

The use of Biomaterials in Infection Prevention in the Hospital Environment

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Abstract

Biomaterials are increasingly gaining space in the hospital environment because they provide researchers with a broad investigative aspect to compose new strategies for use in clinical practices. In this context, the present study aims to investigate the use of biocompounds with antimicrobial action as an alternative in the coating of surfaces in the hospital context. Thus, the guiding methodology of this study was a narrative review of the literature. To this end, the following databases were consulted: PubMed, Embase, Lilacs, using the PICo strategy and subjected to the following descriptors: ("Biomaterial" OR "Biopolymer" OR "Polymer"); AND ("Nosocomial infections") AND ("RCT OR randomized OR random OR case-control"). It was observed in this study a wide use of biomaterials, especially hydrogels related to natural compounds with the purpose of promoting antimicrobial action in the hospital environment, fighting pathogens, especially bacteria and fungi, which are responsible for most hospital infections. Furthermore, the use of copper and chitosan nanoparticles for coating dental and medical materials was verified, with bactericidal activity for the pathogens *Staphylococcus aureus* and *Pseudomonas aeruginosa*, affirming that the development of these surfaces is a promising tool against infections acquired in the hospital environment. Thus, the results obtained report a new perspective on combating antimicrobial agents responsible for aggravating patient life in the hospital setting.

Introduction

In the hospital environment, surfaces and objects such as syringes, scissors, catheters are more prone to the development of bacterial contamination, characterizing a potential mode of infection transmission in this environment [1]. Thus, microorganisms commonly acquired in this environment are characterized by presenting resistance to drugs, such as antibiotics and antimicrobial agents, especially strains of *Staphylococcus aureus* and *Pseudomonas aeruginosa*, which are the most responsible for the development of bacterial biofilms and transmission of infections [1,2].

Thus, the scarcity of drugs with effective action generates the need for measures that mitigate this problem. At the same time, antimicrobial coatings have presented themselves as a new aspect of research, in order to contribute positively to the progress of science in this field. In this context, biomaterials gain prominence, through sets of synthetic or natural substances, which aim to replace non-functional matter with biocompatibility, accessibility, biodegradability in certain situations [3]. Thus, the applicability

of these materials in hospital environments in order to prevent the formation and proliferation of microorganisms is considered [2].

In this prism, it is coherent to emphasize the necessity of involving interaction of the living organism with the biocompounds, besides promoting biocompatibility in possible cases of surgery [4]. A vast number of these products are available on the market. One can mention biomaterials in the composition of intravenous catheters as prevention of phlebitis, such as the use of vialon, which demonstrates a lower rate of inflammation when compared to Teflon catheters. Or even, endotracheal tubes coated with biocompounds, which present themselves as a good proposition in preventing the formation of bacterial biofilms helping to prevent infections, are examples of strategies with good results in the hospital context [5,6]. In this conjuncture, the need to explore and develop research aiming at the promotion and application of these strategies as methods and treatment prophylaxis is exalted, as well as for exposing and reviewing data

already available on the theme in the scientific literature. Thus, the study aims to describe the potential of the use of biomaterials in the hospital context aiming at preventing infections in patients.

Methodology

Characterization of the study

A narrative of the scientific literature was conducted as a methodological tool to conduct this study. It is a qualitative and descriptive study, which used the scientific bibliography to expose the theme. Thus, the analysis developed had the purpose of prioritizing the capture of the most relevant data in order to obtain a critical view of the subject.

The conception of the state of the art on the chosen theme occurred from a broad search, subsidized by the protocol mentioned by Almeida *et al.* [7] The synthesis of this article occurred from the elaboration of the guiding question. For this purpose, the acronym PICO, corresponding to population/interest/context of the research in question, was used.

Conducting the investigation

The study in question raised the question: "What is the effect of hospital materials coated with biomaterials (P), as an antibiotic therapeutic strategy (I), considering cases of infections developed from the use of these objects (Co)?" Moreover, the conduction of this investigation began during the months of January until March 2023 in online databases of scientific articles, such as PubMed, Embase, Lilacs. In this bias, descriptors were selected

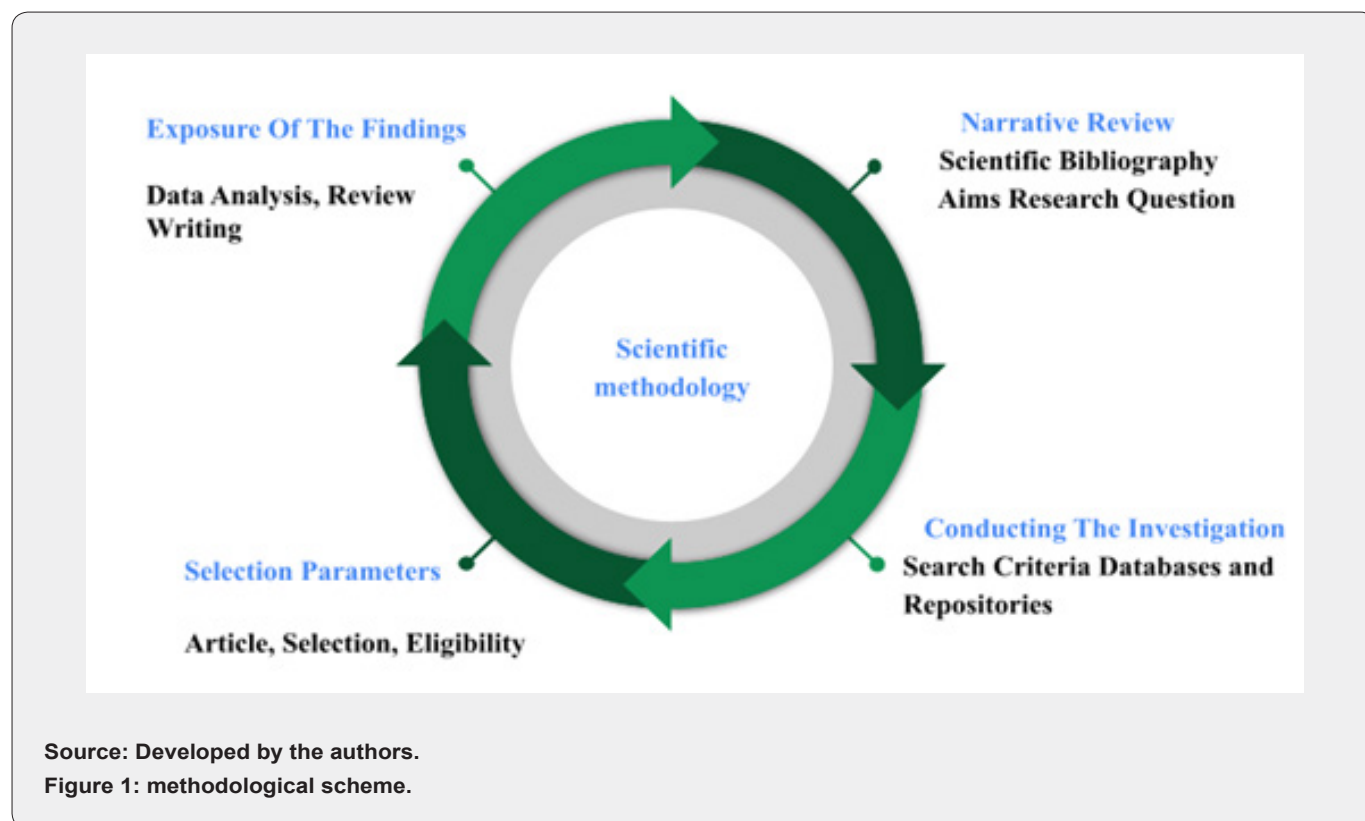
in the following search formula: ("Biomaterial" OR "Biopolymer" OR "Polymer";) AND ("Nosocomial infections") AND ("Biofilm" or "Antimicrobial" or "Antibiotic") AND ("RCT OR randomized OR random OR case-control"). For the success of this review, a time interval of the last 5 years was prioritized, however, there were no restrictions when the relevance of the data was perceived. The chosen studies expose directly in their title and abstract that their research refers to a look directed to the issues of nosocomial infections after the use of medical objects.

Selection parameters

This research selected and prioritized works published as scientific articles, written in the languages: Portuguese, English and Spanish. Soon after the selection of findings, the works that did not meet or were not formulated to answer the central question of this publication were excluded. Thus, the studies approved to compose this article had their most relevant information highlighted in order to contemplate the purpose of the scientific development of this work.

Presentation of the results and synthesis of the information

Thus, after contemplating each paper individually, the review was drafted to match the scope of the investigation. Illustration 1 shows the methodological step followed. It is consistent to point out that submission to the Ethics Committee was not necessary, since the samples are in the public domain (Figure 1).



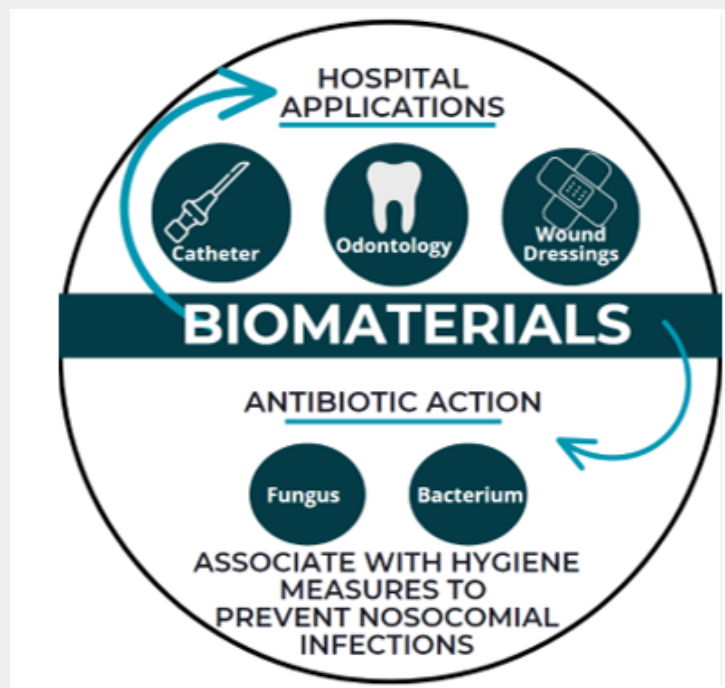
Results and Discussion

Currently, biocompounds have been gaining space in the biomedical and medical engineering area, because they present satisfactory results in the interaction in systems, such as coating objects, prostheses and implants and treatments of health problems [3]. Thus, the importance of such materials is perceived, because they present themselves as possibilities of innovation aiming to contribute with antimicrobial action against pathogens increasingly resistant to drugs.

That said, throughout the construction of this research, 11 studies were pre-selected, correlating natural or synthetic products with application in the hospital environment. Among

these, 7 were correlated to the use of biomaterials in the hospital environment and 4 presented data and studies only on synthetic or natural compounds. After the selection, the chosen works were analyzed in their entirety, highlighting the main data for later achievement of a more critical analysis regarding this issue.

The characteristics of the selected studies were, as to the methodological approach adopted by the authors, literature review, exploratory experimental method, and randomized study. The languages of publication were Portuguese and English, and the publication ranged from the years 2013 to 2021, being selected articles published in journals, as well as thesis results. The synthesis of the main results observed is shown in (Figure 2).



Source: Developed by the authors.

Figure 2: Summary of main findings.

In Heilman's study [8] a catheter with a polyurethane coating with silver nanoparticles was developed, and it was observed that the use in various polymers, such as polyurethane and silicone, resulted in excellent antimicrobial activity against a broad spectrum of organisms *in vitro*, such as growth and adhesion of *Staphylococcus aureus* on the device surface.

Andrade [9] produced a hydrogel combined with chitosan nanoparticles to combat infections and burns infected by bacteria of the genus *S. aureus*, demonstrating that the compound encapsulated in Nps-H proved to be 2 to 3 times more active than the free compound (C-H) against the tested strains, thus being a

possible application of the material in the treatment of infected burns.

Tavaria [10] studied chitosan as a biomaterial for coating dental objects, proving that the antioxidant, antimicrobial, healing power and anti-inflammatory action of this compound, inhibits the proliferation of biofilms potentiating the treatment of diseases associated with the oral cavity, especially *Streptococcus mutans*. Furthermore, it was observed that applying mouthwashes, toothpastes and dental materials based on chitosan can reduce and prevent the number of microorganisms present and accelerate the healing process.

Assunção [11] investigated copper-based coatings and their influence on the behavior of bacteria, and concluded that copper possesses bactericidal activity for the pathogens *Staphylococcus aureus* and *Pseudomonas aeruginosa*, stating that the development of copper surfaces are a promising tool against hospital-acquired infections.

Antezana [12] developed a biomaterial for coating dressings, with long-term antimicrobial effects from collagen directly related to hydrogel and silver nanoparticles against bacteria *S. aureus* and *P. aeruginosa*. Such compounds presented satisfactory results against infection caused by such pathogens and proved to be effective in wound healing application.

Gonçalves [13] performed a study testing the oil *Melaleuca alternifolia* Cheel, evaluating the antifungal activity of this compound against yeasts of the genus *Candida spp.* responsible for 80% of all hospital fungal infections. It was concluded that, the synthesized material showed a good fungicidal, stable and antioxidant action, revealing itself with great potential to combat these microorganisms.

From this, it is possible to demonstrate that biomaterials in the prevention of hospital infections have scientific support, but do not replace asepsis and sterilization strategies. Thus, it is proposed that a greater application of these compounds with antibiotic, antimicrobial, antioxidant potential and prevention of bacterial biofilm formation occur in the synthesis of such materials, in order to act together with the already recommended hygiene strategies to mitigate the number of infections acquired in these health institutions.

Conclusion

Given the tested and proven action in the most variable studies available in literature, biomaterials are revealed as a new potential alternative in the fight against multidrug-resistant pathogens. It is worth pointing out that these compounds have shown great relevance in several areas, from acting in the development of catheters, dental objects or wound coverings, proving to be a method of great versatility. Furthermore, it is of paramount importance to emphasize their high impact activities against pathogens that cause hospital infections, especially bacteria and fungi. Therefore, this study demonstrated the alternatives to combat the microorganisms that are in the hospital environment causing the worsening of the patient's health through biomaterials. However, it is clear the need for a greater research framework in this area, such as the development of more clinical studies. It is recommended, therefore, the use of these strategies concomitant to the hygiene conducts present in the hospital environment, to

achieve better results in fighting infection.

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