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Patients and neurologists have different perceptions of multiple sclerosis symptoms, care and challenges

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ABSTRACT

Background: Basic steps in the management of patients with Multiple Sclerosis (MS), such as good patient understanding of the disease and active participation in its management are extremely important, as they directly influence treatment adherence and success. Therefore, this study aimed to evaluate the perception of MS patients and neurologists pertaining to the most common disease symptoms, disabilities that impact on quality of life, and patient concerns and difficulties during medical visits, as information that can be used to improve the doctor-patient relationship.

Methods: A cross-sectional study involving two groups: the first composed of neurologists and the second of patients. Participants of the first group were selected by a Steering Committee (15 predetermined neurologists representing each region of Brazil and specialized in MS and neuroimmunological disorders, who also assumed the role of creating the survey and questionnaire). Participants of the second group were selected following dissemination of a questionnaire on the AME's social networks (*Amigos Múltiplos pela Esclerose*, a non-governmental organization to support patients with MS). Questions about sociodemographic data, disease impact on quality of life, symptoms perception, and concerns and issues regarding disease care were put to both groups.

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Results: A total of 317 patients and 182 neurologists answered the questionnaires. Significant divergences were found between the perceptions of patients and neurologists in relation to orientation and information given during medical appointments, and also regarding patient participation in treatment and therapy choice. Considering the topic assessing impact on quality of life, more than 70% of neurologists perceived that autonomy to work and travel, and future planning were aspects that most affected patient lives, however, almost 50% of patients reported that disease monitoring did not affect their life in any way. Analysis of data regarding MS symptoms revealed neurologists to consider physical symptoms, such as ambulation issues, imbalance, falls and urinary incontinence, to be those most interfering with patient quality of life, whereas patients considered non-physical symptoms, such as fatigue, pain, cognitive and memory problems to be more significant. Patients with primary progressive MS complained more about ambulation issues, imbalance and falls ($p < 0.05$), when compared to patients with other disease phenotypes.

Conclusion: Significant differences in disease perception were found in this study. While neurologists tended to overestimate the consequences and symptoms of the disease, for most patients, the disease impact on activities did not appear to be as significant, with more complaints regarding non-physical symptoms. Although neurologists described involving patients in treatment decisions and providing them with appropriate orientation during medical appointments, the opposite was reported by patients. These results may help to improve treatment adherence and disease outcomes by redefining the doctor-patient relationship.

1. Introduction

Multiple sclerosis (MS) is the most prevalent chronic inflammatory disease of the central nervous system (CNS), affecting over 2.8 million people worldwide (MS International Federation, 2020). Disease onset most frequently occurs between 20 to 40 years of age and deeply hinders the professional and economic activities of the individual. (Filippi et al., 2018 and Reich et al., 2018).

The accumulation of demyelinating lesions in the brain and spinal cord contributes to progressive disability, which negatively impacts on the daily physical and social activities, and cognition of the patient (Mitchell et al., 2005; Forbes et al., 2007; Miller and Allen, 2010).

A patient's perception of illness is a complex multifactorial process involving specific symptoms of the disease and their impact on physical, social and cognitive aspects, in addition to their expectations of therapies and interventions (Scherbourne et al., 1999). Recent studies have demonstrated that patient opinions regarding health and disease do not always correlate with those of the neurologists who take care of them (Suarez-Almazor et al., 2001; Rothwell et al., 1997; Kremenchutsky and Walt, 2013; Ysraelit et al., 2018). Although neurologists analyze the imaging features of the CNS lesions, frequency of disease relapses, and disability progression over time, they frequently do not assess additional health domains that are associated with the disease and are relevant to patient quality of life (QoL). Patient perceptions related to QoL can allow physicians to recommend treatment based on a balance between positive clinical benefits and potential QoL improvement, and the negative consequences of therapy related to adverse events (Janse et al., 2004). Therefore, a shared decision-making process that includes not only the neurologist's judgement based on clinical findings, but also the patient's own perception of their condition is essential in MS care (Heesen et al., 2007).

Since there are few on the subject published so far, this study aimed to evaluate the perception of MS patients and neurologists pertaining to the most common disease symptoms, disabilities that impact on QoL and patient concerns and difficulties during medical visits.

2. Methods

2.1. Participants

Participants were divided into two groups: one comprised of Brazilian neurologists involved in the care of MS patients, and the other formed of Brazilian MS patients. Data were collected via links to online questionnaires over a period of ten months for neurologists (March 2019 to January 2020), and five days for patients (March 2020). The research and questionnaires were provided by BCTRIMS (Brazilian Committee for Treatment and Research in Multiple Sclerosis) and AME (*Amigos*

Múltiplos pela Esclerose, a non-governmental patient support organization composed of a closed group of people diagnosed with MS).

Participating patients were selected on a volunteer basis following dissemination of a questionnaire on the AME's social networks and a total of 317 individuals agreed to respond to the questionnaire. Patients were eligible if having a previous diagnosis of MS according to the McDonald 2010 or 2017 criteria, and questions could be answered by either the patient, their legal representative, or caregiver.

Brazilian neurologists were selected based on their membership of regional and national MS organizations. A Steering Committee, composed of fifteen predetermined neurologists representing each region of the country and specialized in MS and neuroimmunological disorders, assumed the role of selecting the potential respondents of the survey. Board certified neurologists were included, as in Brazil, it is not solely MSologists who usually treat MS patients. Participants in this group were also included based on their willingness to take part in the survey. Approximately 400 neurologists received the survey, of which 182 agreed to participate.

2.2. Survey

The survey was created by the Steering Committee and specifically designed to consider demographic data and medical aspects of the disease. The questions were chosen based on the daily challenges and situations experienced by Steering Committee members (supplemental file). The questionnaire for patients included details of age, gender, MS type, disease and treatment duration and health system accessed (public or private). For neurologists, the questions were specifically about the workplace, number of MS patients followed up per month and time of experience with MS patients. Questions about disease impact on QoL, symptoms perception, and concerns and issues regarding disease care were proposed for both groups.

2.3. Ethics

The study protocol was approved by the Institutional Ethics Committee. Details of the research goals, forms of participation, confidentiality of personal information and the option to withdraw consent at any time were explained to each participant before initiation of the questionnaire. All respondents agreed to participate through an informed consent obtained online.

2.4. Data analysis

Data was captured online using the web application REDCap. Categorical variables were described using counts and percentages. The chi-squared or Fisher's exact tests were used to assess statistical significance.

A p-value of less than 0.05 was considered statistically significant. The IBM-SPSS software, version 25.0, was used to process and analyze data.

3. Results

A total of 317 patients and 182 neurologists answered the questionnaires. The MS patient and neurologist clinical and demographic data are described in Table 1 and Table 2, respectively.

The participating neurologists and patients were presented with the same set of six different questions. The first topic approached was the impact of MS on QoL. The main challenges for patients, as suggested by neurologists, were concerns about costs, problems with future adverse reactions, medication intolerance and therapy application method, with these issues being indicated by more than 80% of neurologists. More than 50% of patients agreed with neurologists in reporting concerns about costs and problems with future adverse reactions, however, medication intolerance and therapy application method were not expressed by patients as a problem.

The effect of disease monitoring on aspects of patient life were also evaluated. In the perception of more than 70% of neurologists, the autonomy to work and travel, as well as future planning were the aspects of patient life most affected, however, almost 50% of patients reported that disease monitoring did not affect their life in any way. One-third of patients considered that autonomy to work and future planning were of concern to them, while aspects such as family or partner relationships, leisure activities and autonomy to travel were not reported by patients as being areas affected by disease monitoring.

The second topic addressed the perception of symptoms, more precisely, those symptoms that patients felt uncomfortable in reporting during medical appointments and the symptoms that most interfere in the QoL of the patient. These results are presented in Table 3. It is important to highlight that half of the patients reported there being no symptoms that were left unreported during medical appointments. The most indicated complaints by patients were not related to their age (fatigue $p = 0.76$; ambulation issues $p = 0.09$; imbalance and falls $p = 0.64$; cognitive and memory problems $p = 0.08$) or disease duration (fatigue $p = 1.00$; ambulation issues $p = 0.41$; imbalance and falls $p =$

Table 1

Demographic and clinical data of MS patients. RRMS (relapsing-remitting multiple sclerosis); SPMS (secondary progressive multiple sclerosis); PPMS (primarily progressive multiple sclerosis).

| Characteristics | Total patient numbers (%) |
|------------------------|---------------------------|
| Respondent patients | 317 (100) |
| Patient age (years) | |
| 18 - 19 | 1 (0.3) |
| 20 - 40 | 174 (54.9) |
| 41 - 50 | 80 (25.2) |
| 51 - 64 | 58 (18.3) |
| 65 - 80 | 4 (1.3) |
| Female gender | 270 (85.2) |
| Type of MS | |
| RRMS | 285 (89.9) |
| SPMS | 14 (4.4) |
| PPMS | 18 (5.7) |
| Disease duration | |
| Less than 1 year | 27 (8.5) |
| 1 to 2 years | 53 (16.7) |
| 2 to 5 years | 85 (26.8) |
| 5 to 10 years | 76 (24.0) |
| More than 10 years | 76 (24.0) |
| Treatment duration | |
| Less than 1 year | 37 (11.7) |
| 1 to 2 years | 57 (18.0) |
| 2 to 5 years | 87 (27.4) |
| 5 to 10 years | 72 (22.7) |
| More than 10 years | 64 (20.2) |
| Health system accessed | |
| Private | 183 (57.7) |
| Public | 84 (26.5) |
| Both | 50 (15.8) |
| Treatment access | |
| Private treatment | 51 (16.1) |
| Health insurance | 109 (34.4) |
| Public health system | 157 (49.5) |

Table 2

Neurologist demographics data.

| Characteristics | Total neurologist numbers (%) |
|---|-------------------------------|
| Total included | 182 (100) |
| Region of Brazil | |
| Northeast | 22 (11.9) |
| Midwest | 6 (3.2) |
| Southeast | 86 (47.2) |
| South | 68 (37.3) |
| Main place of work (n=182) | |
| Teaching Hospital with MS reference Center | 87 (47.8) |
| Public Hospital | 15 (8.2) |
| Private Hospital or Clinic | 78 (42.9) |
| Basic health Center | 2 (1.1) |
| Percentage of MS patients treated (n=182) | |
| 0 - 10% | 87 (47.7) |
| 11 - 20% | 21 (11.5) |
| 21 - 50% | 46 (25.1) |
| 50 - 75% | 18 (9.8) |
| > 75% | 10 (5.5) |
| Years of experience with MS patients (n=182) | |
| Less than 5 years | 60 (32.9) |
| 5 to 10 years | 38 (20.8) |
| 11 to 15 years | 24 (13.1) |
| 16 to 20 years | 18 (9.8) |
| More than 20 years | 42 (22.8) |
| Number of MS patients followed up per month (n=181) | |
| Less than 10 patients | 88 (48.6) |
| 11 to 50 patients | 62 (34.3) |
| 51 to 100 patients | 23 (12.8) |
| More than 100 patients | 8 (4.6) |

0.72; cognitive and memory problems $p = 0.90$). However, patients with primary progressive MS (PPMS) complained more about ambulation issues, imbalance and falls ($p < 0.05$), when compared to patients with relapsing-remitting MS (RRMS) or secondary progressive MS (SPMS). Fatigue, pain, cognitive and memory problems were not related with MS type ($p = 0.32$, $p = 0.84$, $p = 0.44$, respectively).

The last topic approached in our study addressed concerns and issues regarding disease care, focused on the priority and quality of information about MS received by patients during medical appointments. Only a third to a half of patients reported receiving good quality information about disease course and its characteristics, treatment options and the process for purchasing medication. However, some divergent results were noted between neurologists and patients when asked about patient participation in treatment choice, information about future planning, and orientation about smoking cessation. These results are illustrated in Table 4. Participants were also asked to respond about the difficulties they faced during disease treatment and follow-up. The two groups of participants revealed the biggest problem to be finding specialized multidisciplinary teams. In addition, the patient group reported other difficulties related to the management of medication adverse effects and frequency of monitoring appointments, while the neurologist group revealed struggles with frequency of monitoring appointments, imaging exams access and waiting time for these exams. In multivariate analysis, patients using the public health system showed greater association with imaging exam schedules and frequency issues, as well as experiencing longer waiting times in comparison to patients using the private health system ($p < 0.05$).

4. Discussion

The present study evaluated the differences in perception between neurologists and patients regarding the symptoms and treatment of MS through the application of a questionnaire with six different questions. Most of the topics analyzed revealed disagreements in opinion between the two groups.

In general, the responses indicated that the neurologists tended to overestimate patient symptoms, as well as the information and orientation given in medical appointments. This was demonstrated in the first and second topics, in which neurologists reported several challenges

Table 3

Perception of neurologists and patients regarding symptoms that patients feel uncomfortable reporting and symptoms that interfere with quality of life.

| Symptoms | Number of patients N = 317 (%) | Number of neurologists N = 141 (%) | P value |
|--|-----------------------------------|---------------------------------------|---------|
| Symptoms that patients feel uncomfortable reporting | | | |
| Sexual issues | 87 (27.4) | 124 (86.7) | <0.001 |
| Mood disorders | 54 (17.0) | 38 (28.1) | 0.010 |
| Cognitive and memory problems | 52 (16.4) | 36 (26.3) | 0.020 |
| Fatigue | 52 (16.4) | 22 (16.4) | >0.99 |
| Urinary disturbances/ incontinence | 46 (14.5) | 71 (51.8) | <0.001 |
| Pain | 30 (9.5) | 9 (6.8) | 0.463 |
| Ambulation issues | 27 (8.5) | 11 (8.2) | >0.99 |
| Imbalance and falls | 25 (7.9) | 9 (6.9) | 0.845 |
| Sensitivity loss | 22 (6.9) | 10 (7.7) | 0.840 |
| Vertigo | 21 (6.6) | 7 (5.3) | 0.674 |
| Fine motor skill problems | 21 (6.6) | 28 (21.2) | <0.001 |
| Muscle spasms | 18 (5.7) | 12 (9.1) | 0.214 |
| Visual disorders | 19 (6.0) | 8 (6.1) | >0.99 |
| Speech problems | 17 (5.4) | 13 (9.9) | 0.096 |
| Tremor | 15 (4.7) | 9 (6.9) | 0.363 |
| Swallowing issues | 9 (2.8) | 26 (19.4) | <0.001 |
| Superior limbs motor issues | 9 (2.8) | 9 (6.8) | 0.065 |
| None of these | 160 (50.5) | 10 (9.9) | <0.001 |
| Symptoms that most interfere with quality of life | | | |
| Fatigue | 259 (81.7) | 135 (97.1) | <0.001 |
| Imbalance and falls | 138 (43.5) | 134 (97.1) | <0.001 |
| Ambulation issues | 122 (38.5) | 141 (100.0) | <0.001 |
| Pain | 121 (38.2) | 126 (94) | <0.001 |
| Mood disorders | 118 (37.2) | 113 (84.3) | <0.001 |
| Urinary disturbances/ incontinence | 93 (29.3) | 132 (97.1) | <0.001 |
| Vertigo | 85 (26.8) | 98 (78.4) | <0.001 |
| Sensitivity loss | 83 (26.2) | 54 (43.5) | <0.001 |
| Muscle spasms | 74 (23.3) | 92 (72.4) | <0.001 |
| Cognitive and memory problems | 73 (23.0) | 129 (92.8) | <0.001 |
| Sexual issues | 60 (18.9) | 117 (89.3) | <0.001 |
| Visual disorders | 59 (18.6) | 113 (88.3) | <0.001 |
| Tremor | 30 (9.5) | 70 (56.5) | <0.001 |
| Superior limbs motor issues | 28 (8.8) | 114 (88.4) | <0.001 |
| Speech problems | 22 (6.9) | 97 (77.6) | <0.001 |
| Swallowing issues | 13 (4.1) | 99 (79.2) | <0.001 |

Table 4

Divergent results between patient and neurologist perceptions about disease orientation.

| Topics addressed | Number of patients N = 317 (%) | Number of neurologists N = 137 (%) | P Value |
|---|-----------------------------------|---------------------------------------|---------|
| Patient participation in treatment choice | 91 (28.7) | 122 (89.1) | <0.001 |
| Information given about future planning | 75 (23.7) | 117 (85.4) | <0.001 |
| Orientation about smoking cessation | 51 (16.1) | 135 (98.5) | <0.001 |

secondary to disease treatment, and aspects of patient life being affected by disease monitoring. However, from a patient perspective, the challenges provided by the illness were mainly linked to costs and troubles with future adverse reactions, but not affecting their lives to the extent reported by the doctors. In a study by [Dehghani et al. \(2019\)](#), which analyzed the challenges in daily living activities faced by MS patients, the main challenge of participants related to fears about future aspects, including confrontation to physical, psychological and behavioral changes, fear of disabilities, financial burden and handling of sociocultural myths about the disease.

Some disagreement was identified when evaluating the symptoms that patients felt uncomfortable in reporting during medical appointments. There was statistical significance related to sexual issues, mood disorders, cognitive and memory problems, urinary disturbances, incontinence and fine motor skill problems, revealing that neurologists tended to highlight these symptoms as complaints that patients usually do not talk about during appointments. In contrast, half of the patients reported there being no symptoms that made them feel uncomfortable when talking to their doctors, while for the remaining half, sexual issues, mood disorders, fatigue and cognitive problems were the most common symptoms patients mentioned feeling less comfortable reporting to physicians. Moreover, when analyzing symptoms that interfere in patient QoL, the neurologists tended to overestimate all of the symptoms evaluated, while solely some patients reported non-physical and physical symptoms as being the most significant, such as fatigue, imbalance and falls, ambulation issues and pain. These divergent results could be explained by the fact that neurologists tend to imagine multiple disease scenarios when answering the questionnaire, whereas patients tend to answer the questions based on their own reality of illness.

Convergent and divergent results about the perception of symptoms have been demonstrated in previous studies. [Ysrraelit et al. \(2018\)](#) evaluated agreement levels between patient and neurologist perceptions of QoL, revealing that patients considered vitality, and emotional and mental health to be just as important as physical aspects. A review [Lysandropoulos and Havrdova \(2015\)](#) described that factors contributing to QoL decline in patients with MS, with cognitive issues, fatigue, isolation, sexual dysfunction, family dynamics, relationship issues and inability to work included, increasing the idea that non-physical symptoms can affect QoL more, from a patient perception. A similar result was found by [Kremenchtzky and Walt \(2013\)](#), in which around 60% of patients and 10% of neurologists considered mental health to be an important domain for QoL, whereas 50% of patients and 70% of neurologists described physical function as being a relevant domain for QoL. In contrast, despite cognition having been shown as an important factor in patient QoL, a Spanish study ([Tintoré et al., 2017](#)) revealed that a low number of patients identified cognition as a problem, when compared to responses about relapses and disability progression. The authors suggest this result may relate to the lack of correlation between perceived and objective cognitive issues by patients. In the present study, patient perceptions regarding symptoms affecting QoL were not related to their age or disease duration, which may signify from a patient viewpoint that MS can be complex and disabling, despite the disease stage. However, these aspects were significantly associated with patients with a primary progressive MS disease diagnosis. [Yalachkov et al. \(2019\)](#), in a study published in 2019, showed that progressive forms of MS, such as primary and secondary MS, were more associated with low scores on a QoL scale.

Another significant difference in perception between neurologists and patients concerned the information and orientation given during medical appointments. Previous studies have shown that communication methods and the quality of information provided by neurologists can affect treatment adherence, clinical outcomes and QoL ([Suarz-Almazor et al., 2001](#); [Janse et al., 2004](#); [Heesen et al., 2007](#); [Tintoré et al., 2017](#); [Koudriavtseva et al., 2012](#); [Lugaresi et al., 2012](#)). In the present study, about 80-90% of patients revealed that they were not included in the therapy decision-making process and did not receive information about smoking cessation or about future planning. This is a very relevant result as more than 70% of neurologists reported that concerns about future planning is an aspect of patient life that can be affected by disease monitoring. [De Seze et al. \(2012\)](#), in a French study, described that less than half of patients had been well informed by the doctors about MS disease and treatment. Furthermore, [Reen et al. \(2017\)](#) also found similar results, in which the experience of many patients in regard to the information provided during the standard healthcare system did not give a satisfactory understanding of the risks and benefits of therapy choice. These results are essential to assist in the

reformulation of the doctor-patient relationship, as patient inputs into the decision-making process about disease treatment and follow-up has an influence on their levels of satisfaction and dedication to treatment, and also on alleviation of symptoms and future prognosis (Tintoré et al., 2017; Heesen et al., 2004). Patients that received a good quality of information were significantly associated with better therapy adherence. De Seze et al. (2012) showed that 40% of patients confessed skipping their medication from time to time and almost 20% reported periods without medication use, which they called “drug holidays”. The lack of adherence to treatment was associated with poorly informed patients.

More recently, markers have been created to assess patient perceptions of MS outcomes and their participation in the disease management process. PRO (Patient-Reported Outcome) and PROMS (PRO for MS) are initiatives established to define information given directly by patients and to ensure their active participation in the decisions involving their disease, reflecting their experiences of treatment (Weldring and Smith, 2013). Some recent studies have emphasized the importance of standardized disease-specific and sensitive measures for outcomes reported by patients (D’Amico E et al., 2019; Khurana V et al., 2017). PRO is considered an endpoint in clinical trials and in real-life studies, encompassing questionnaires about symptoms, functionality, health-related quality of life and health status. Although there is currently no standardized approach to evaluate PRO in MS, there are some options available, including generic forms, target-symptoms and PROMS (Cella et al., 2007; Chua et al., 2015; Van Munster and Uitdehaag, 2017). The latter also addresses specific questions related to symptoms and the treatment of MS. The present study aimed to analyze and compare the general perceptions of patients and neurologists about different aspects of MS, although it might not be considered a proper PRO, as not all of the information required in questionnaires used for this purpose was available, with details of disability scores and specific therapy used missing. However, it is worth mentioning that the results found emphasize the need for patients to be included in decision-making, as well as the necessity for neurologists to allow more time for talk about aspects that most concern patients. Some authors described the difficulty of detailing PRO during medical appointments and reinforces the need to use questionnaires through a standardized system of data capture (D’Amico E et al., 2019). In addition, evaluation of PRO in clinical trials helps to identify the approved treatment for MS that is most effective for patients, according to the outcomes that matter most to them (Nowinski CJ et al., 2017).

Limitations to the present study should be mentioned. Firstly, the study was based on six questions about the aspects of life and symptoms of MS patients, which were created by the authors, who considered them relevant for the survey. However, the topics approached may not encompass all the significant aspects required for a full analysis of the agreement and disagreement between the two groups. Secondly, patients were chosen according to their desire to participate in the study, which can influence the responses of the group, as motivated and functional patients tend to more easily accept the survey protocol. A further limitation is the absence of information about type of treatment currently being received by the patient and also their disability status, which can influence answers regarding concerns about the drug, reported symptoms and aspects of QoL.

5. Conclusion

This study enabled the identification of differences in patient and neurologist perceptions regarding MS symptoms and outcomes, with a notable distinction in opinion between the two groups. Major disagreements were evident regarding perception of the orientation and information given by neurologists to MS patients during medical appointments, including information about disease course and future planning, as well as discrepancies linked to patient participation in the treatment and therapy choice. Besides that, neurologists tended to overestimate physical aspects of the disease, while patients considered

emotional and mental health to be as important as physical health. This result highlights the need to review the doctor-patient relationship and the communication that takes place, with the aim of improving access and the understanding of information and, as a consequence, increasing patient treatment adherence and interest in the disease process.

Conflict of Interest

All authors declare that there are no conflicts of interest for this paper.

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Cássia Elisa Marin: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data curation, Resources, Software, Writing - original draft, Project administration. **Paula Prado Kfourir:** Conceptualization, Data curation, Investigation, Resources. **Dagoberto Callegaro:** Conceptualization, Formal analysis, Visualization, Supervision, Project administration, Writing - review & editing. **Marco Aurélio Lana-Peixoto:** Conceptualization, Formal analysis, Visualization, Supervision, Project administration, Writing - review & editing. **Antonio Pereira Gomes Neto:** Conceptualization, Formal analysis, Supervision, Writing - review & editing. **Claudia Cristina Ferreira Vasconcelos:** Conceptualization, Formal analysis, Supervision, Writing - review & editing. **José Artur Costa d’Almeida:** Conceptualization, Formal analysis, Supervision, Writing - review & editing. **Marcus Vinícius Magno Gonçalves:** Conceptualization, Formal analysis, Supervision, Writing - review & editing. **Maria Fernanda Mendes:** Conceptualization, Formal analysis, Supervision, Writing - review & editing. **Mônica Koncke Fiuza Parolin:** Conceptualization, Formal analysis, Supervision, Writing - review & editing. **Oswaldo Nascimento:** Conceptualization, Formal analysis, Supervision, Writing - review & editing. **Paulo Diniz da Gama:** Conceptualization, Formal analysis, Supervision, Writing - review & editing. **Rafael Paternò Castello Dias-Carneiro:** Conceptualization, Formal analysis, Writing - review & editing. **Ronaldo Maciel Dias:** Conceptualization, Formal analysis, Supervision, Writing - review & editing. **Alfredo Damasceno:** Conceptualization, Formal analysis, Supervision, Writing - review & editing. **Gustavo San Martin:** Conceptualization, Data curation, Investigation, Resources. **Jefferson Becker:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data curation, Resources, Software, Writing - review & editing, Supervision, Visualization, Project administration.

Supplementary materials

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