

Review Article

Pseudomona Aeruginosa: A Challenge for Intensive Care Units

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Abstract: *Introduction:* Pseudomonas Aeruginosa is one of the main gram-negative germs that cause nosocomial infections, very frequent in intensive care units, with an increase in antimicrobial resistance in recent years. The World Health Organization (WHO) expressed the existence of a problem that threatens modern medicine: bacterial resistance together with infections associated with healthcare. *Objectives:* to carry out a bibliographic review on the incidence of Pseudomonas Aeruginosa in intensive care units and its presence as a causal agent of coinfection in patients with COVID-19. *Methods:* a search of articles was carried out in internet search engines in Spanish and English such as: Pubmed, Medline, Academic Google, Dialnet; of articles published in the last ten years in Spanish or English, the term Pseudomonas Aeruginosa was used as the only descriptor in intensive care units, COVID-19. *Conclusions:* in almost all patients with nosocomial infections, mainly those with pneumonia associated with mechanical ventilation, the common denominator is the isolation of Pseudomona Aeruginosa in at least one of the cultures performed. This situation is maintained as a problem to be solved that shows greater complexity in the context of the current pandemic. Is necessary to establish new cross infection control measures and analyze other therapeutic alternatives if one takes into account that resistance has been increasing in recent years.

Keywords: Pseudomona Aeruginosa, Nosocomial Infection, Intensive Care Unit

1. Introduction

In April 2014 the World Health Organization (WHO) expressed the existence of a problem that threatens modern medicine: bacterial resistance together with infections associated with healthcare. In the particular case of Pseudomona Aeruginosa, he recognized it as the main cause of infection in hospital institutions. [1]

P. aeruginosa is one of the main Gram negative germs that cause nosocomial infections (NI), very significant in intensive care units (ICU). In recent years, an increase in resistance to antimicrobials, including carbapenems, has been observed, associated with an increase in mortality. [2]

The bacterial genus Pseudomonas was first described in the late 19th century by Professor Walter Migula of the Karlsruhe Institute in Germany. I would describe it as a microorganism of (...) "Cells with polar organs. The formation of spores occurs in some species, but it is rare"(...) Later it is detected that what the professor called "spores" were actually refractiles granules of reserve materials. This is how the term

"Pseudomonas" originates, it etymologically refers to "false units or cute". [3]

The term "Aeruginosa" was described by the researcher Schroeter in the year 1872. It alluded to the colors that the bacterium took under culture conditions, similar to oxidized copper, as a bluish-green. Shroeter considered this to be due to a water soluble pigment. In his account he proposed the name for the newly grown bacterium as Bacterium aeruginosum. [3, 4]

Transmission occurs through contact with damaged skin or mucous membranes. In the healthcare field, they constitute a source of infection for patients, surgical instruments, respirators, catheters or contaminated hands of healthcare personnel, among others. [5]

Despite the advances in the use of antibiotics and the improvement in the different preventive measures, NIs remain as a cause of associated mortality. Multiple studies define it as that which occurs 48 hours after hospital admission and its treatment depends on the severity and on many occasions it has to be approached in critical care units. [6]

NI represent an epidemiological and clinical problem of great magnitude because, at the same time that they increase morbidity and mortality rates, they lengthen the days of hospital admission and prolong the economic cost of the same [7, 8]

In countries such as Spain and the United States, the incidence of *P. aeruginosa* is 10% and 25%, figures may vary depending on the type of hospital, antimicrobial therapies and the underlying disease of the patients who are admitted, with a rate mortality that can be between 35-70% depending on its location. [2, 9] In Cuba, it has remained among the first three high-risk germs that cause sepsis in the different hospital services. [10]

ICUs are considered high-risk areas with an incidence of NI between two and five times higher than other hospital areas due to the use of invasive procedures such as vascular accesses, endotracheal tubes or urinary catheters, among others. [2]

The personnel who attend to patients in these services have been implicated as a reservoir and vector of outbreaks, the transmission of *Pseudomonas* through their hands has been considered a frequent mechanism in infections of this type. This germ reaches hospital institutions through water, bathroom drains, in various liquid supplies. This is why hospitals have been postulated as one of the main reservoirs of *P. aeruginosa*, which causes its environmental dissemination and persistence, with a high incidence in ICUs, where it is a frequent cause of pneumonia associated with mechanical ventilation (PAMV). [10]

This microorganism has two very important characteristics that make it an extremely dangerous pathogen: intrinsic resistance to antibiotics and the production of virulence mechanisms. [11]

In 2017, the WHO issued a statement related to a list of bacteria for which new antibiotics were urgently needed, in the second place of the Priority 1 (Critical Priority) list was *P. aeruginosa*. [11]

Due to their ability to acquire new mechanisms of resistance to a wide variety of antimicrobials such as carbapenems, fluoroquinolones and aminoglycosides, the increase in the prevalence of IN by multiresistant *P. aeruginosa* strains, limits the therapeutic options and becomes a challenge for the patient. medical equipment in many hospital services but significantly in ICUs.

Currently, in the context of COVID-19, it is usual to prescribe antimicrobials to patients with suspected or confirmed SARS-CoV-2 infection, although the use of the drugs does not show effectiveness, they are recommended in many cases due to the difficulty to rule out a coinfection or a secondary bacterial infection. A situation that is worrying given the potential excessive use of antibiotics and the possible damage associated with resistance. *P. aeruginosa* is among the most frequent germs detected in patients with COVID-19 admitted to the ICU.

The objective of this work is to carry out a bibliographic review on the incidence of *P. aeruginosa* in ICUs and its presence as a causal agent of coinfection in patients with COVID-19

2. Methods

A search was carried out for articles related to the incidence of nosocomial infections in intensive care units, caused by *Pseudomona Aeruginosa* and its presence as a causal agent of coinfection in patients diagnosed with COVID-19. The search was carried out in the months of April and May of the year 2021.

Internet search engines in Spanish and English were used such as: Pubmed, Medline, Academic Google, Dialnet; of articles published in the last ten years in Spanish or English, the term *Pseudomonas Aeruginosa* was used as the only descriptor in intensive care units, COVID-19.

From this search, those studies that were useful for the development of this research work were selected.

The study obtained the approval of the scientific council and research department of the institution, the results of which will only be used for research purposes. The ethical principles, dictated in the Declaration of Helsinki, [12] for medical research on human beings were respected.

3. Background

Critically ill patients are highly vulnerable to NI, it is estimated that between 9% - 20% of them will present an infection during their hospitalization in the ICU, in this sense different predisposing factors converge. [13]

- 1) Immunosuppression secondary to drugs (chemotherapies, steroids)
- 2) The pathology that led to their admission to the ICU (mainly surgical ones)
- 3) During their stay they are subjected to many invasive procedures, which favors cross infections.

This growing prevalence of NI and antimicrobial resistance, involves very significantly strains of *P. aeruginosa*, sometimes it can cause pan-resistance to all available antibiotics, which compromises the choice of an effective treatment, therefore it is associated with a high morbidity and mortality. [14, 15]

In an analysis of the impact of bacteraemia in a tertiary hospital in Spain, a significant percentage of the episodes occurred in the ICU, and in most patients the previous colonization by *P. aeruginosa* was already documented, in which the the most frequent location was the respiratory tract. [16]

In 2012, in research carried out in the ICU of the "Gustavo Aldereguía" hospital in the province of Cienfuegos, *P. aeruginosa* was the most prevalent germ in patients with VAP in a surgical ICU, mainly in polytraumatized patients. [17]

On the other hand, the polyvalent ICU of the Hospital "León Cuervo Rubio" in Pinar del Rio in research carried out in the period 2017 - 2018 *P. aeruginosa* was isolated in a large number of cultures of respiratory secretions with a frequency that exceeds that of other microorganisms such as *Acinetobacter Baumani* and *Klebsiella Pneumoniae*, highly prevalent in these services. [18]

A similar result was obtained in research carried out in the

ICU of the National Center for Minimal Access Surgery on incidences and causes of sepsis, in 2020, *P. Aeruginosa*, according to its authors, was presented as the germ with the highest frequency. [19]

In another more recent study carried out in Cuba that involved ten ICUs (seven for adults and three for pediatric patients), an increase was observed in the prevalence of infections associated with health care, mainly VAP, where the causative microorganism with the greatest recurrence was *P. aeruginosa*. [20]

The literature reviewed describes that at least 40% of *P. aeruginosa* strains show resistance to at least one carbapenem and 39% are intermediate sensitive or resistant to imipenem. In vivo studies indicate that the global prevalence of strains not sensitive to piperazilin / tazobactam is 25%, however in Latin America it can reach 37.2% [21]

Currently, the pressure exerted by the COVID-19 pandemic on health systems worldwide has required immediate and unprecedented responses to control the spread and at the same time protect the most vulnerable. The use of antibiotics as part of the intervention package runs the risk of leaving us a more dangerous legacy: the marked increase in resistance to antibiotics. [22]

Patients admitted to the ICU for COVID-19 have a predisposition to bacterial and fungal infection, due to the action of the SARS-CoV 2 virus, the release of cytokines and the weakening of the immune system, in addition to the influence exerted by the patient characteristics and the presence of comorbidities such as diabetes mellitus and chronic kidney failure. [23]

According to a study carried out at the University Clinical Hospital in Valladolid, the incidence of coinfection of patients with COVID-19 in Spain during the first wave of the pandemic was similar to that observed in the Wuhan hospital (China) and in hospitals in the United Kingdom, in both with high mortality in ICUs. [2, 3]

The number of patients with COVID-19 in whom coinfections have been detected is lower when compared to other coronaviruses. However, this could be the explanation for the high administration of even broad-spectrum antibiotics. [24]

In order to analyze the global percentage of confirmed acute bacterial infections in patients with COVID-19, a rapid systematic review was carried out, which included 28 studies in countries such as China, the United States, and Spain. A randomized meta-analysis was performed and the presence of bacterial coinfection in the course of the disease was identified in multiple patients; the results reported that the most frequent pathogen was *Haemophilus influenzae* followed by *P. aeruginosa*. [25]

In an international survey completed by different doctors from more than 20 countries, with the aim of investigating the pattern of antibiotic prescription in patients with COVID-19, they rated the need for coverage of atypical pathogens as high, followed by *Staphylococcus aureus* and *P. Aeruginosa* patients admitted to the ICU. [26]

In Cuba, the confrontation with the COVID-19 pandemic

has constituted a challenge for health professionals, especially for those who work in critical patient care units, a study similar to the one published was developed at the Villa Clara Military hospital by the Clinical Microbiology and Infection site. With an important predominance of *E. Coli* and secondly, *P. aeruginosa* as a coinfection in these patients [24].

In the literature review, no other works carried out in Cuba in relation to this topic were found, which is why it was possible to establish comparisons between the different institutions that care for patients with COVID-19.

4. Conclusions

Despite the prevalence of microorganisms in ICUs such as *Acinetobacter Baumannii*, *Klebsiella Pneumoniae*, *Staphylococcus aureus*, among others; The presence of which is favored by dissimilar factors, highlights that in almost all patients with nosocomial infections, mainly those with PAMV, have as a common denominator the isolation of *P. aeruginosa* in at least one of the cultures performed.

This makes it necessary to establish new cross infection control measures and analyze other therapeutic alternatives if one takes into account that resistance has been increasing in recent years.

NIIs in ICUs remain a problem to be solved that is currently becoming more complex due to the significant number of SARS CoV-2 positive patients admitted to these services, because in general they are high-risk patients, which It causes the combination of many factors to generate serious, life-threatening complications for the most part.

Conflict of Interests

The author does not declare that she has no conflict of interest.

Declaration of Authorial Contribution

Evelin Noriega Campos: idea of the study and the research design, carried out the data collection, the bibliographic review, wrote the manuscript, revision and approval of the final version.

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