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REVIEW ARTICLE

Fungal osteomyelitis of immunosuppressed patients after cardiac surgery

Osteomielitis micótica de pacientes inmunodeprimidos tras cirugía cardíaca

Osteomielite fúngica de pacientes imunossuprimidos em pós cirurgia cardíaca

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Abstract

Objective: to know the social determinants of health that influence the lives of women victims of domestic violence. Method: Integrative literature review guided by the following question: What are the social determinants of health that influence the lives of women victims of domestic violence? The search was carried out in the databases: National Library of Medicine National Institutes of Health, Latin American and Caribbean Literature in Health Sciences, Web of Science, Cumulative Index to Nursing and Allied Health Literature and the Cochrane Library; articles published in the period from 2015 to 2019. Results: Ten studies were included in the selection, which after analyzed demonstrated the high prevalence of domestic violence, resulting from physical, sexual, emotional aggressions related to social determinants of health such as low educational level, time marriage, unemployment, culture, housing and food insecurity. Conclusion: The health determinants identified in the studies that most influence violence against women are related to the low level of education, economic condition and unemployment, which affect women are only physically, but psychologically, demonstrating the relevance of the study, in knowing the main determinants and to reverse the situation of violence against women.

Descriptors: Protocols; Surgical Wound; Adult; Immunosuppressants; Postoperative Care; Mycoses.

Resumén

Los pacientes que usan fármacos inmunosupresores tienen un alto riesgo de desarrollar infecciones posoperatorias. Y no necesariamente serán bacterianos. Las infecciones por hongos son de baja incidencia, pero no existen. Los pacientes inmunodeprimidos en el postoperatorio de cirugía cardíaca pueden desarrollar osteomielitis fúngica en la esternotomía. Así, el problema de investigación a investigar fue: ¿Cuál es la ocurrencia de osteomielitis fúngica y las conductas a adoptar en pacientes adultos inmunosuprimidos en el postoperatorio de cirugía cardíaca? Es una revisión integradora, buscando estudios de los últimos 10 años en la BVS regional y Google Scholar. Se seleccionaron 13 estudios que cumplieron con los criterios de inclusión y exclusión. Se concluyó que la detección precoz de la infección por hongos es muy importante para la reducción de la mortalidad y un mejor pronóstico. La reacción en cadena de la polimerasa es el método más eficaz para la detección temprana de infecciones por hongos. En base a esto, se elaboró un diagrama de flujo de hospitalización para pacientes inmunosuprimidos.

Descriptores: Protocolos; Herida Quirúrgica; Adulto; Inmunosupresores; Cuidado Postoperatorio; Micosis.

Resumo

Pacientes em uso de drogas imunossupressoras são de alto risco para o desenvolvimento de infecções pós-operatórias. E não necessariamente serão bacterianas. As infecções fúngicas são de baixa incidência, mas não inexistentes. Pacientes imunodeprimidos em pós-operatório de cirurgia cardíaca podem desenvolver osteomielite fúngica na esternotomia. Dessa forma, o problema de pesquisa a ser sondado foi: Qual a ocorrência de osteomielite fúngica e condutas a serem adotadas à pacientes adultos imunossuprimidos em pós-operatório de cirurgia cardíaca? Trata-se de uma revisão integrativa, com busca de estudos dos últimos 10 anos na BVS regional e Google Scholar. Selecionou-se 13 estudos que atendiam os critérios de inclusão e exclusão. Concluiu-se que a detecção precoce da infecção fúngica é muito importante para a diminuição da mortalidade e melhor prognóstico. A Reação em Cadeia da Polimerase é o método mais eficaz para a detecção precoce da infecção fúngica. Baseado nisso foi criado um fluxograma de internação de pacientes imunossuprimidos.

Descritores: Protocolos; Ferida Cirúrgica; Adulto; Imunossupressores; Cuidados Pós-Operatórios; Micoses.

Introduction

Postoperative complications still frequently occur in patients undergoing this procedure. These complications are almost always related to infection of the surgical wound.

The preoperative period is a crucial stage for the realization of the nursing process, with a thorough investigation of the patient's history and establishment of the care plan. This step needs to be done in a multidisciplinary way, which is not usually part of the hospital units. In addition, there are many failures in this process.

The specifics of patients are often not given due attention. Patients using immunosuppressive drugs, for example, with a history of organ transplantation, are at high risk for the development of postoperative infections. And they will not necessarily be bacterial.

Fungal infections are low in incidence but are non-existent. However, if the patient's entire history is performed properly, it is possible to predict this complication. And when it occurs, the existence of an admission flow chart for immunodepressed patients would assist in the conduct of the diagnosis. Immunodepressed patients in the postoperative period of cardiac surgery may develop fungal osteomyelitis in the sternotomy, however this occurrence is so rare that many times its possibility is not considered.

Deep sternal wound infections (DSWI), including osteomyelitis, are potentially fatal complications after cardiac surgery and are caused mainly by staphylococci and gram-negative bacteria. Thus, chronic sternal osteomyelitis caused by colonization by fungi is a rare entity in the clinical routine.[1]

Given the above, the research problem to be investigated is: What is the occurrence of fungal osteomyelitis and conducts to be adopted to adult immunosuppressed patients in the postoperative period of cardiac surgery?

To answer this question, the objective was to carry out a literature review in order to seek scientific evidence on the occurrence of fungal osteomyelitis and the conducts adopted in the face of the problem in immunosuppressed adult patients in the postoperative period of cardiac surgery.

Methodology

It is an integrative literature review. The search in the bibliographic base was carried out in April 2020 and used the Health Sciences Descriptors (DeCS) that index the articles, combined with other terms contained in titles and abstracts. Chart 1 illustrates the search equation used in the VHL Regional Portal. Google Scholar searches were also carried out, with the descriptors separated and together, where a total of 3076 studies were found, of which 13 were selected that satisfied the research.

Inclusion Criteria: studies in Portuguese, English and Spanish related to fungal infection of the surgical wound that caused osteomyelitis in adults (men and women) were included, full text available, articles, systematic reviews and cohort studies and case studies and control over the past 10 years. Exclusion Criteria: specific research on antimicrobial therapy and bacterial infections, target audience involving animals and children, / case reports, clinical series.

Chart 1. Split and combined search equation used in Google Scholar. Rio de Janeiro, RJ, Brazil, 2020

1st Equation (1st EQ)	PROTOCOLOS OR ("PROTOCOLO" OR "PROTOCOLO DE PESQUISA") AND FERIDA CIRÚRGICA OR ("FERIDA OPERATÓRIA" OR "FERIDAS CIRÚRGICAS" OR "INCISÃO CIRÚRGICA") AND ADULTO OR ("ADULTOS") AND IMUNOSSUPRESSORES OR ("AGENTES IMUNOSSUPRESSORES" OR "FÁRMACOS IMUNOSSUPRESSORES" OR "IMUNOSSUPRESSOR")
2nd Equation (2nd EQ)	OSTEOMIELITE AND MICOSE OR ("INFECÇÕES FÚNGICAS" OR "INFECÇÕES POR FUNGOS")

Chart 2. Split and combined search strategy used in the VHL. Rio de Janeiro, RJ, Brazil, 2020

Order	Research equation	Research Details
1st Equation (1st EQ)	PROTOCOLOS OR ("PROTOCOLO" OR "PROTOCOLO DE PESQUISA") AND FERIDA CIRÚRGICA OR ("FERIDA OPERATÓRIA" OR "FERIDAS CIRÚRGICAS" OR "INCISÃO CIRÚRGICA") AND ADULTO OR ("ADULTOS") AND IMUNOSSUPRESSORES OR ("AGENTES IMUNOSSUPRESSORES" OR "FÁRMACOS IMUNOSSUPRESSORES" OR "IMUNOSSUPRESSOR")	protocolos OR ("PROTOCOLO" OR "PROTOCOLO DE PESQUISA") AND ferida cirúrgica OR ("FERIDA OPERATÓRIA" OR "FERIDAS CIRÚRGICAS" OR "INCISÃO CIRÚRGICA") AND adulto OR ("ADULTOS") AND imunossupressores OR ("AGENTES IMUNOSSUPRESSORES" OR "FÁRMACOS IMUNOSSUPRESSORES" OR "IMUNOSSUPRESSOR") AND (fulltext:("1") AND type_of_study:("cohort" OR "case_control") AND la:("en" OR "es" OR "pt")) AND (year_cluster:[2009 TO 2019])
2nd Equation (2nd EQ)	OSTEOMIELITE AND MICOSE OR ("INFECÇÕES FÚNGICAS" OR "INFECÇÕES POR FUNGOS")	tw:(osteomielite AND micose OR ("INFECÇÕES FÚNGICAS" OR "INFECÇÕES POR FUNGOS")) AND (fulltext:("1") AND db:("MEDLINE" OR "LILACS") AND mj:("Osteomielite") AND type_of_study:("systematic_reviews" OR "cohort" OR "case_control") AND la:("en" OR "es")) AND (year_cluster:[2009 TO 2019])

Results and Discussion

The studies selected for this review are shown below (Chart 3).

Chart 3. Studies selected on Google Scholar and the VHL. Rio de Janeiro, RJ, Brazil, 2020

Title	Author	Year	Methodology	Results	Conclusion
Avaliação da adesão às medidas para prevenção de infecções do sítio cirúrgico pela equipe cirúrgica	Oliveira AC, Gama CS	2015	Prospective study	An average of nine professionals were present during the surgery and the door to the operating room remained open in 94.4% of the procedures.	Partial adherence to the recommended, reaffirming the need for greater attention to these critical steps / actions to prevent infection of the surgical site.
Aspergillus e Aspergilose – desafios no combate da doença	Carvalho LIC	2013	Descriptive study	Even when the infection is accurately diagnosed and the most appropriate antifungal therapy is performed, the results are not always positive.	The incidence and severity of fungal infections have been increasing at an alarming rate. The diagnosis depends on clinical suspicion and obtaining the appropriate material for identification.
Incidência de infecções fúngicas em pacientes cirúrgicos: Uma abordagem retrospectiva	Nakamura HM, Caldeira SM, Avila MAG	2013	Quantitative, retrospective, and cross-sectional study	Sixty-four patients had post-surgical fungal infections and two had infection with two different species of Candida. The most frequent infectious agent was C. albicans (51.51%), followed by C. tropicalis, C. parapsilosis and other species.	There was a high incidence of C. albicans species and the emergence of non-albicans species. We note the greater importance of nursing performance, acting on the issue of team discussion regarding the treatment needs for the improvement of patients, in addition to issues of prevention, health education and control of hospital infections.
Diagnóstico laboratorial de aspergilose invasiva: avaliação de métodos moleculares e detecção de antígenos	Gavronski S, BotelhoTKR, Cordova CMM	2016	Literature review	One of the most recent advances in the diagnosis of API is related to the detection of the disease-causing agent through the use of molecular methods (PCR) and also to the detection of Aspergillus antigens in body fluids, with special emphasis on galactomannan and (13) -β-D-glucan.	The use of molecular techniques and the detection of fungal antigens contribute largely to the detection of invasive aspergillosis, but it is recommended that its use be combined with the clinical, radiological and microbiological evaluation of the patient and not used in a way to replace them.
Infeções fúngicas emergentes	Santos IN	2015	Descriptive study	The incidence of fungal infections is due to the large number of immunocompromised individuals and resistance acquired to drugs by microorganisms. The genera Candida and Aspergillus present themselves as the main responsible for the emerging fungal infections.	New therapeutic strategies are being investigated. It is necessary to carry out further studies on the antifungal susceptibility of the most problematic genera, and to focus essentially on diagnosis and prevention.
Aspergilose invasiva em pacientes imunodeprimidos: comparação entre as provas de galactomanana, 1,3 BD-glucana, dados tomográficos e desfecho clínico.	Batista, MV	2015	Prospective cohort study	Good performance was observed for GM in serum and BAL.	GM in BAL and serum were useful in diagnosing Aspergillosis. Excellent agreement in the CT analysis.
Fungos anemófilos em uma unidade de terapia intensiva	Gonçalves CL, Mota FV, Ferreira GF, Mendes JF, Pereira EC, Freitas CH, Vieira JN, Villarreal JP, Nascente OS	2017	Laboratory study	Seven fungal genera were identified: Penicillium spp. (15.18%), the most frequent genus, followed by Aspergillus spp., Cladosporium spp., Fusarium spp., Paecelomyces spp., Curvularia spp., Alternaria spp., In addition to sterile zygomycetes and mycelia.	As they are involved in different diseases, the identified genders can be classified as potential pathogens for hospitalized patients. These results reinforce the need to monitor environmental microorganisms more frequently and efficiently in health institutions.
Infecções por Candida spp em pacientes imunodeprimidos	Varano N, Lima MFM, Cardoso IR, Barbosa GG, Jesus ALL, Prado CR, Marques LA,	2019	Literature review	It was observed that Candida, despite being part of the normal microbiota of men and other animals, causes mycoses when changes occur in the host organism, which makes it opportunistic.	It is yeast that has generated more than half of hospital fungal infections and leads to the death of at least a quarter of patients who develop candidemia.

	Silva NBS, Röder DDB				
Osteomielite fúngica em pacientes submetidos à esternotomia: análise secundária de dados	Souza S, Bastos H	2013	Literature review	The main clinical indicators found were drainage of secretion (92.9%), edema, skin lesion and fever (42.9%) and local erythema (35.7%). CABG was a surgical indication in 9 of 11 cases. Mediastinitis was a complication in 100% of cases. Lesion culture was used for diagnosis in 100% of cases and Candida sp. was isolated in 92.9% of cases.	The presence of fungal infection of the sternal wound and osteomyelitis, especially when there is mediastinitis, are potentially fatal, contributing to the increase in hospital mortality, which makes early interventions essential for an adequate therapeutic response.
Infecções fúngicas nosocomiais em unidade de terapia intensiva: ocorrência e controle	Parahym AMRC	2012	Laboratory study	All isolates tested were sensitive to amphotericin B. Death occurred in 39.7% of patients.	Nosocomial fungal infections affect ICU patients, with C. albicans being the most frequent etiological agent.
Infecções fúngicas invasivas nas unidades de cuidados intensivos	Alves LSG	2014	Descriptive study	The etiological agents most involved in this type of infections are the Candida species, especially the C. albicans species. However, in recent years there has been an increase in the number of IFIs by non-albicans species, by filamentous fungi of the genus Aspergillus and Mucorales.	Advances in health care have contributed to the increased incidence of IFI. The standard diagnosis continues with culture and histopathology. the implementation of preventive measures is extremely important given that a large number of IFIs are acquired in health facilities.
O cuidado do enfermeiro na evolução do paciente com infecção hospitalar em sítio cirúrgico	Pitombeira PCP	2016	Quantitative and qualitative study	The results showed the rate of 4.25% of nosocomial infection from December 2013 to December 2014; changes in the surgical site corresponded to 67% of total nosocomial infection in surgical patients.	The study shows that nosocomial infection is in fact a public health problem and is the responsibility of everyone who works at the hospital, especially the nurse who performs his activities in front of the patient, in order to maintain an effective control for patient safety.
Bone and joint infections caused by mucormycetes: A challenging osteoarticular mycosis of the twenty-first century.	Taj-Aldeen, Saad J; Gamaletsou, Maria N; Rammaert, Blandine; Sipsas, Nikolaos V; Zeller, Valerie; Roilides, Emmanuel; Kontoyiannis, Dimitrios P; Henry, Michael; Petraitis, Vidmantas; Moriyama, Brad; Denning, David W; Lortholary, Olivier; Walsh, Thomas J.	2017	Systematic review	Among 34 patients with a median age of 41, 24 (71%) were male. While 12 (35%) were immunocompromised patients, 14 (41%) underwent previous surgery and seven (21%) suffered trauma. Other underlying conditions included diabetes mellitus, hematological neoplasms, transplantation, and corticosteroid therapy. The average delay in diagnosis since the onset of symptoms and signs was 60 (10–180) days. The main mechanism of infection was direct inoculation, and in immunocompromised patients, hematogenous was generally disseminated.	Osteoarticular mucormycosis occurs most often after trauma or surgical procedures. These infections are progressively destructive and more virulent in individuals with compromised immune systems. Early diagnosis, timely administration of amphotericin B, control of underlying conditions, and surgical debridement of infected tissue are critical to successful treatment.
Th17 cytokine deficiency in patients with Aspergillus skull base osteomyelitis.	Delsing, Corine E; Becker, Katharina L; Simon, Anna; Kullberg, Bart Jan; Bleeker-Rovers, Chantal P; van de Veerdonk, Frank L; Netea, Mihai G	2015	Experimental study	Proinflammatory responses to cytokines did not differ between patients with SBO and healthy volunteers.	It was shown that patients with Aspergillus skull-based osteomyelitis infection have specific defects in Th17 responses.
Bilateral polymicrobial osteomyelitis with	Kaldau, Niels Christian; Brorson, Stig;	2012	Literature review	We have identified 40 new cases in the literature since the last review in	Candida osteomyelitis should be considered when a patient has risk factors and pain without previous

Candida tropicalis and Candida krusei: a case report and an updated literature review.	Jensen, Poul-Einar; Schultz, Charlotte; Arpi, Magnus			2004. Most cases of Candida albicans osteomyelitis.	trauma. The recommended treatment is surgery and fluconazole alone or initially combined with a fungicidal agent.

The results pointed to discussions regarding the most common fungi found in the hospital in the occurrence of fungal osteomyelitis and the most used conducts for treatment and diagnosis.

Surgical antimicrobial prophylaxis is one of the most important methods available to prevent infection of the surgical site.[2] However, not all infections are prevented with this method, as is the case with fungal infections, making clear the importance of the nurse's perception regarding cases of surgical wound infection. Knowledge of the patient's health history is essential for the correct decision making. Immunodepressed patients are at high risk of developing infections.

Fungi are ubiquitous organisms widely distributed in the environment, and can be found in plants, animals, soil, water and air. These microorganisms are transported by water, insects, humans and animals, having the ability to disperse in atmospheric air.[3]

When we talk about immunocompromised individuals, we mean the deficiency of the immune system to act when necessary. This deficiency occurs for several reasons, among which is the use of immunosuppressive drugs. The fact is that, when in contact with fungi present in nature, immunosuppressed individuals are at great risk of developing infections .

In a study carried out in 2017, among 34 patients with bone and joint infection, severely immunocompromised patients, including those with hematological neoplasms, bone marrow / stem cell transplantation, solid organ transplantation and HIV / AIDS, were responsible for 35 % of cases.[4]

Fungal infections in health care institutions have become very important in recent years, due to their progressive increase and high rates of morbidity and mortality. Many of these infections are acquired endogenously and others exogenously, the last of which comes from the hands of healthcare workers, therapeutic instruments, biomaterials, among other sources. They usually affect individuals who use immunosuppressive drugs. The most prevalent opportunistic infections are candidiasis (Candida albicans and other Candida species), aspergillosis (several species of the genus Aspergillus, but mainly by Aspergillus fumigatus), cryptococcosis (Cryptococcus neoformans) and mucormic diseases (Rhizopus oryzae).[5]

The species associated with the genera Candida and Aspergillus stand out significantly in terms of the etiology of emerging fungal infections. The sharp and increasing number of hosts with compromised immunity, such as patients with diabetes, infected with HIV, transplanted, with cancer, among others, as well as the use of certain invasive medical methods and the increase in resistance to available antifungals, form a set of factors that promote the increase of emerging infections.[6]

The prevalence of Aspergillus spp. in osteomyelitis it increased with the increase in the population of immunocompromised patients. Fungal endocarditis is sometimes seen in patients undergoing cardiac surgery.3 Thus, it is evident the existence of this form of infection in the context of cardiology.

Fungal osteomyelitis at the base of the skull (SBO) is a serious complication of otitis externa or nasosinusal infection and is caused mainly by Aspergillus species.[7]

Intensive Care Units (ICUs) are characterized by being an environment prone to infections in general, due to the number of invasive procedures performed in these sectors. And Cardiointensive Units follow the same pattern. Cardiac surgeries are major, with bone part invasion (Sternotomy), with high complexity postoperative, and use of various invasive devices (probe, drains, endotracheal tube).

The invasive procedures commonly used in ICUs are extremely important; however, the use of endotracheal tubes, by preventing the cough reflex, decreases ciliary mobility, providing primarily colonization and, secondarily, infection of the lower airway as well as upper airways by fungi and bacteria; introduction of intravascular catheters and the use of parenteral nutrition increase the risk of fungemia and bacteremia.[8]

It is important to reevaluate the use of invasive devices, together with the medical team, care related to inflammatory signs, care with dressings, adequate cleaning of inanimate bodies, asepsis control measures, rational use of antibiotics, rationalization of procedures, improvement of standards and routines, in addition to the issue of health education, both for professionals already working, as well as in academic training.[5]

Candidiasis is an opportunistic infection caused by fungi of the genus Candida, more severe when it manifests in immunodepressed patients. Although the causative fungus is part of the normal human microbiota, when a person's immune system is deficient, the state of that microbiota is altered. Due to low immunity, changes in the oral cavity and intense treatments with the use of drugs, the balance between man and the microorganism can be affected, compromising the immune system and facilitating the emergence of opportunistic infections caused by Candida spp.[9] In this way, Candida can cause osteomyelitis in any bone part of the human body.

Osteomyelitis due to Candida should be considered when a patient has risk factors and pain without previous trauma, because Candida, despite being part of the normal

flora, is the fourth leading cause of hematogenous nasocomial infections.[10]

In addition to environmental issues and immunosuppression, facts such as heavy use of medications and use of multiple antibiotics contribute to the emergence of fungal infections, especially by Candida, according to the studied literature.

One of the main factors for the occurrence of the infections studied, both in the case of candidiasis and candidiasis, is the use of multiple antibiotics, of broad spectrum and for long periods, which, in addition to the problem of resistance of bacteria, has helped in the infectious process fungal, since it destroys the natural and competitive endogenous bacterial flora of man, thus providing accelerated and facilitated growth for fungi, mainly in the woman's gastrointestinal and vulvovaginal tract, which, in turn, can migrate to other regions of the organism.[5]

The nurse has a fundamental role in the early detection of the infection, since he is with the patient at 24h. It is also worth mentioning the importance of attention to risk factors for the development of infection. Immunosuppression is a major risk factor, but it is often not taken into account.

The identification of risk factors for surgical site infections (SSI) contributes significantly to the planning and implementation of nursing actions, making it possible to establish adequate prevention measures and promote the effective control of surgical infections. Nurses' knowledge about SSI is essential for monitoring and implementing nursing care for surgical patients and can influence clinical practice, since nursing care must be planned for infection control.[11]

Detecting signs and symptoms of fungal infection is difficult, as these signs and symptoms are very similar to those of bacterial infection. However, some can be mentioned in relation to Aspergillosis.

The clinical manifestations of Aspergillosis are determined by the host's immune response to Aspergillus spp. with a spectrum of diseases ranging from inadequate local inflammatory response, causing a hypersensitivity reaction, saprophytic lung disease with the presence of fungal balls, to a disease spread due to failure of the immune response.[12]

The rarity of cases of sternal fungal osteomyelitis in the postoperative period of cardiac surgery means that many nurses do not pay attention to this possibility in immunosuppressed patients, generating serious consequences for them.

These are infectious complications after median sternotomy: infections of superficial and deep wounds, osteomyelitis of the sternum and mediastinitis. Staphylococci cause most infections, but Gram-negative bacteria, mycoplasmas and fungi have also been reported as agents of infection of the sternum.[1]

Due to the lack of a diagnostic method capable of identifying the fungus responsible for the infection, treatment is not done in advance, which may be associated with high mortality rates.

Due to the clinical cases that have been reported, and some studies of recorded antifungal susceptibility, the main reasons for a lack of appropriate antifungal therapy for provoked infections are the lack of reliable identification sequences for the identification of the species involved in such infections. Due to this difference in antifungal susceptibility, it is necessary to carry out previous tests to determine the correct species with which the patient is infected, to later administer the most effective therapy.[6]

The accurate diagnosis of invasive aspergillosis is complicated and can be difficult to obtain, since clinical symptoms are often similar to those of other infections. For diagnosis, several techniques must be used together, namely imaging techniques (high resolution computed tomography) and laboratory techniques, such as direct observation, cultivation and detection of markers (fungal antigens, such as Aspergillus galactomannan or DNA) that can be found in the blood at an early stage of infection.13 However, the detection of galactomannan (part of the Aspergillus cell wall) is a test to detect only this type of fungus. So it would not be an ideal diagnostic method.

Conventionally used techniques have low analytical sensitivity and delay in the presentation of results. A diagnostic method that has been occupying a position of increasing prominence in medical and biological research laboratories is the Polymerase Chain Reaction (PCR), in which it is possible to detect the DNA of the disease-causing agent through the in vitro replication of a sequence characteristic target of the researched microorganism.[14]

Diagnostic methods based on nucleic acids have been shown to be quite interesting since they yield results more quickly than traditional methodologies. In addition, they are non-invasive and highly sensitive methods. As for negative aspects, this methodology is prone to false positives. The fact that it is not a standardized method, that it is expensive and requires sophisticated equipment are also disadvantages.[15]

The interesting thing about this technique is that it detects any form of microorganism (bacteria, fungi and viruses) and is not invasive. The study is carried out on any biological material (blood, urine, secretion). That is, if a sternotomy, for example, shows minimal secretion output, this material can be sent for analysis. With a positive result for a species of fungus (fungal infection), a tomography would complement the diagnosis of a possible fungal osteomyelitis of the sternum, for example.

It has already been found that traditional diagnostic methods are not reliable for the detection of fungi.

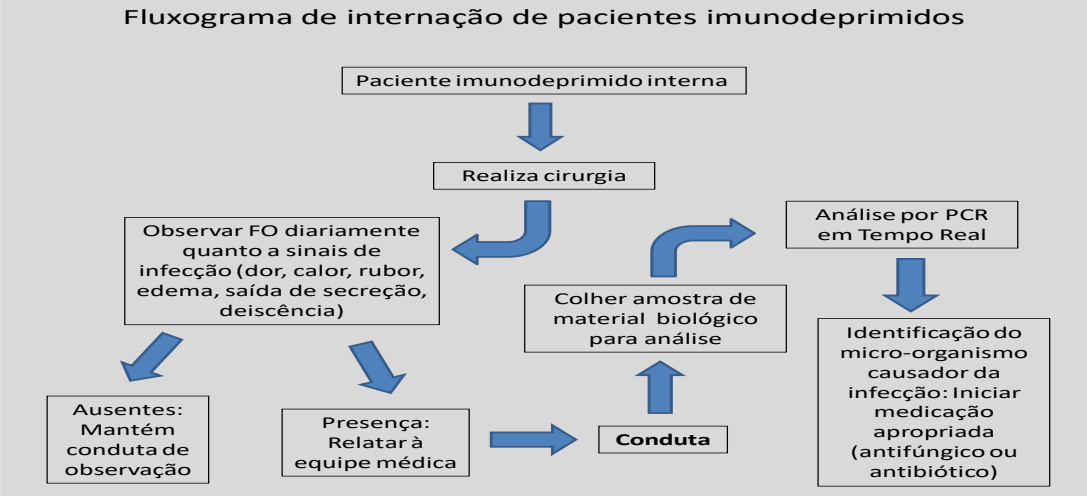
In culture, fungi have a longer life span than most bacteria, which takes time to grow in the culture media. In histopathology, like culture media, it is an invasive method, as the samples used for analysis are tissues and, again, it may not be possible to collect in patients with thrombocytopenia due to the high risk of hemorrhagic complications. This methodology cannot be used in isolation for the identification of fungi due to similarities in the morphological characteristics of the various pathogens.[15]

Taking into account that the PCR technique would be used for early diagnosis only in immunocompromised

patients, the question of the cost of the equipment would not have as much weight.

Therefore, the use of an admission flow chart is of great importance. With him, as much as a professional is not aware of a specific occurrence, he manages to conduct a guided conduct, as this is already registered in the unit. Thus, it follows the protocol created based on the research carried out.

Figure 1. Flowchart hospitalization of immunosuppressed patients. Rio de Janeiro, RJ, Brazil, 2020



Note: PCR - Polymerase Chain Reaction; FO - Operative Wound.

Conclusion

Based on the study, it was concluded that the early detection of fungal infection is extremely important for the reduction of mortality and better prognosis. Based on this, a flowchart of hospitalization of immunosuppressed patients was created, in order to avoid unnecessary approaches, loss of time for the correct treatment and unwanted outcome, where when presenting signs of infection in the surgical wound, the same would be addressed by the PCR technique (Polymerase Chain Reaction) for early detection of a possible fungal infection. In addition, the nurse's important role in identifying signs of infection is emphasized, and the importance of this professional's knowledge of considering the patient's history of immunosuppression and associating it with an infection condition.

The study contributes to the advancement of nursing care and knowledge. In addition, it contributes to the creation of a protocol to be used not only for the area of cardiac surgery, but for any other surgical area, which addresses a patient with this peculiarity.

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