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### Evaluation of Polymicrobial Pulmonary Infections during Five Years at a Tertiary Hospital in Mashhad, Eastern Iran

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#### ABSTRACT

**Background:** Lung infection is a global health problem associated with high morbidity and mortality world-wide and increasing rates of hospitalization. Polymicrobial Pleuropulmonary infection is defined as the simultaneous isolations of two or more other organisms from lung secretions culture which are associated with increased infection severity outcome compared to monomicrobial Pleuropulmonary infections. The aim of this study is evaluation of polymicrobial pulmonary infection rate during March 2019 to February 2024 at a Tertiary Hospital in Mashhad, Eastern Iran.

**Methods:** This single-center retrospective study was conducted from March 2019 to February 2024 in Shahid Kamyab Hospital, Mashhad, Iran. Our data in this study included 429 patients with pulmonary infection in the five years studied, which 34 patients were under 18 years old and 395 patients were over 18 years old. The total number of positive lung samples of these patients was 532. In this study, we investigated the prevalence of polymicrobial lung infections along with the bacteria that cause them.

**Results:** A total of 532 positive lung culture specimens were included, which 196 cases were polymicrobial (36.8 %) and 336 cases were monomicrobial (63.2 %). This study showed that *Acinetobacter baumannii* had the most frequency among other bacteria which cause polymicrobial pulmonary infections (32 %).

**Conclusion:** Pulmonary infection is a serious complication, which significantly increases mortality rate and medical costs(1). In this retrospective study we have found that polymicrobial pulmonary infections in patients in this hospital was 36.8 % that *Acinetobacter baumannii* was the most cause of infections.

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## Introduction

Infections in humans occur in complex niches (1, 2). The interaction between microorganisms is complicated and involves competition for space and nutrients (3, 4). Polymicrobial infections are the presence of two or more pathogens which one micro-organism generates a niche for other pathogenic micro-organisms to colonise, in other hands, one micro-organism predisposes the host to colonisation by other micro-organisms. Polymicrobial diseases, caused by combinations of viruses, bacteria, fungi, and parasites (4, 5). Polymicrobial infections are often associated with increased infection severity outcome compared to monomicrobial infections due to pathogens cooperative interaction (2, 6, 7). In fact, microorganisms can interact synergistically that promote polymicrobial infections by inducing virulence traits, alter the infected niche and modulate the host immune response (7). Lung infection is a global health problem associated with high morbidity and mortality world-wide and increasing rates of hospitalization (8, 9, 10). Among all diseases, respiratory tract infections have the greatest burden on human health with a two and six-fold greater disability-adjusted life years compared to ischaemic heart disease and diabetes mellitus, respectively (10).

A variety of microorganisms can infect the lungs including viruses, bacteria, fungi, and parasites. Gram-positive and negative-bacteria are a common cause of pulmonary infection (11). Lung infection with two or more dominant organisms, known as polymicrobial pneumonia. Pleuropulmonary infections include bronchitis and bronchiolitis, pneumonia, lung abscess, cavity formation and empyema. Sputum, bronchoscopic brushing washing and Bronchoalveolar lavage (BAL) are useful procedures that can provide a fast, cost-effective and noninvasive diagnosis of pulmonary infection (9, 11). The aim of this study is evaluation of polymicrobial pulmonary infection

rate during March 2019 to February 2024 at a tertiary hospital in Mashhad, Eastern Iran.

## Materials and Methods

This single-center retrospective study was conducted from March 2019 to February 2024 in Shahid Kamyab Hospital, A Tertiary teaching Hospital connected to Mashhad University of Medical sciences, a 325-bed healthcare facility in Mashhad, Iran. Due to the retrospective nature of the study, the Ethics Committee determined that no patient consent was required. In addition, a statement of permission from patients for submission was not required as the study did not include any personal information. The patients' data were collected by hospital's health information system (HIS). We recorded demographic data including age and clinical microbiological data were collected including mono-microorganism and poly-microorganisms in Pleuropulmonary infections. Our data in this study included 429 patients with pulmonary infection in the five years studied, which 34 patients were under 18 years old and 395 patients were over 18 years old. The total number of positive lung samples of these patients was 532. In this study, we investigated the prevalence of polymicrobial lung infections along with the bacteria that cause them. The examined samples included lung secretions, bronchial trachea, sputum and pleural fluid.

## Results

A total of 532 positive lung culture specimens were included, which 196 cases were polymicrobial (36.8 %) and 336 cases were monomicrobial (63.2 %) (Fig. 1).

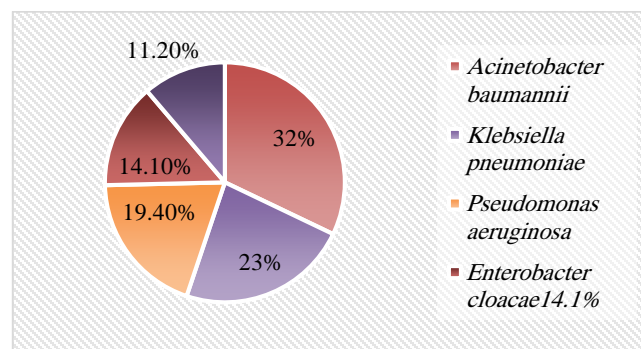
Our study demonstrated that the most common bacteria causing polymicrobial pulmonary infections in this hospital during these five years included *Acinetobacter baumannii*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Enterobacter cloacae* and *Escherichia coli*.

**Table 1.** The most frequent bacterial causes of polymicrobial pulmonary infection (2019-2023) (%).

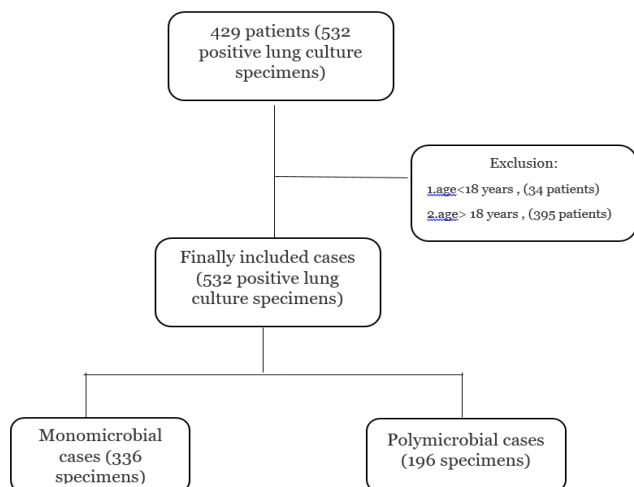
	<i>A. baumannii</i>	<i>K. pneumoniae</i>	<i>P. aeruginosa</i>	<i>E.cloacae</i>	<i>E. coli</i>
2019	34.50	16.30	23.60	12.70	12.70
2020	30.40	21.70	13.10	23.70	9.00
2021	31.50	25.00	19.50	17.30	6.50
2022	30.70	29.80	17.50	9.60	12.20
2023	27.70	22.20	16.60	11.10	22.20

Meanwhile, *Acinetobacter baumannii* 32% (119 cases), *Klebsiella pneumoniae* 23% (88 cases), *Pseudomonas aeruginosa* 19.4% (73 cases), *Enterobacter cloacae* 14.1% (53 cases) and *Escherichia coli* 11.2% (42 cases) (Fig. 2). In addition this study showed that *Acinetobacter baumannii* had the most frequency among other bacteria causing polymicrobial pulmonary infections.

complication which significantly increases mortality rate and medical costs (1).



**Fig 2.** The most bacteria causing polymicrobial pulmonary infection during five years.



**Fig 1.** Flowchart of study participant enrollment.

### Discussion

The lungs are a portal between the ambient environment and the internal milieu therefore they can be considered as a frequent site of infectious diseases. Pulmonary infection is a serious

As a large variety of microorganisms can infect the lungs, the optimal treatment of infection requires diagnosing its cause. Most Gram-negative bacilli produce a necrotizing bronchopneumonia with hemorrhage and abscess formation. Certain virulent Gram-negative species including *Klebsiella*, *Pseudomonas* and *Acinetobacter*, have a propensity to infect the lungs (12). In this retrospective study we have found that polymicrobial pulmonary infections in patients in this hospital was 36.8 % that *Acinetobacter baumannii* was the most cause of infections (32%). Qiu-Mei Cao et al (2019) demonstrated that Gram-negative bacteria were the main cause of pulmonary infection in hospitalized patients (75.6%) which these bacteria were mainly *Acinetobacter baumannii* and *Pseudomonas aeruginosa* (1). Also This is similar to the result reported by Zongding Zeng (13). Therefore the

clinical course and outcome of polymicrobial infections are more severe compared to monomicrobial infections (13).

## Conclusion

Pulmonary infection is an important cause of morbidity and mortality worldwide. Various microorganisms can cause it which Gram-negative bacteria including *Klebsiella*, *Pseudomonas* and *Acinetobacter* have a propensity to infect the lungs. Meanwhile, *Acinetobacter baumannii* is the most important member associated with hospital-acquired infections worldwide.

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## Ethics approval and consent to participate

Not needed.

## Conflict of interest

None declared.

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