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# Use of electrostimulation in outpatients after ischemic stroke

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**Abstract:** Stroke is considered the 2nd most fatal disease worldwide, this pathology, is responsible for physical and cognitive sequelae for the consequences of its aggressiveness that damages the structures and functions of the brain, where it interferes effectively in the quality of life of those affected. Following a literature review, in the current year 2022, the following electronic databases were used: VHL, SciELO, MEDLINE, PEDro and PubMed between 2012 and 2022. The Boolean operator AND was used to association the following descriptors: Stroke. Electrostimulation. Physiotherapy. Rehabilitation. The main relevant changes due to the obstruction of brain vascular regions provide neural deficit, loss of function of the region to the affected area and irreversible functional conditions of affected individuals who survived this pathology. Physiotherapy through techniques, studies and emphasis on the use of functional electrostimulation has the role of safeguarding the functionalities of affected individuals.

**Keywords:** Stroke. Electrostimulation. Physiotherapy. Rehabilitation

## 1. Introduction

Stroke, where this term has been replaced by stroke by some professionals due to the premise that this accident

can manifest itself in all or any part of the brain to be mentioned brain, brain stem and cerebellum and not only in the regions of the cerebral hemispheres (GAGLIARDI, 2010). However, the term stroke is more popular and used by many professionals over the years. Where, even if there is a new name the term Stroke is more popular.

Stroke is the second leading cause of death in the world and, in some cases, leaves patients unable to perform their daily activities. Approximately 85% of stroke cases are ischemic and only 15% hemorrhagic (BRASIL, 2017). On a day one in six people in the world will have a stroke (Barbosa *et al.*, 2015).

According to Rochemont *et al.* (2020) although smoking has a reduced incidence in mainland France, other risk factors such as obesity, hypertension and diabetes for stroke have been frequent and the estimated standardized incidence of stroke, both ischemic (189.5 / 100,000) and hemorrhagic (65.7 / 100,000), is the highest in this territory.

Cerebrovascular diseases are among the top 5 causes of premature death in view of ages below 65 years. (Rochemont *et al.*, 2020)

According to Rochemont *et al.* (2022) the social differences in the incidence, severity and prognosis of strokes are possibly the result of a higher frequency of risk factors, problems in access to care and the quality of emergency care and therapy and rehabilitation. Progress in controlling risk factors and improving emergency stroke care has led to significant progress, and the most socially vulnerable countries segments of the population may not benefit equally from these advances. (Rochemont *et al.*, 2022)

In stroke there are neurological impairments and sensory-motor deficits that cause alterations such as hemiplegia u hemiparesis, coordination and sensitivity disorders that can generate limitation of Daily Living Activities (ADL), and functional disabilities limit the social life of patients (MARTINST; KESSLER., 2017).

Stroke is a contributor to the reduction of life-related life in developing countries, and is the third largest contributor in developed countries after ischemic heart disease, low back and cervical pain. This emphasizes the importance of stroke as one of the main global health professionals that requires urgent and sustained attention from governments. Although there have been improvements in mortality and incidence rates from 1990 to 2013, the magnitude of the differences between these changes in developed and developing countries have increased over time. (Feigin *et al.*, 2015)

Current rehabilitation approaches have limited efficacy in improving the performance, function, muscle strength, and cognitive abilities of ADLs (including spatial neglect) after stroke, but a possible complement to stroke rehabilitation may be noninvasive brain stimulation by transcranial direct current stimulation (tDCS). (Elsner *et al.*, 2016)

The relevance of the research is based on the investigation of quality of life for patients affected after the lesion of AVCI in an outpatient setting, which allows the expansion of the physiotherapeutic nature and its knowledge

in relation to interventional possibilities, through the Electrical Stimulation Functional which in the English language is called "Functional Electrical Stimulation " (FES) proposing effective rehabilitation with high support, low cost and wide possibility of recovery of function, promotes the resumption of physical and mental quality.

Functional Electrostimulation (FES) acts in the recovery of patient functionality, where it stimulates muscle fibers to produce contractions through an electric current, thus promotes increased muscle strength and contributes to the normalization of spasticity (MILESKI *et al.*, 2013).

## 2. Methodology

The study is characterized by a descriptive literature review with a qualitative approach on the use of electrostimulation in outpatients after ischemic stroke. In the midst of the searches, the following databases were used: Medical Literature Analysis and Retrieval System Online - MEDLINE, via the Virtual Health Library (VHL), PubMed and Physiotherapy Evidence Database (PEDro).

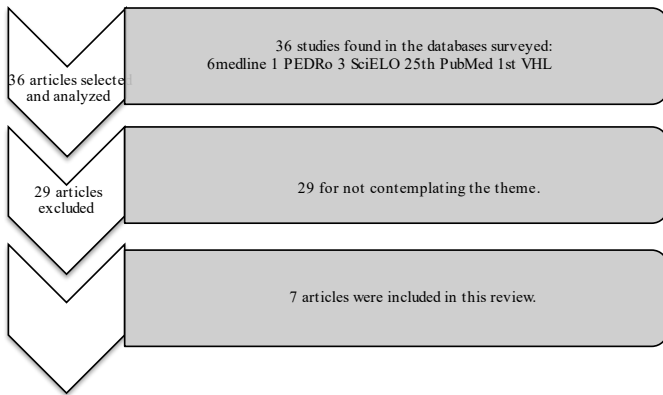
The searches were carried out in 2022. Articles from scientific journals referring to the last 10 years were selected. The descriptors used in the study, in the English and Portuguese languages, according to the DeCs (Descriptors in Health Sciences) were: Stroke. Electrostimulation ( Electrostimulation). Physiotherapy. Rehabilitation (Rehabilitation). They were combined when using the Boolean operator "AND".

The inclusion criteria were to establish for this study articles indexed with full text available, documents that addressed the objective on the use of electrostimulation in outpatient patients after stroke, available and free; publications in English and Portuguese; published in the year 2012 to 2022. Exclusion criteria were: studies without abstracts, a central theme that did not contemplate the objective of the research; articles published in the period prior to 2012; articles with double indexation; abstracts and theoretical studies or that inquired other topics that did not support the proposed theme.

After the selection of titles and their abstracts according to the inclusion criteria, the articles considered relevant were selected to be read in full, the articles will be presented in the form of a table, containing the authors, year of publication, titles, objectives and results.

## 3. Results and Discussion

Based on the criteria and inclusion and exclusion, 36 articles were initially located in the databases surveyed. After reading the titles and abstracts, 29 of these were excluded: because they did not contemplate the proposed theme to be addressed.



**Figure 1:** Flowchart of the search result, selection and inclusion of the studies.

**Table 1.** Search result with the descriptors Stroke, *Electrostimulation, Physiotherapy, Rehabilitation*, describing authors, year of publication, article title, objective and conclusion of the study.

Authors	Year	Title	Goal	Conclusion
MILESKI <i>et al.</i> ,	2013	Effects of electrostimulation and proprioceptive neuromuscular facilitation on hemiparetic gait	To determine whether the concomitant use of Proprioceptive Neuromuscular Facilitation (PNF) and Functional Electrical Stimulation (FES) would positively influence the gait of volunteers who suffered stroke that occurred at least 18 months before their engagement in the study.	Thus, we considered that the use of PNF in concomitance with FES brought benefits due to increased mobility in a period in which no more functional gains would be expected in patients with spastic hemiparesis.
POMPEU <i>et al.</i> ,	2014	The effect of transcutane	Check the effect of TENS burst mode	TENS burst promoted reduction of quadriceps muscle

		ous electrostimulation on spasticity after stroke	(TENSSb) on the spasticity and mobility of patients with hemiparesis after stroke.	spasticity and contributed to improvement in the mobilize of spastic hemiparetic individuals. Positive effects were observed after four applications that remained after 72 hours without the application of the
ALVES <i>et al.</i> ,	2018	Analysis of the main sequelae observed in patients' victims of stroke - stroke.	Analyze the main sequelae observed in stroke patients in an Integrated Rehabilitation Center (CEIR) and in the Rehabilitation and Intensive Rehabilitation of Teresina-Piaui	However, the motor, balance and coordination, behavioral and emotional, sequelae of speech and sensitivity was noticeable with more relevance.
GOULART <i>et al.</i> ,	2016	Characterization of stroke focusing on oral communication disorders in patients of a regional hospital	To characterize patients with stroke, to verify the prevalence of oral communication disorders and the frequency of referral for speech therapy rehabilitation	More than 50% of individuals affected by stroke present oral communication disorders during hospitalization. There was no indication or request for speech therapy in this period, nor in referral for care after hospital discharge.
		Profile of deaths from stroke not specified	The aim of this study was to identify the	In the proper study, it was evidenced that deaths from

Mamed <i>et al.</i> ,	2019	after investigation of garbage codes in 60 cities in Brazil, 2017	profile of causes reclassified after investigation of deaths from STROKE-NE in Brazil.	STROKE-NE, after investigations, are reclassified with a higher percentage for stroke squeamish, followed by hemorrhagic stroke. In addition, ischemic stroke was reclassified more frequently in the older age group (70 years and older), while hemorrhagic stroke was reclassified more frequently in the age group 30 to 69 years.
Melo <i>et al.</i> ,	2019	Safety in the application of neuromuscular electrostimulation in critically ill patients: a pilot study	Check the safety of the application of NMES in Intensive Care Units (ICUs) of a public hospital in the city of Salvador.	In a statement in the present article, it was possible to show in this research that the application of neuromuscular electrostimulation in critically ill patients, provided that respecting the established limits and correct parameters based on evidence, is a safe and viable technique in the ICU, since no statistically significant differences were observed in relation to the

				hemodynamic variables studied.
<i>Elsner et al.</i> ,	2016	Trans cranial direct current stimulation (ETCC) to improve function and activities of daily living in patients after stroke	Evaluate the effects of ETCC on generic activities of daily living (ADLs) and motor functioning people with stroke.	At present, very low to low quality evidence is available on the efficacy of ETCC (a modal/cathode/dual) versus control (sham/any other intervention) to improve the performance and function of ADLs after stroke.

The number of papers selected for this study, six, shows the importance of using the technique and the speed in the recovery of the desired capacities to be enjoyed in a positive way with the process and quality in the rehabilitation.

When developing this study, it aims to evaluate the influence of the concomitant use of the Pop and FeS on gait and mobility of the three participants, where success was expected, and it can be considered that the objectives of the present study were broadly achieved: all three patients showed improvement in gait, both in qualitative and quantitative view. This occurred despite the chronicity of their case and their limited access to physiotherapeutic care since stroke, which was only during the period in which they were hospitalized (MILESKI *et al.*, 2013).

According to the tests performed before and after the application of TENS *and in the follow-up, they obtained the results* that provided two main findings: TENS *burst* mode promoted positive effects on the spasticity and mobility of hemiparetic patients; these effects remained after 72 hours of the end of applications, suggesting long-term maintenance. There is evidence that TENS can promote reduction of spasticity and applied for a continuous period. (POMPEY *et al.*, 2014).

A study evaluating the effects of TENS and baclofen in individuals with spinal cord injury did not observe a reduction in spasticity after a single 15-minute application where in the article used a frequency of 100Hz on the tibial nerve, but there were positive effects after 15 sessions of application. These results are in accordance with those obtained in our study that verified the reduction of spasticity after four applications of TENS burst with maintenance of the effect after 72 hours. (POMPEY *et al.*, 2014).

*Elsner et al.*, (2016) mentioned as a modulator of cortical activity, being related to neuro modulator and neuro plastic effects demonstrating as an important resource in the treatment of sequelae resulting from stroke, being related to the clinical and functional improvement of these patients.

However, *POMPEU et al.*, (2014) with TENS in *conventional burst mode* of 100Hz, for 20 minutes in dermatomes L3 and L4 in six individuals with incomplete spinal cord injury and verified improvement of spasticity, evaluated by pendulum test, where it can be an adjunct in the treatment of spasticity and contribute to mobility.

Findings shown by Albano *et al.*, 2013 that physiotherapy through techniques and methods produce significant results in individuals with sequelae after a stroke in chronic and acute condition, when compared with the alterations found in individuals in the same conditions to whom physiotherapy care was not provided. However, Silva *et al.* (2014) points out that the success of rehabilitation depends not only on several sessions of therapy, but also on what occurs with the patient during the remaining hours that the patient is not in rehabilitation (Silva *et al.*, 2014).

According to Jacob *et al.* (2012) in their studies with 46 elderly with stroke sequelae, he demonstrated that physiotherapy through methods and techniques such as motor facilitation and training of activities of daily living provided the elderly with improvement in terms of functional capacity, reducing the sequelae that arose after stroke. Through the analysis, it was possible to highlight in this study that the most recurrent sequelae in post-stroke patients are motor, sensory and communicative.

In the literature presented by Cruz, Son; Colaço (2010) it was possible to find several protocols overtreated physical therapy that can be used in patients with stroke according to the type of sequela presented, where manual therapeutic resources, mechanical and electrical devices can be applied aiming at inhibiting postural patterns, gait training, improvement of proprioception, stretching and muscle strengthening among others. (ALVES *et al.*, 2018).

According to Goulart *et al.* (2016) the absence of data on smoking, use of oral contraceptives or physical activity practices, which are risk factors for stroke and common in young adults. However, it is known that smoking is common in the population of Rio Grande do Sul, given the incidence of lung cancer in the said State. Thus, the more detailed investigation of these factors and other etiologies that make up the differential diagnosis could have contributed to better explain the proportion of young adults with stroke. (Goulart *et al.* 2016)

Of the individuals who participated in the study, the majority had ischemic stroke and the minority, hemorrhagic stroke, demonstrating a significant difference in relation to the prevalence of stroke types and confirming the results of other studies. The mean length of hospital stays of the individuals studied was five days, minor than the average of other studies. (Goulart *et al.*, 2016)

Possibly, such a short hospital stays for patients with complex clinical characteristics, commonly associated with the demand for care for life maintenance, can inhibit the most detailed evaluation of aspects, such as communication, so relevant for the maintenance and/or rescue of man's autonomy and conviviality with his peers, besides being strongly requested for work activities, today. (Melo *et al.*, 2019).

The higher turnover of patients, as a result of the low hospital stay, probably relegate aspects, such as communication, to the background, so that identification and treatment end up being rarer. On the other hand, the time of hospitalization contributes to the reduction of possible complications inherent to prolonged hospitalization, besides reducing the financial impact on the health system (Melo *et al.*, 2019).

## 4. Conclusions

According to a holistic view of the selected articles, both had a relevant view to positively ask the use of electrostimulation in the recovery and evolution of cases of motor and physical involvement stemming from the aggravating sequelae obtained biased by the evolution of the picture from ischemic stroke (AVCI).

## References

- [1] Ansari NN, Naghdi S, Mashayekhi M, Hasson S, Fakhari Z, Jalaie S. Intra- rater reliability of the Modified Modified Ashworth Scale (MMAS) in the assessment of upper-limb muscle spasticity. *NeuroRehab* 2012; 31:215-22. <http://dx.doi.org/10.3233/NRE-2012-0791> Acesso em: 8 fev. 2022
- [2] Bakheit AM. The pharmacological management of post-stroke muscle spasticity. *Drugs Aging* 2012; 29:941-7. <http://dx.doi.org/10.1007/s40266-012-0034-z> Acesso em: 8 fev. 2022
- [3] Bakhti KKA, Laffont I, Muthalib M, Froger J, Mottet D. Kinect-based assessment of proximal arm non-use after a stroke. *J Neuroeng Rehabil.* 2018 nov. 14;15(1):104. doi: 10.1186/s12984-018-0451-2. PMID: 30428896; PMCID: PMC6236999. Acesso em: 20 set. 2022
- [4] BARBOSA DJ, *et al.* Recuperação após acidente vascular cerebral em adultos jovem submetido à fisioterapia alternativa. *Revista Interfaces: Saúde, humanas eTecnologia.* 2015;2(6)Fonte: <https://interfaces.unileao.edu.br/index.php/revista-interfaces/article/view/447> Data de acesso: 09fev.2022
- [5] Béjot, Y., Touzé, E., Jacquin, A., Giroud, M., & Mas, J. L. (2009). Epidémiologie des accidents vasculaires cérébraux [Epidemiology of stroke]. *Medecine sciences: M/S,* 25(8-9), 727-732. <https://doi.org/10.1051/medsci/2009258-9727> Acesso em: 19 set. 2022.
- [6] BRASIL. Ministério da saúde. Acidente vascular cerebral, 2019. Disponível em: <http://portalms.saude.gov.br/saudede-a-z/acidente-vascular-cerebral-avc>. Acesso em: 10 fev. 2022.
- [7] BRASIL. Ministério da saúde. Acidente vascular cerebral, 2017. Disponível em: <http://portalms.saude.gov.br/saudede-a-z/acidente-vascular-cerebral-avc>. Acesso em: 10 fev. 2022.
- [8] Broderick, M., Almedom, L., Burdet, E., Burrige, J., & Bentley, P. (2021). Self-Directed Exergaming for Stroke Upper Limb Impairment Increases Exercise Dose

- Compared to Standard Care. *Neurorehabilitation and neural repair*, 35(11), 974-985. <https://doi.org/10.1177/15459683211041313> Acesso em: 20 set. 2022
- [9] Costa, F. A., Silva, D. L., Rocha, V. M. (2011). Severidade clínica e funcionalidade de pacientes hemiplégicos pós-AVC agudo atendidos nos serviços públicos de fisioterapia de Natal (RN) [Clinical severity and functionality of acute stroke patients attended at the physiotherapy public services of Natal, Rio Grande do Norte State, Brazil]. *Ciencia & saude coletiva*, 16 Suppl 1, 1341-1348. <https://doi.org/10.1590/s1413-81232011000700068> Acesso em: 21 set. 2022
- [10] Chen, Z. J., He, C., Guo, F., Xiong, C. H., & Huang, X. L. (2021). Exoskeleton-Assisted Anthropomorphic Movement Training (EAMT) for Poststroke Upper Limb Rehabilitation: A Pilot Randomized Controlled Trial. *Archives of physical medicine and rehabilitation*, 102(11), 2074-2082. <https://doi.org/10.1016/j.apmr.2021.06.001> Acesso em: 20 set. 2022
- [11] Elsner B, Kugler J, Pohl M, Mehrholz J. Transcranial direct current stimulation (tDCS) for improving activities of daily living, and physical and cognitive functioning, in people after stroke. *Cochrane Database Syst Rev*. 2016;3(3):CD009645. Published 2016 Mar 21. doi:10.1002/14651858.CD009645. Acesso em: 12 set. 2022.
- [12] Feigin V, L, Krishnamurthi R, V, Parmar P, Norrving B, Mensah G, A, Bennett D, A, Barker-Collo S, Moran A, E, Sacco R, L, Truelsen T, Davis S, Pandian J, D, Naghavi M, Forouzanfar M, H, Nguyen G, Johnson C, O, Vos T, Meretoja A, Murray C, J, L, Roth G, A: Update on the Global Burden of Ischemic and Hemorrhagic Stroke in 1990-2013: The GBD 2013 Study. *Neuroepidemiology* 2015; 45:161-176. doi: 10.1159/000441085 Acesso em: 20 set. 2022
- [13] GAGLIARDI, R. J. Acidente Vascular Cerebral ou Acidente Vascular Encefálico? Qual a melhor nome Sakai K, Yasufuku Y, Kamo T, Ota E, Momosaki R. Repetitive peripheral magnetic stimulation for impairment and disability in people after stroke. *Cochrane Database Syst Rev*. 2019;11(11):CD011968. Published 2019 Nov 30. doi:10.1002/14651858.CD011968.pub3nclatura? Revista Neurociências, [S. l.], v. 18, n. 2, p. 131-132, 2010. DOI: 10.4181/RNC.2010.1802.02p. Disponível em: <https://periodicos.unifesp.br/index.php/neurociencias/article/view/8501>. Acesso em: 4 jun. 2022.
- [14] GOULART, Bárbara Niegia Garcia; et al; Caracterização de acidente vascular cerebral com enfoque em distúrbios da comunicação oral em pacientes de um hospital regional. *Audiol Commun Res*. 2016; Acesso em: 29 jul. 2022
- [15] KUMAR S, et al. Effect of PNF technique on gait parameters and functional mobility in hemiparetic patients. *Journal of Exercise Science and Physiotherapy*. 2012; 8: 67-73. Acesso em: 29 jul. 2022
- [16] KYO CSC, KIM H. The effects of ramp gait exercise with PNF on stroke patients' dynamic balance. *Journal of Physical Therapy Science*. 2015; 27: 1747-1749. Acesso em: 7 maio. 2022.
- [17] Lynch, D., Ferraro, M., Krol, J., Trudell, C. M., Christos, P., & Volpe, B. T. (2005). Continuous passive motion improves shoulder joint integrity following stroke. *Clinical rehabilitation*, 19(6), 594-599. <https://doi.org/10.1191/0269215505cr9010a> Acesso em: 22 set. 2022
- [18] Mamed, Samira Nascimento et al. Perfil dos óbitos por acidente vascular cerebral não especificado após investigação de códigos garbage em 60 cidades do Brasil, 2017. *Revista Brasileira de Epidemiologia* 2019, v. 22, n. Suppl 3, e190013. supl.3. Disponível em: <<https://doi.org/10.1590/1980-549720190013.supl.3>>. Epub 28 nov. 2019. ISSN 1980-5497. <https://doi.org/10.1590/1980-549720190013.supl.3>. Fonte:<https://www.scielo.br/j/rbepid/a/3FNHYXdBVvtCcb9gKZht9KR/?lang=pt>. Data de acesso: 10 fev. 2022.
- [19] Masiero, S., Poli, P., Rosati, G., Zanotto, D., Iosa, M., Paolucci, S., & Morone, G. (2014). The value of robotic systems in stroke rehabilitation. *Expert review of medical devices*, 11(2), 187-198. <https://doi.org/10.1586/17434440.2014.882766> Acesso em: 22 set. 2022
- [20] MILESKI ME, et al. Efeitos da eletroestimulação e da facilitação neuromuscular proprioceptiva na marcha de hemiparéticos. *Revista Ciência e Saúde*. 2013; 6(1): 29-36 Acesso em: 7 maio. 2022.
- [21] Nibras, N., Liu, C., Mottet, D., Wang, C., Reinkensmeyer, D., Remy-Neris, O., Laffont, I., & Schweighofer, N. (2021). Dissociating Sensorimotor Recovery and Compensation During Exoskeleton Training Following Stroke. *Frontiers in human neuroscience*, 15, 645021. <https://doi.org/10.3389/fnhum.2021.645021>
- [22] Pila, O., Duret, C., Laborne, F. X., Gracies, J. M., Bayle, N., & Hutin, E. (2017). Pattern of improvement in upper limb pointing task kinematics after a 3-month training program with robotic assistance in stroke. *Journal of neuroengineering and rehabilitation*, 14(1), 105. <https://doi.org/10.1186/s12984-017-0315-1> Acesso em: 20 set. 2022
- [23] PINTO, D. de S.; DUARTE, H. B.; COSTTA, C. de A.; DOS ANJOS, J. L. M.; GASPAR, L. C.; MELO, R. L.; MENEZES, C. de S. Segurança na aplicação da eletroestimulação neuromuscular no doente crítico: estudo piloto. *Revista Pesquisa em Fisioterapia*, [S. l.], v. 9, n. 4, p. 464-469, 2019. DOI: 10.17267/2238-2704rpf.v9i4.2498. Disponível em: <https://www5.bahiana.edu.br/index.php/fisioterapia/article/view/2498>. Acesso em: 6 maio. 2022.
- [24] Rahbar, M. H., Medrano, M., Diaz-Garelli, F., Gonzalez Villaman, C., Saroukhani, S., Kim, S., Tahanan, A., Franco, Y., Castro-Tejada, G., Diaz, S. A., Hessabi, M., & Savitz, S. I. (2022). Younger age of stroke in low-middle income countries is related to healthcare access and quality. *Annals of clinical and translational neurology*, 9(3), 415-427. <https://doi.org/10.1002/acn3.51507> Acesso em: 19 set. 2022.
- [25] Rémy-Néris, O., Le Jeannic, A., Dion, A., Médée, B., Nowak, E., Poiroux, É., Durand-Zaleski, I., & REM Investigative Team\* (2021). Additional, Mechanized

- Upper Limb Self-Rehabilitation in Patients with Subacute Stroke: The REM-AVC Randomized Trial. *Stroke*, 52(6), 1938-1947. <https://doi.org/10.1161/STROKEAHA.120.032545> Acesso em: 20 set. 2022
- [26] Rochemont, D. R., Mimeau, E., Misslin-Tritsch, C., Papaix-Puech, M., Delmas, E., Bejot, Y., DeTofol, B., Fournel, I., & Nacher, M. (2020). The epidemiology and management of stroke in French Guiana. *BMC neurology*, 20(1), 109. <https://doi.org/10.1186/s12883-020-01650-2> Acesso em: 19 set. 2022.
- [27] Rochemont, D. R., Mimeau, E., Misslin, C., Papaix-Puech, M., de Toffol, B., Sabbah, N., Delmas, E., Bejot, Y., Fournel, I., & Nacher, M. (2022). A Prospective Comparative Study of Health Inequalities and the Epidemiology of Stroke in French Guiana and Dijon, France. *Frontiers in public health*, 10, 849036. <https://doi.org/10.3389/fpubh.2022.849036> Acesso em: 19 set. 2022.
- [28] Sakai K, Yasufuku Y, Kamo T, Ota E, Momosaki R. Repetitive peripheral magnetic stimulation for impairment and disability in people after stroke. *Cochrane Database Syst Rev*. 2019;11(11):CD011968. Published 2019 Nov 30. doi:10.1002/14651858.CD011968. Acesso em: 12 set. 2022.
- [29] SANTOS NS, *et al.* Facilitação neuromuscular proprioceptiva na marcha em pacientes com sequela de acidente vascular encefálico. *Arquivo de Ciências e Saúde*. 2016; 23(2): 87-91 Acesso em: 15 ago. 2022.
- [30] Takebayashi, T., Takahashi, K., Okita, Y., Kubo, H., Hachisuka, K., & Domen, K. (2022). Impact of the robotic-assistance level on upper extremity function in stroke patients receiving adjunct robotic rehabilitation: sub-analysis of a randomized clinical trial. *Journal of neuroengineering and rehabilitation*, 19(1), 25. <https://doi.org/10.1186/s12984-022-00986-9> Acesso em: 20 set. 2022
- [31] Tomi? T. J., Savi?, A. M., Vidakovi?, A. S., Rodi?, S. Z., Isakovi?, M. S., Rodríguez-de-Pablo, C., Keller, T., & Konstantinovi?, L. M. (2017). Arm Assist Robotic System versus Matched Conventional Therapy for Poststroke Upper Limb Rehabilitation: A Randomized Clinical Trial. *BioMed research international*, 2017, 7659893. <https://doi.org/10.1155/2017/7659893> Acesso em: 21 set. 2022
- [32] Townsend, N., Nichols, M., Scarborough, P., & Rayner, M. (2015). Cardiovascular disease in Europe--epidemiological update 2015. *European heart journal*, 36(40), 2696-2705. <https://doi.org/10.1093/eurheartj/ehv428> Acesso em: 19 set. 2022.
- [33] Ward AB. A literature review of the pathophysiology and onset of post-stroke spasticity. *Eur J Neurol* 2012; 19:21-7. <http://dx.doi.org/10.1111/j.1468-1331.2011.03448.15> ago. 2022.
- [34] Winstein, C. J., Stein, J., Arena, R., Bates, B., Cherney, L. R., Cramer, S. C., Deruyter, F., Eng, J. J., Fisher, B., Harvey, R. L., Lang, C. E., MacKay-Lyons, M., Ottenbacher, K. J., Pugh, S., Reeves, M. J., Richards, L. G., Stiers, W., Zorowitz, R. D., & American Heart Association Stroke Council, Council on Cardiovascular and Stroke Nursing, Council on Clinical Cardiology, and Council on Quality of Care and Outcomes Research (2016). Guidelines for Adult Stroke Rehabilitation and Recovery: A Guideline for Healthcare Professionals from the American Heart Association/American Stroke Association. *Stroke*, 47(6), e98-e169. <https://doi.org/10.1161/STR.0000000000000098> Acesso em: 21 set. 2022
- [35] Wissel J, Manack A, Brainin M. Toward an epidemiology of poststroke spasticity. *Neurology* 2013;80(Suppl 2):S13-9. <http://dx.doi.org/10.1212/WNL.0b013e3182762448>. Acesso em: 15 ago. 2022.
- [36] Zuber, M., & Mas, J. L. (1992). Epidémiologie des accidents vasculaires cérébraux [Epidemiology of cerebrovascular accidents]. *Revue neurologique*, 148(4), 243-255. Acesso em: 20 set. 2022.