each case throughout a 3-year period (2017-2019). **Results:** A total of 7863 patients diagnosed with respiratory infections were admitted to various hospital departments. During 2017, the percentage of hospitalized patients was equivalent to 33.6% of cases, and during the year 2018, this percentage increased by roughly 4.61% before decreasing by 10.03% in 2019. Males were the most affected with a proportion of 61%, while females did not exceed 31%. The pulmonology department had the highest proportion of hospitalized patients (62.60%), followed by the medicine department (14.63%), and gastroenterology (13.55%). The seasonal distribution peaks in spring with a percentage of 37.6%. According to the bacteriological examination, 20 patients (5.42%) had a bacterial respiratory infection. The biochemical classification of the isolated bacterial species revealed the presence of three bacterial species with a high isolation frequency of *Streptococcus pneumoniae* (85%), followed by *Escherichia coli* (10%) and *Staphylococcus aureus* (5%). **Conclusion**: Respiratory infections are widespread throughout the spring season, with male being the most affected. Monitoring and characterization of epidemiological and microbiological data are still required to prevent and mitigate the burden of these infections on patients, healthcare systems, and society.
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Introduction

Bacterial infections constitute a serious challenge that threatens the public health and healthcare systems [1-3]. Conventional treatment of bacterial infections using chemotherapeutics accentuates the emergence and development of bacterial resistance [4]. Bacterial infections may affect different parts of the respiratory tract. They

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are ubiquitous and commonly affected both adults and children, causing mortality and morbidity [4,5]. Infections are most usually in the respiratory tract and according to the current estimates; pneumonia accounts for approximately 15 % of global fatalities in children under the age of five [6].

Furthermore, the healthcare acquired infections (HAIs) is higher in developing countries than European and American countries. In fact, these infections can arise at any age and in various clinical situations, including immunosuppression, genetic background (cystic fibrosis), intubated-ventilated patients, and healthy individuals. Particularly, the prevalence of HAIs is highly widespread in intensive care units [7]. As a result, they have a significant economic influence and carry a significant weight in our society. The frequency of consultations by general practitioners for respiratory tract infections outnumbers all other reasons combined [8-10].

The direct contact with the environment and permanent exposure to microorganisms suspended in the air can explain the frequency of respiratory tract infections. Pathogenic bacteria can affect healthy subjects, but infections occur in case of defense system damaged. The infection can be located at any level of the respiratory tract and the topography determines the clinical manifestations [11]. The clinical syndromes vary according to their location. The clinical manifestations of the respiratory tract infections also depend on the causative agent. The viruses are particularly important in the upper airway infections and are responsible for the most cases of the pharyngitis [12]. The bacteria are mainly responsible for the otitis media, the pharyngitis, the epiglottitis, the bronchitis and the pneumonia. Presumably, the scarcity of data on the real burden of bacterial infections and its prevalence and epidemiology in Morocco is a key stone of the preparation of the present study.

The main purpose of the present study was to establish the bacterial infection distribution according to sex, department and season, as well as the resistance of isolated strains against different used antibiotics. It is worth to be noted that this is the first study designed to examine the respiratory infections and antibiotic resistance of strains isolated from outpatients and hospitalized patients in Mohamed V Hospital of Meknes over a three-year period (2017-2019). The results of the present study will be of paramount importance to take the right and preventive actions to avoid HAIs.

Material and methods

Study setting

According to the last Moroccan territorial division of 2015, Fez-Meknes is one of the twelve new regions of Morocco with 4236892 inhabitants, which represents approximately 13% of the overall population of the country [13]. The region is spread over an area of order of 40075 km^2, which corresponds to 5.7% of the total area of the country.

Hospital Mohamed V is a provincial reference center for care and consultation. It is one of the most important hospital structures in the Fez-Meknes region. It has a functioning bed capacity of 378 beds and provides diagnostic services and specialized care in 22 disciplines.

Methodology

The current study focuses on cases of respiratory infections collected in the Mohamed V hospital laboratory over a three-year period (2017-2019). For this purpose, different clinical (acute infections, angina, acute bronchitis …), biochemical and microbiological variables that are noted in the registers of Microbiology laboratories of Hospital of Meknes are collected on pre-established sheets for each case.

Bacterial isolation and bacterial resistance frequency

7863 patients attending the outpatient of different departments of Mohamed V hospital diagnosed with respiratory infections were involved in the preparation of the current study.

Clinical sampling

Respiratory infection was carefully diagnosed. Pleural fluid, nasal sections, throat and protected distal sampling were collected from different patients and sent for further microbiological analysis [14].

The germs were isolated using several culture mediums, including chapman agar, cysteine-lactose-electrolyte-deficient agar and chocolate agar. The microorganisms were identified based on cultural, morphological, and biochemical characteristics, supplemented with other assays, including Gram coloration, catalase, cytochrome oxidase and emission of gas bubbles [15].

Antibiogram

The antimicrobial susceptibility assays were conducted on Muller-Hinton agar according to

the method of the Kirby-Bauer disk diffusion [16]. The antibiotic agents tested were: Amoxicilline (AML) 25 µg, Amoxicillin+clavulanic acid 25/20µg (AMC), cefoxitin 10µg (FOX), ceftazidime 30µg(CAZ), cefotaxime 30µg (CTX), imipenem 10µg (IMP), trimethoprim/sulfamethoxazole 1.25/23.75µg(SXT), ciprofloxacin 5µg (CIP), amikacin 30µg (AK), penicillin G 6µg (PenG), erythromycin 30µg (ERY), tobramycin 10µg (TOB), tetracycline 30 µg(TET), colistin 50µg (CL), vancomycin 30µg (VAN), antibody antibiotic conjugate (TAC), fusidic acid 10µg (FA), levofloxacin 5µg (LE), gentamicin 10µg (GEN), rifampicin 30µg (RA), and netilmicin 30µg (NET). Resistance results were evaluated in accordance with Clinical and Laboratory Standards Institute [17].

Ethics and confidentiality

The protocol for the study was approved by the ethics commission of the Regional Delegation of Public Health of the Littoral. The confidentiality of the information was respected since the names of the patients did not appear on the study documents.

Statistical analysis

The statistical analysis was performed by multiple comparison (Tuckey test) at a significant level of 95% ($p<0.05$). The findings were executed using Graph Pad Prism 5 software.

Results

Distribution of diagnosed patients according to gender

The current study included 7863 patients who were hospitalized and tested for respiratory infections during 2017-2019. During 2017, the percentage of hospitalized patients was equivalent to 33.6% of cases, and during the year 2018, this percentage increased by roughly 4.61% before decreasing by 10.03% in 2019.

It is clearly seen that men represent the highest proportion of patients with a percentage of 61%, whereas females represent 39% of all hospitalized patients.

Distribution of diagnosed patients according to the hospital department

Figure 1 displays the obtained results of frequency of distribution of respiratory infections among all patients. The treatment of the obtained results revealed that the highest frequency was recorded in the department of pulmonology with a percentage of 62.60% followed by department of internal medicine (14.63%) and the department of gastroenterology (13.55%). Whereas, the lowest frequencies were registered in both departments of neurology and emergency with proportions of 0.27% for each.

The results of the seasonal distribution are presented in **Figure 2**. The results are expressed as the average infection proportions of each season during the three-years. The analysis of results showed that the highest percentage of patients affected was registered during spring season with a value of 37.6% followed by winter season with a percentage of 27.1%. Whereas, the lowest percentage of patients affected according season was registered during autumn with a value of 15.4%.

Bacteriological analysis

The results of bacteriological analysis are depicted in **Figure 3**. Microbial identification assays revealed that 90% of isolates are Gram-positive bacteria. It is clearly seen that *Streptococcus pneumoniae* represented 85% of all bacterial strains identified followed by *Escherichia coli* and *Staphylococcus aureus* with proportions of 10% and 5%, respectively.

During the three years and among the 10 hospital departments where the infections were identified, we remark that 6 departments (60%) had bacterial infections. Most of these infections were concentrated in the pulmonology department at a frequency of 65% **(Table 1)**.

S. pneumoniae is more frequently isolated in pulmonology department. *E. coli* is isolated only in two departments (Pulmonology and gastroenterology). Whereas, *S. aureus* was isolated only in the pediatrics department.

Bacterial resistance frequency

The sensitivity of bacterial strains isolated from different patients diagnosed at different Mohamed V hospital departments is presented in **Table 2**. The results showed that all three bacterial strains isolated from patients were resistant to at least five antibiotics. *Escherichia coli* was the most resistant among the isolated bacterial strains with frequencies of 100%, 85%, 84%, 75%, 45%, and 43% against AML, CIP, AMC, FOX, CAZ, and CTX, respectively. However, *S. pneumoniae* and *S. aureus* showed mild resistance against the different antibiotics tested with a percentage that did not exceed 59%.

Table 1. Frequency of bacterial species according to the hospital services.

Department	**Number of bacterial species**			
	S. pneumoniae	***E. coli***	***S. aureus***	**Total (%)**
Pulmonology	12	1	0	13(65%)
Pediatrics	1	0	1	2 (10%)
Surgery	2	0	0	2 (10%)
Cardiology	1	0	0	1 (5%)
Medicine	1	0	0	1 (5%)
Gastroenterology	0	1	0	1 (5%)

Table 2. The resistance frequency of different bacterial strains isolated from patients diagnosed with bacterial respiratory infections.

	AML	AMC	FOX	CAZ	CTX	IMP	SXT	CIP	AK	PenG	ERY	TOB	TET	CL	VAN	TAC	FA	LE	GEN	RA	NET
Escherchia coli	100	84	75	45	43	0	57	85	42	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
S. pneumonia	28	ND	ND	ND	19	ND	ND	ND	ND	52	59	31	17	8	ND	ND	ND	ND	ND	ND	ND
S. aureus	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0	0	54	50	45	17	11

ND: Not determined

Figure 1. Distribution of the patients according to the hospital department.

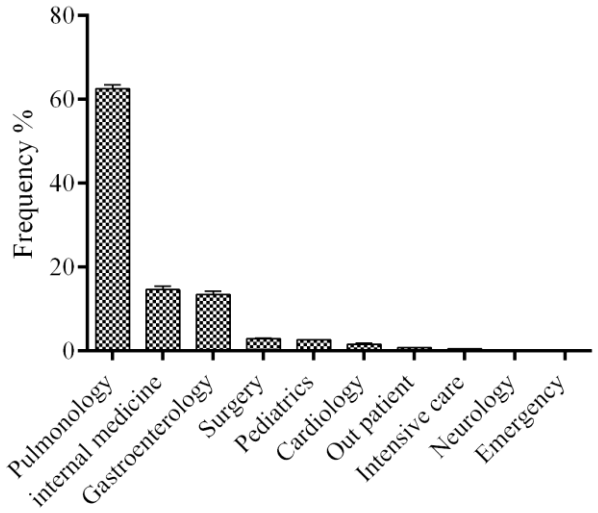


Figure 2. Seasonal distribution of respiratory infections according to the seasons.

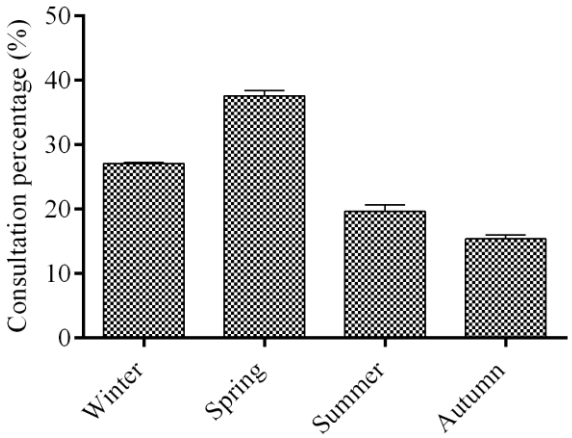
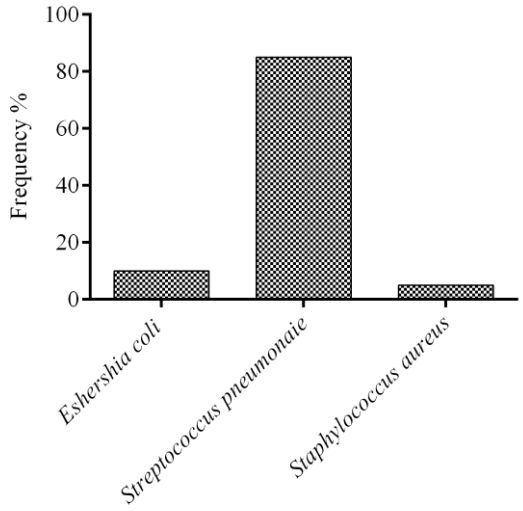


Figure 3. Distribution of identified bacterial species.



Discussion

Respiratory infections are a serious challenge of human health and healthcare systems. They can have very varied clinical manifestations depending on the site of infection, patient dietary status, pathophysiology, and immunological system. Respiratory infections are one of the top causes of death worldwide. It is the primary reason for a consultation and prescription in the practice of general medicine. The prevalence of these infections in populations varies according to different factors, including the year, the country , the monitoring systems, and the level of health prevention [18]. Within this framework, the present study was undertaken for the first time to study the bacterial respiratory infection epidemiology in Mohamed V hospital during three years (2017-2019). The findings revealed that the males were the most individuals affected by bacterial respiratory infections. Furthermore, *S. pneumoniae* was the main responsible pathogenic bacteria of bacterial respiratory infections, which presents mild resistance against numerous antibiotic agents. The ministry of health reported that respiratory infections are a serious health challenge and represented approximately 5.5 million medical consultations [19].

The monthly and seasonal distribution of these infections at Mohammed V Hospital in Meknes revealed that respiratory infections are particularly common in the spring, especially in March, April and May. Furthermore, Elhella and Lahrach demonstrated that respiratory infections are extremely common throughout the winter season, particularly January, February and March [20]. The obtained results from this study are in accordance with those of a retrospective study conducted at the military hospital, Rabat. The sampling method used to examine respiratory infections is always determined by the site of infection and the patient's terrain. The authors reported that more than 90% of the proven microbiological infections are caused by *S. pneumoniae*, *H. influenzae*, *M. pneumoniae*, *L. pneumophila*, *C. pneumonia* and *S. pneumonia*, which are the most common cause of hospitalization [21,22]. In fact, the results of the present study demonstrated that the *S. pneumonia* is the most frequently isolated (85%). It has been found that *S. pneumonia* is pathogenic bacterial strain causing pneumonia, otitis media, sepsis, and meningitis [23]. In the same context, numerous studies reported the same findings reporting that *S. pneumonia* is the main reason of bacterial respiratory infections with a proportion of 50.5% [24,25]. Interestingly, the bacterial strains detected and identified showed high variability of resistance against several antibiotics, particularly *Escherichia coli* **(Table 2)**. Pathogenic bacteria develop antibiotic resistance throughout different strategies, including target modification and efflux transporters [23]. Due to the occurrence of negative side effects and elevating risk of resistance to the antibacterial agents, there has been a real need to in the quest of natural alternatives.

Conclusion

The overall outcomes of the current study revealed that the respiratory infections are common throughout the spring season, with men being the

most impacted. Respiratory infections are primarily caused by *S. pneumonia*, which affects the respiratory tract. The current study investigated the progression and prevalence of the respiratory infections at Mohamed V hospital, Morocco. These infections are widespread in the spring months, when the majority of the patients have been admitted to the pulmonology department.

Author contributions

All authors have read and approved the final version of the manuscript for publication.

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The study received no financial support or sponsorship.

Conflicts of interest

The authors declare no conflicts of interest related to this research.

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