CHARACTERIZATION OF PULMONARY INFECTIONS IN THE LATE POSTOPERATIVE PERIOD OF KIDNEY TRANSPLANTATION: AN INTEGRATIVE REVIEW

Caracterização de infecções pulmonares no pós-operatório tardio de transplante renal: uma revisão integrativa

Caracterización de infecciones pulmonares en el postoperatorio tardío de trasplante renal: una revisión integrativa

Review Article

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ABSTRACT

Objective: The aim of this study was to characterize the nature and frequency of pulmonary infections in late post-kidney transplant adult recipients. **Methods**: A bibliographic review was conducted in the following electronic databases: PubMed, SciELO and Web of Science. The study eligibility criteria were articles published between the years 2010 and 2015, in English, Portuguese or Spanish, comprising clinical trials, randomized or not, case-control studies, cohort studies, and longitudinal studies in humans. Articles whose research subjects were aged under 18 years were excluded, as well as repeated articles, which appeared in more than one of the databases. The keywords used and combined in the research were: pneumonia, lung infection, infection, kidney transplantation, hospitalization. **Results**: The most common etiologic agents are *Pneumocystis jirovecii*, *Mycobacterium tuberculosis* and *Aspergillus fumigatus*. Pulmonary infections are, in a large number, due to the immunosuppressive regimen, extensive length of time on hemodialysis, graft dysfunction and interhuman transmission. Often, such infections evolve with progressive dyspnea and acute respiratory failure, thus requiring invasive or non-invasive mechanical ventilation. **Conclusion**: The evidences point out a high prevalence of pulmonary infections in kidney transplant recipients.

Descriptors: Hospitalization; Kidney Transplantation; Respiratory Tract Infections.

RESUMO

Objetivo*: Caracterizar a natureza e frequência das infecções pulmonares em pacientes adultos pós-transplantados renais tardios.* **Métodos***: Foi realizado um estudo de revisão bibliográfica nas seguintes bases de dados eletrônicas: PubMed, Scielo e Web of Science. Os critérios de elegibilidade do estudo foram: artigos publicados entre os anos de 2010 e 2015, nos idiomas inglês, português ou espanhol, do tipo: ensaios clínicos, randomizados ou não, estudos de caso-controle, estudos de coorte e estudos longitudinais em humanos. Foram excluídos os artigos cujos participantes da pesquisa fossem menores de 18 anos de idade, além dos artigos duplicados em mais de uma das bases de dados. As palavras-chave utilizadas e combinadas na pesquisa foram: pneumonia, infecção pulmonar, infecção, transplante renal, hospitalização.* **Resultados:** *Os agentes etiológicos mais incidentes são Pneumocystis jirovecii, Mycobacterium tuberculosis e Aspergillus fumigatus. As infecções pulmonares são devidas, em grande número, ao regime imunossupressor, tempo prolongado de hemodiálise, disfunção de enxerto e transmissão inter humana. Frequentemente, essas infecções evoluem com dispneia progressiva e insuficiência respiratória aguda, sendo necessária ventilação mecânica invasiva ou não invasiva.* **Conclusão***: As evidências científicas apontam uma alta prevalência de infecções pulmonares nos pacientes transplantados renais.*

Descritores*: Hospitalização; Transplante de Rim; Infecções Respiratórias.*

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RESUMEN

***Objetivo**: El objetivo del estudio fue caracterizar la naturaleza y la frecuencia de las infecciones pulmonares de pacientes adultos pos trasplante renal tardío. **Métodos**: Se realizó un estudio de revisión bibliográfica en las siguientes bases de datos electrónicas: PubMed, Scielo y Web of Science. Los criterios de elegibilidad del estudio fueron: artículos publicados entre los años de 2010 y 2015 en los idiomas inglés, portugués o español, del tipo ensayos clínicos randomizados o no, estudios de caso-control, estudios de cohorte y estudios longitudinales en humanos. Fueron excluidos los artículos cuyos los participantes de la investigación tenían menos de 18 años de edad, además de los artículos repetidos en más de una base de datos. Las palabras-clave utilizadas y asociadas en la investigación fueron: neumonía, infección pulmonar, infección, trasplante renal, hospitalización. **Resultados**: Los agentes etiológicos más incidentes son la Pneumocystis jirovecii, el Mycobacterium tuberculosis y el Aspergillus fumigatus. Las infecciones pulmonares son causadas, en su mayoría, por el régimen inmunosupresor, el largo tiempo de hemodiálisis, la disfunción del injerto y la trasmisión inter humanos. Esas infecciones evolucionan, con frecuencia, con disnea progresiva e insuficiencia respiratoria aguda y la necesidad de ventilación mecánica invasiva o no invasiva. **Conclusión**: Las evidencias científicas apuntan elevada prevalencia de infecciones pulmonares en los pacientes trasplantados renales.*

***Descriptores**: Hospitalización; Trasplante de Riñon; Infecciones del Sistema Respiratorio.*

INTRODUCTION

The most common solid organ transplantation in the world is kidney transplantation, which is the treatment of choice for end-stage renal disease (ESRD). In Brazil, it is the most frequently performed type of transplant surgery - between January and June 2015, 2664 renal transplants were performed[1]. Compared to chronic dialysis, kidney transplantation is cost-effective, provides improved quality of life and a progressive benefit to the patient's life expectancy. The graft survival rate has consistently increased over the past decades[2].

The use of immunosuppression in patients after kidney transplantation can predispose to opportunistic infections such as the ones affecting the respiratory system[3]. Due to immunosuppression, patients with functioning grafts are exposed to different pathogens, which impact on morbidity and mortality, thus explaining why infection is the second cause of death in renal transplant patients[1]. Lung infections such as pneumonia and lower respiratory tract infections are among the postoperative complications, as well as non-infectious complications, such as atelectasis, pleural effusion and diaphragmatic dysfunction.

During the period of maximum immunosuppression (within six months after transplantation), the risk of viruses or opportunistic agents is high. Lung infections represent 20% of all infections. Immunosuppressive drugs can induce a negative effect on the lungs, such as toxicity, particularly in renal transplant patients, leading to interstitial pneumonitis, obliterative bronchiolitis and pneumonia[4].

This study aimed to characterize the frequency and nature of lung infections in adult patients in the late postoperative period of kidney transplantation.

METHODS

This is a literature review, consisting of a search conducted in the following electronic databases: PubMed, SciELO and Web of Science.

The study eligibility criteria were: articles published between the years 2010 and 2015, in English, Portuguese, or Spanish, reporting clinical trials, whether randomized or not, case-control studies, cohort studies, and longitudinal studies conducted in humans. Articles whose research subjects were under 18 years of age were excluded, in addition to those duplicated, found in more than one database.

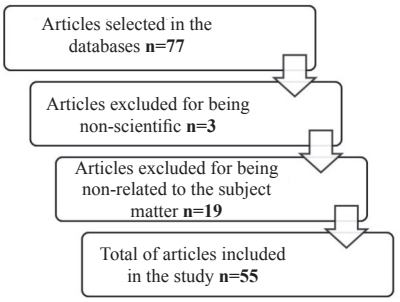
The research used and combined the following keywords: pneumonia, lung infection, infection, kidney transplantation, hospitalization, and their correspondents in Portuguese and Spanish. The selected articles were then analyzed by two researchers through the reading of the title, abstract and full text, respectively.

The outcomes analyzed were: type of study, year of publication, number of patients, study site, data collection instrument, elapsed time after transplantation, infection etiologic agent, length of hospital stay, period and/or need for mechanical ventilation, death rate, details on the clinical status evolution, and whether there was the progress to Acute Respiratory Distress Syndrome (ARDS) and performance of alveolar recruitment maneuver.

RESULTS AND DISCUSSION

After the researchers have jointly analyzed and identifyied the inclusion and exclusion criteria, 77 articles were selected. Of these, 22 articles were excluded (3 were non-scientific articles and 19 lacked relationship to the topic being discussed), and a total of 55 items remained for reading and analysis, as shown in the following flowchart (Figure 1). The demographic characteristics of patients in their study are listed in Table I, in which only three selected articles, classified as literature review, were not included. The remaining results will be presented in topics, for better understanding by the reader.

Figure 1 - Flowchart of scientific articles selection.



The types of studies found were case reports[9,12,17,22,25,30,37,41,42,44,47,50,51,57,58], retrospective studies[5,7,8,10,11,21,24,28,29,31,32,35,39,43,45,56], cohort[13,14,18,19,23,27,33,34,36,38,40,46,48,49,55], case-control[6,15,20,26,59] and literature review[16,33,52]. The selected articles had their researches held in China[9,11,45,46,50], Spain[12,14,38,39,58], Tunisia[33], Belgium[57], Denmark[15,19], Malaysia[17], Germany[7,18,23,28], Turkey[21,25,32,34,36], Brazil[22], Slovenia[24], Netherlands[26,27,55], Taiwan[8,31,49,56], France[5,6,29,43], Colombia[35,41], India[44], United States[10,51,52,59], Portugal[30], Italy[42], Australia[47], Mexico[48] and Greece[40]. It stands out that, according to the established inclusion criteria, only one study carried out by Brazilian researchers was found, which emphasizes the need for national scientific progress regarding this issue.

Etiologic agents

The most commonly found etiologic agents in the selected articles were *Pneumocystis jirovecii*[5-30], *Mycobacterium tuberculosis*[29,31-36] and *Aspergillus fumigatus*[10,14,21,32,37-41]. The results on these three main etiologic agents will be following displayed in separately.

The reported techniques for the diagnosis of the etiologic agents were: bronchoscopy with bronchoalveolar lavage[5,6,9,10,12-14,17,19-22,25,26,29,30,32,36,38,39,41-54], polymerase chain reaction[6-8,14,15,17-20,22,23,25,27-29,43-45,49,52], histopathology[28,35,37,55], lung biopsy[10,33,36,42,45,51,53,56], radiography and computed tomography[7,9-12,21,22,29,34,41-43,45,47,49,51,54-58], Ziehl-Neelsen staining[21,25,33,41,53,57], Gram technique[41] and immunofluorescence microscopy[15,17,27].

TABLE I - General characteristics of 52 of the 55 selected studies. Campinas, SP, 2010-2015.

Author/year	n	Age in years (mean ± SD)	Length of ICU stay in days	Need for IMV (quantitative)	Deaths (%)
Brunot V. et al., 2012[5]	9	NI	8 to 15	3	NI
Le Gal S. et al., 2012[6]	18	62	NI	NI	NI
Pliquett RU. et al., 2012[7]	29	54.9 ± 14.9	NI	NI	34
Yang CY. et al., 2012[8]	20	54.5 ± 13.0	NI	14 (ARF)	50 (ARI)
Tu GW. et al., 2013[9]	3	46.3	35	NI	33 (SEPSE)
Chen G. et al., 2010[10]	53 cases and 2520 controls	47.3 ± 13.1 years - cases 42.6 ± 12.5 years - controls	NI	NI	45 (PNM)
Song T. et al., 2010[11]	13	37	NI	NI	NI
Perez-Ordoño L. et al., 2014[12]	4	50.5	21	4	NI
Phipps LM. et al., 2011[13]	14	46.6 ± 13.2	NI	10 (ARF)	14 (PNM)
Hoyo I. et al., 2012[14]	1656	51	NI	NI	1.5 (PNM)
Rostved AA. et al., 2013[15]	16 cases and 32 controls	46 years - cases 46 years - controls	25	NI	NI
Boer MGJ. et al., 2011[16]	50 cases and 99 controls	57.4 years - cases 52.1 controls	NI	4	6 (PNM)
Iqbal MAH. et al., 2012[17]	1	38	NI	NI	NI
Fritzsche C. et al., 2013[18]	70	55.0 ± 12	NI	NI	NI
Leth S. et al., 2014[19]	46	59.2	NI	NI	NI
De Castro N. et al., 2010[20]	11	53	NI	NI	0,9 (PNM)
Dizdar OS. et al., 2014[21]	82	38 ± 12	NI	NI	34 (PNM)
Ramalho J. et al., 2014[22]	1	54	NI	NI	NI

Maruschke M. et al., 2014[23]	7	64.3 ± 13.9	NI	NI	42 (PNM)
Borstnar S. et al., 2013[24]	13	49 ± 4	NI	NI	23 (PNM)
Metan G. et al., 2011[25]	1	40	25	NI	NI
Struijk GH. et al., 2011[26]	9	56	NI	NI	NI
Eitner F. et al., 2011[28]	60 cases and 60 controls	53.9 ± 13.9 - cases 51.7 ± 13.5 - controls	NI	23	26 (PNM)
Bige N. et al., 2014[29]	83	55.6	19	32	37 (PNM)
Bento C. et al., 2014[30]	1	51	22	NI	NI
Chen CH. et al., 2014[31]	153	46.6 ± 12.7	NI	NI	NI
Eyüboğlu FÖ. et al., 2013[32]	90	42.3 ± 12.3	19	27 (PNM)	62 (PNM)
Boubaker K. et al., 2013[33]	16	32.2 ± 12.7	NI	NI	6.2 (TB)/6.2 (SEPSIS)
Kupeli E. et al., 2011[34]	136	36.3 ± 12.2	NI	NI	NI
Higuita LMS. et al., 2014[35]	12	52.5	14 to 72	NI	16 (TB)
Ersan S. et al., 2011[36]	9	46.7 ± 11.7	NI	NI	11 (TB)
Nasim A. et al., 2011[37]	1	35	NI	NI	NI
Hoyo I. et al., 2010[38]	610	52.3	NI	15	1,4 (PNM)
Hoyo I. et al., 2014[39]	9	58.9	NI	NI	NI
Moloudi E. et al., 2012[40]	27	42.7 ± 12.3	19	27 (PNM)	62 (PNM)
Encarnación AA. et al., 2012[41]	1	41	20	NI	100 (PNM)
Rizza V. et al., 2011[42]	1	32	10	NI	NI
Canet E. et al., 2011[43]	200	56	10	NI	NI
Kute VB. et al., 2013[44]	1	46	NI	NI	NI
Jiang T. et al., 2012[45]	89	43.7	NI	NI	NI
Tu G. et al., 2015[46]	60	53.5	20	21 (ARF)	13 (ARI)
Jabbar Z. et al., 2013[47]	1	70	NI	NI	NI
Valdez-Ortiz R. et al., 2011[48]	350	37.96 ± 11.4	NI	NI	3.7 (PNM)
Shih CJ. et al., 2014[49]	33	56.9 ± 11.4	12	33 (PNM)	45 (PNM)
He Q. et al., 2011[50]	2	48	NI	NI	NI
Cunha BA. et al., 2012[51]	1	77	37	NI	100 (PNM)
Gainer SM. et al., 2012[52]	18	46	18	4 (ARF)	16 (OF)
Baas MC. et al., 2014[55]	13	50	NI	NI	NI
Ou SM. et al., 2012[56]	109	47.6 ± 11.2	NI	NI	22 (PNM)
Ho TA. et al., 2010[57]	1	54	14	NI	NI
Fraile P. et al., 2013[58]	1	27	NI	NI	NI
Simkins J. et al., 2014[59]	13 cases and 39 controls	53 ± 18 cases and 55 ± 16 controls	NI	NI	46 (PNM)

SD: Standard Deviation; OF:Organ Failure; ARF: Acute Respiratory Failure; n: Number of patients; PNM: Pneumonia; TB: Tuberculosis; ICU: Intensive Care Unit; IMV: Invasive Mechanical Ventilation; NI: not informed in the article.

Pneumocystis jirovecii

Pneumonia caused by the fungus *Pneumocystis jirovecii* (PJ) is recognized as an important cause of morbidity and mortality among patients taking immunosuppressants after solid organ transplantation. Kidney recipients are patients at high risk of infection in the transplantation postoperative period, especially in the first two years, with a mortality rate that amounts to over 50%[16,18,22-24,28].

The causes of PJ pneumonia outbreaks and their specific risk factors are not yet clearly defined. There are suppositions that closer contact and inter-human transmission, reactivation of latent infection, environmental exposure and more sensitive analysis contribute to the PJ increased incidence[13,16,24]. Other studies suggest the transmission via airborne droplets, low CD4 T-cell count, and the graft rejection as causes of PJ infection[5,6,19,20]. The reduced immunity resulting from the immunosuppressive treatment and cytomegalovirus infections has also influenced on the higher number of pneumocystis pneumonia **cases** in renal transplant patients[5,6,19,20]. Other factors for the development of PJ pneumonia include impaired renal functioniong and episodes of graft rejection[8,28].

The most evident radiographic and tomographic findings after the diagnosis of PJ pneumonia were diffuse bilateral infiltrates, ground-glass pattern and/or consolidation throughout the entire lung[11,17,26]. The most frequently reported clinical status comprises progressive dyspnea, hypoxemia, fever, non-productive cough, and acute respiratory failure (ARF), with frequent need for endotracheal intubation[12,20,25,26]. The most common causes of ARF in kidney transplant patients are bacterial pneumonia, cardiogenic pulmonary edema and acute respiratory distress syndrome (ARDS). Such respiratory impairment is associated with increased mortality and graft loss, and prophylaxis is essential[43].

Mycobacterium tuberculosis

Mycobacterium tuberculosis (MT) pulmonary tuberculosis is an important cause of mortality in endemic countries, and its incidence is 20 to 70 times higher in renal transplant patients, mainly because of their immunosuppressed state[33,35,53,60]. Donor-derived tuberculosis has already been reported in kidney, liver and lung transplants. The bacteria can also be acquired after the transplant surgery, with higher infection rate in developing countries[53].

Similarly, the extrapulmonary or disseminated tuberculosis has a higher occurrence in the transplant recipient population compared with the general population. Its symptoms and clinical manifestations are often non-specific, rendering it difficult to reach an early diagnosis[36,61]. Risk factors include direct contact with carriers of the bacteria, AB blood group, hepatitis C, graft dysfunction, serum creatinine, use of immunosuppressants, prolonged pre-transplant hemodialysis time, diabetes mellitus, chronic obstructive pulmonary disease (COPD), autoimmune diseases and cirrhosis of the liver[33,56].

The clinical status is commonly characterized by fever, weight loss, pleuritic syndrome and pulmonary infection resistant to antibiotic therapy. Chest radiographs show miliary pattern, pleural effusion, cavitations, pulmonary nodules, consolidations, air bronchograms and pulmonary infiltrates[33,35,36,53]. The diagnosis of tuberculosis is, in fact, late and often requires invasive procedures such as bronchoscopy with bronchoalveolar lavage, or biopsy of the lung tissue or tissue involved[53].

Aspergillus fumigatus

Aspergillosis is one of the most important opportunistic fungal infections in solid organ transplant recipients, with high mortality rate. The majority of cases occur within 90 days post-transplantation[14]. The incidence of fungal infections such as aspergillosis varies between 1 and 14%, with an incidence of 74% in the first year after renal transplantation. The fungus *Aspergillus fumigatus* causes four known syndromes: bronchopulmonary allergic aspergillosis, aspergilloma, chronic necrotizing aspergillosis and invasive pulmonary aspergillosis. Pulmonary aspergillosis may progress to an invasive disease with mortality rate close to 63%. The main risk factors for aspergillosis are graft dysfunction, immunosuppressive regimen, and renal failure and requiring hemodialysis[37,41].

The clinical status shows productive cough, hemoptysis, chest pain, dyspnea and fever. The clinical findings range from the colonization of a previous lung cavity to parenchymal and vascular invasion. Radiologically, there is involvement of the upper lobes, cavitation, pleural thickening, peribronchial consolidation, ground-glass opacification areas, and centrilobular nodules[37,39].

Other etiologic agents

Other less frequently cited etiologic agents, with no description of risk factors related to their onset, incidence of percentage, clinical or radiological findings, are: *Pseudomonas aeruginosa*[21,29,32,38,43,46,49], *Staphylococcus aureus*[32,43,45,46,48,49], *Klebsiella pneumoniae*[32,46,49,59], *Acinetobacter baumannii*[34,49], *Candida albicans*[32,45,48], *Cytomegalovirus*[7,29,40,45], *Herpes simplex*[42,43,51], *Adenoviruses*[14], *Burkholderia pseudomallei*[47], *Escherichia coli*[32,43,46,48], H1N1[52,58], *Haemophilus influenzae*[21], *Legionella pneumophila*[38], *Lophomonas blattarum*[50], *M. catharralis*[32], *Mycobacterium avium*[57], *Nocardia spp*[14], *Stenotrophomonas maltophilia*[21,32], *Streptococcus hemolyticus*[46], *Streptococcus pneumoniae*[32,34,38,43], *Enterococcus*[48], *Mycobacterium intracellulare*[57] and *Varicella zoster*[14]. A case-cohort study evaluated the incidence and risk factors for everolimus-induced pneumonitis in post-renal transplant patients[55]. Two articles have brought the incidence of bronchiolitis obliterans organizing pneumonia in association with infectious pulmonary conditions[44,51].

Acute Respiratory Distress Syndrome

ARDS is a condition characterized by an inflammatory process which results in increased alveolar-capillary permeability, with a consequent interstitial and alveolar edema. Its main signs are severe hypoxemia, low lung compliance, and bilateral infiltrates on chest radiography[62]. ARDS-induced respiratory failure has a high mortality rate (50 to 70%), with most cases caused by sepsis and immunosuppressive therapy[58]. Pulmonary infections predispose to ARDS onset and, in a study conducted in 2015, of 60 kidney transplant patients who developed pneumonia, 35 developed ARDS[46].

In a retrospective multicenter study including 200 kidney transplant patients admitted to the Intensive Care Unit (ICU) with ARF, 15.5% were diagnosed with ARDS. The events of graft rejection and immunosuppressive therapy, in addition to previous pulmonary infections, predispose to an increased risk for development of ARDS[43]. According to the retrospective study published in 2010, 24 of 53 patients with pulmonary mycosis died, mostly because of ARDS (17%)[10].

Length of hospital stay

No studies were found showing an average length of hospital stay for kidney transplant patients due to complications and risks that each patient might develop over time. Many factors may contribute to the risk of infections, such as the immunosuppressive profile adopted, postoperative care and exposure to various infectious diseases. In addition to these, the unfavorable socioeconomic profile contributes to increase the incidence of such complications, in developing countries[63].

Episodes of infections are usually more common in the first months of monitoring of the renal transplant recipient and are directly related to the use of immunosuppressant, mainly focusing the urinary tract and the surgical wound. Between the second and sixth months, opportunistic infections caused by viral or fungal agents are predominant. After six months, infections of community origins predominate[64].

Mechanical ventilation and non-invasive mechanical ventilation

The main pulmonary complications found in the postoperative period are atelectasis, tracheobronchial infections, pneumonia and respiratory failure[65]. The consequences of such complications are an intrapulmonary arteriovenous shunt, thickening of the alveolar membrane and parenchymal inflammation, with resulting edema and fibrosis. Lungs become unable to provide the blood with enough oxygen, causing severe dyspnea, requiring invasive or non-invasive mechanical ventilation. If not reversed, such condition can lead to death[66].

Community-acquired pneumonia and ventilator-associated pneumonia (VAP) were also found as reports of pulmonary complications in renal transplant patients in the late postoperative period, reporting the need for use of mechanical ventilation or non-invasive mechanical ventilation in this patient profile[40,49]. Some authors report in their studies that patients have received treatment with mechanical ventilation and non-invasive mechanical ventilation because of respiratory failure. The ARF is a respiratory dysfunction caused by changes in oxygenation or CO_2 supply, which does not meet the metabolic needs of the body in terms of gas exchange. ARF can result from pulmonary or non-pulmonary conditions: ARDS, pneumonia, atelectasis, pulmonary edema, pulmonary embolism and COPD[8,13,46,52].

Some of the authors studied also mention that the patients included in their respective studies have required mechanical ventilation and non-invasive mechanical ventilation, without specifying the reasons for such procedure or addressing this issue[5,12,16,28,29,38].

Causes of death

Of the 52 articles, 27 describe the causes related to death. The series of deaths shows a mortality rate ranging from 1% to 33%, and the main causes were pneumonia, severe sepsis and tuberculosis[7-10,13,14,16,20,21,23,24,28,29,33,35,36,38-41,46,48,49,51,52,56,59].

The incidence of *P. jirovecii* pneumonia is found at 4% in kidney transplant recipients, 4% in heart recipients, 11% in liver recipients, and 33% in heart and lung recipients[67]. *Pneumocystis jirovecii* causes an intra-alveolar pneumonitis due to the occupation of the airspaces by a protein-rich exudate, which may result in pulmonary complications and death[66].

The high mortality from severe sepsis and septic shock is closely related to the approach to the infectious agent. The therapeutic management, including the antimicrobial therapy, will differ substantially according to the primary infection site. Inadequate initial choice of antimicrobial therapy can lead to a significant increase in the mortality rate in septic patients[68].

Despite the potential toxicity of antituberculosis treatment in patients admitted to the Intensive Care Unit (ICU), it is suggested that medications be started before the results of diagnostic tests, since delaying the beginning of treatment may result in death. In immunocompromised patients, the index of suspicion should be even greater. Patients with tuberculosis hospitalized in ICUs may develop other complications, such as ventilator-associated pneumonia, multiple organ failure, septic shock, acute

renal failure, disseminated intravascular coagulation, and gastrointestinal bleeding. Acute respiratory failure caused by tuberculosis and requiring MV has been associated with mortality rates between 17.5% and 81.0%[69].

The current study has some limitations. The studies included in this review do not report the reason for the patient's clinical outcomes, as regards the need for mechanical ventilation, length of stay and percentage of deaths, thus rendering diffuse the knowledge of these aspects in this profile of patients. It is suggested that further studies be carried out, producing additional information on the use of mechanical ventilation, the length of stay in hospital or ICU, as well as the death incidences.

CONCLUSION

Based on the results obtained, it is concluded that the most common etiologic agents in kidney transplant patients on immunosuppressive regimen are *P. jirovecii*, *A. fumigatus* and *M. tuberculosis*. The occurrence of lung infections in kidney recipients is largely due to the use of immunosuppressive medication, need for long-term dialysis, history of graft dysfunction and/or rejection, and interhuman transmission.

The frequency of infection by these agents is high, particularly in immunosuppressed patients, as are the kidney recipients. The most common symptoms are progressive dyspnea and ARF, requiring invasive and non-invasive mechanical ventilation. The evolution of lung infections can lead to severe complications such as ARDS, with a high death rate.

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