National Institute of Health Stroke Scale, modified Rankin Scale and modified Thrombolysis in Cerebral Infarction as autonomy predictive tools for stroke patients. A review.

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Autonomy predictive tools of stroke patients. A review.

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Abstract

Whereas mortality from ischemic stroke is decreasing in all age groups, the prevalence of stroke continues to increase. Its increasing incidence in the younger population adds to the large number of survivors who will live many years with their disabilities related to stroke. Thus, the objectives of this study are to determine the National Institutes of Health Stroke Scale (NIHSS), the modified Rankin Scale (mRS), and the modified Thrombolysis in Cerebral Infarction (mTICI) as adequate prognostic functionality tools for stroke patients and to analyze the relation between stroke and rehabilitation. This study involved a systematic review. We obtained articles found on Google Scholar and MEDLINE and published from January 2008 to May 2018. The functionality of the patient after a stroke is associated with the likelihood of a hospital readmission, which should be taken into account during the diagnosis. Patients with poor functionality at discharge are also more likely to need long-term care and intensive rehabilitation plans. The severity of the initial stroke is a primary determinant of the clinical outcome. The NIHSS, mRS, and mTICI appear to be predictive tools of the functionality of the patient with ischemic stroke, especially in the acute phase. Rehabilitation demonstrates better results in reducing disability and greater participation

of affected people.

Keywords: autonomy, ischemic, reperfusion, stroke.

Background

Acute stroke is the third cause of mortality worldwide, the first cause of disability in the adult population in developed countries, and the second cause of dementia (Guiu-Guía et al., 2009). Its incidence increases according to age, with stroke being directly proportional to the aging population at 280 per 100 000 hab/year (>20 years). Hospital mortality due to stroke ranges from 8% to 14% depending on age, severity, previous functionality, and the associated disease (Mata et al., 2011). The global mortality is 32% (Guiu-Guía et al., 2009). Mortality is decreasing, and this reduction is related to the specialization of specific care units and early detection and treatment protocols (Instituto Nacional de Estadística, 2013). Whereas mortality from ischemic stroke is decreasing in all age groups, the prevalence of stroke continues to increase. The trend in the younger population is an increasing incidence of acute ischemic stroke, which adds to the large number of survivors who will live many years with stroke-related disabilities (Krishnamurthi et al., 2015).

Six months after a stroke, 26.1% of the patients died, 41.5% achieved an independent life, and 32.4% were dependent on their family. Of those who achieved an independent life, approximately 44% suffer from functional dependence (Guiu-Guía et al., 2009). The functionality of the patient after a stroke is associated with the likelihood of a hospital readmission, which is an important result during the diagnosis, taking into account the latest recommendations of Medicare readmission. Patients with poor functionality at discharge are also more likely to need long-term care and intensive rehabilitation plans, which implies a greater financial impact and more serious consequences for the stroke survivor's family (Jain et al., 2016).

Increased attention to the stroke patient has commonly focused on the acute phase, where recent medical efforts and advances have reduced morbidity and mortality. However, studies

focused on the subacute phase are less frequent, and few studies focus on longer-term evolution improvement, which continues in most cases during the first 3–6 months; and finally a chronic phase of functional stabilization. Some authors postulate a progressive functional improvement after 12 months when it is accompanied by rehabilitative treatment and, on the contrary, a progressive functional deterioration in the absence of a specific rehabilitative therapy (Mata et al., 2011).

In relation to the acute phase, the severity of the initial stroke is a primary determinant of the clinical outcome in patients with acute ischemic stroke. Different measures of stroke severity have been developed that include the Scaling Scale of the National Institutes of Health Stroke Scale (NIHSS), among others, but the modified Thrombolysis in Cerebral Infarction (mTICI) is not used frequently as a prognostic functional tool (Dargazanli et al., 2017).

This paper aims to determine the most adequate prognostic functionality tool for stroke patients, including the mTICI, the NIHSS, and the modified Rankin Scale (mRS), and to analyze the relation between stroke and rehabilitation. (Mata et al., 2011).

Material and methods

Search strategy

This review was developed by consulting the search engines Scholar Google and Medline Database. They were searched for publications from January 2008 to May 2018 and there were included articles written in English or Spanish.

First, in a preliminary search to put the work into context, there were identified articles dealing with incidence, prevalence, mortality and health results related with acute ischemic stroke.

After the preliminary search, the next combination of terms was used to delimit the search: “stroke”, “acute”, “ischemic”, “autonomy” “functionality”, “thrombectomy”, “mecanical”, “NIHSS” “mRS”, “mTICI” and “dependence” interrelated with the Boolean “AND” or “and”.

The keywords were: stroke, ischemic, modified Rankin scale, National Institutes of Health Stroke Scale, Stroke stage, activities of daily living (ADL), reperfusion, autonomy.

The NIHSS scale scores the severity of stroke numerically (mild, <4; moderate, <16; severe, <25; very severe, ≥25). It should be applied at the beginning and during the evolution of the stroke. Its minimum score is 0, whereas the maximum score is 42. It also indicates the need for revascularization treatment; furthermore, it has a prognostic value for autonomy results (Queralt-Tomas, 2015).

The mTICI assesses cerebral perfusion. Its value ranges from 0 to 3, with 0 = absence of perfusion and 3 = complete anterograde reperfusion, with total reperfusion in the distal branches.

The mRS is an instrument that measures the degree of disability or dependence in the daily activities of people who have suffered a vascular accident or other causes of neurological disability. Its value goes from 0 to 6, with 0 = absence of symptoms and 6 = death.

Study inclusion criteria

This review was based on the Centro Cochrane Iberoamericano traductores (2012) assessment criteria:

Type of Study

- Review.
- Meta-analysis.
- Cohorts.

- Cases and controls.
- Descriptive.

Type of participants

- Humans.

Intervention type

- Acute ischemic stroke has a great impact on patient autonomy.
- To establish functional outcome tools.

Outcome measures

The studies were evaluated in terms of the following:

- *Primary outcomes:*
  - The NIHSS is a relevant functional outcome tool.
  - The mRS is a relevant functional outcome tool.
  - The mTICI is a relevant functional tool.
- *Secondary outcomes:*
  - To determine the relation between stroke and rehabilitation.
  - Functional tools are important to early activate rehabilitation resources in stroke patients.

Study selection

Two review authors independently assessed the titles and abstracts of all the documents found by the search for relevance against the inclusion criteria. The review team retrieved full-text versions of potentially eligible studies and independently assessed the papers for eligibility, with disagreements resolved through input by a third author.

Methodologic Quality

Quality assessment was independently performed by two members of the research team. The Downs and Black's (1998) Risk of Bias checklist was chosen.

Results and discussion

Search strategy results and assessment criteria results

Excluded articles

- From MEDLINE, 53 items were found, but 50 of them were removed after applying the assessment criteria. One article was excluded due to a duplicate in the database.
- From Google Scholar, 1656 items were found, and 1635 of them were removed after applying the assessment criteria.

Included studies

Twenty three articles were selected that satisfied the assessment criteria at systematic research.

- From MEDLINE, 2 articles that satisfied the assessment criteria were selected.
- From Google Scholar, 21 articles were included as selected articles for this review.

Outcomes

The studies were evaluated in terms of the following:

- Primary outcomes:
    - 6 studies determine that NIHSS is a relevant functional outcome tool.
    - 14 studies analyze that mRS is a relevant functional outcome tool.
    - 6 studies determine that mTICI is a relevant functional tool.
- Secondary outcomes:
    - 21 articles determine that NIHSS, mTICI and mRS are important to early activate rehabilitation resources in stroke patients.

Review results

Table 1 showed the different studies included from Google Scholar and Table 2 shows the studies included from the Medline.

Downs and Black's (1998) Risk of Bias checklist showed good-excellent quality of studies; however, five articles were considered fair (Figure 1).

NIHSS as a prognostic functionality tool

Initial measures of the severity of the stroke are always reported and represent the best pretreatment measure to predict the outcome and to have an initial idea of the resources needed to implement the relevant care for the patient after a stroke episode. Other magnitudes measuring stroke severity that include posttreatment information may be better predictors of clinical and functional outcomes. For example, the change in the NIHSS, infarct volume, and 24 h NIHSS have been shown to be the strongest predictors of subjects' 90-day stroke outcomes (Kerr et al., 2012).

Repeated assessments of the severity of stroke are routinely collected in stroke research studies that provide an opportunity to evaluate longitudinal and retrospective data on functional outcomes after discharge of the patient (Zhao et al., 2018).

The NIHSS was designed primarily as a research instrument but may also be useful in clinical practice. It is routinely applied to patients who have an acute stroke. Although there have been previous studies that relate the severity of the stroke to the expected mortality, there is scarce information about the use of the NIHSS as a prediction tool of functional results (Jain et al., 2016).

Although the predictive performance of repeated evaluations at 5 and 30 days of stroke severity was also investigated in different articles, the improvement in the predictive capacity

of repeated evaluations after the first 48 h was negligible. It has been established that the fast treatment of stroke patients yields good clinical results; however, the repeated early assessment of the severity of the stroke may be useful to develop appropriate tools for determining the functional risk, which help making clinical decisions after stroke treatment (Queralt-Tomas, 2015).

Even so, the knowledge of the results of the stroke in the long term, that is to say, after the first year, is scarce. With the global burden of stroke increasing (Wardlaw et al., 2003), estimates of long-term outcomes and assessment of prognostic factors are increasingly important to plan resources for health services, provide evidencebased rehabilitation after acute care, and also offer information for patients and their families (Tan Tanny et al., 2013).

mTICI as a prognostic functionality tool

Successful reperfusion is considered as the main driver to promote a good functional outcome (Manning et al., 2016), which is supported by a meta-analysis of recent randomized controlled trials (Badhiwala et al., 2015).

The mTICI is included in 'successful reperfusion', which is considered the technical endpoint to be noted in each stroke intervention (Goyal et al., 2013; Yoo et al., 2013).

Recently, two studies have made a compelling case; it was shown that patients with complete reperfusion (mTICI3) have less severe neurological deficits, shorter acute hospital stays, and a better functional outcome on day 90 compared to patients with almost complete reperfusion (mTICI2b; Dargazanli et al., 2017; Kleine et al., 2016).

mRS as a prognostic functionality tool

In relation to the subacute phase, the evaluation of the functional status of the basic ADL is recorded in only 24.6% of the cases at discharge and for 6 months after the episode in the

database of primary care. Functional status after a stroke is a predictor of long-term mortality (Queralt-Tomas, 2015; Ido et al., 2018).

The clinical benefit of treatments for stroke is usually evaluated to assess the functional outcomes at least 3 months after a stroke, when most of the acute recovery has occurred. The spectrum of stroke outcomes can be assessed using the mRS (Lees et al., 2012; Malhotra et al., 2017), which is the most prevalent outcome measure in the trials published in the last decades (Wilson et al., 2017).

The score of the mRS at 3 months after onset is widely used as a clinical outcome in patients with stroke and is a validated measure of functional outcome after a stroke (ranging from 0 = no symptoms to 6 = death), commonly used in large-scale stroke trials and prospective disability studies postictus (Van Hooff et al., 2014). The utility of the mRS has been proven in modified telephone interviews (Bruno et al., 2010, 2011) and at different times after a stroke (Ovbiagele and Saver, 2010). Several previous studies of stroke outcomes have used the mRS in their prediction models, including the multinational Virtual International (Rost et al., 2016).

The 90-day mRS is also the primary outcome measure recommended in acute stroke trials by the European Stroke Organization Working Group (Lees et al., 2012). Stroke treatment is complex and expensive, with effective treatments that include stroke unit care, intravenous thrombolysis with recombinant tissue plasminogen activator (tPA), and, more recently, thrombectomy with stent retriever devices (Berkhemer et al., 2015). The implementation of new treatments requires the evaluation of both the cost and the results in relation to the available alternative interventions or the current practice using costeffectiveness analysis. Reliable cost data relating the mRS by category would be valuable for the broader cerebrovascular accident community when these types of economic health assessments are carried out (Wilson et al., 2017).

Consistently, the studies identified evidence that the increase in the severity of the mRS was associated with the increase in direct medical costs. It is important to evaluate direct medical costs in specialized hospitals, as a patient who has achieved a mRS of 0 through expensive treatment such as thrombectomy (Ganesalingam et al., 2015) will have few or no extra hospital costs but will have high direct medical costs.

Results in acute stroke trials are often based on shortterm mRS, but there are few data from prospective studies on how this measure translates into long-term outcomes (Ganesh et al., 2017).

Rehabilitation and stroke

In Spain, results were published after rehabilitation of patients with initial disability between moderate and very severe categories. Between 60% and 75% of these patients with moderate to very severe impairment recovered their independent walking capacity, and close to 50% recovered the functional independence in ADL, obtaining functional gains with multidisciplinary rehabilitation treatment, in acute and subacute phase, more than 50 points on the Barthel scale (Duarte et al., 2010).

The need for evaluation and rehabilitative treatment after a stroke is collected by the main clinical practice guides in Europe and North America. Also, the existing guides in Europe and North America include the need for rehabilitation in the acute and postacute phases (Duarte et al., 2010). The preparation of these guides that, based on scientific evidence, lay the foundations for the most appropriate treatment is, of course, very useful, but it is not enough. We must also make sure of its compliance throughout the process (Mata et al., 2011). In addition, interventions that facilitate prolonged participation in physical activity not only demonstrate better results in reducing disability but also in greater participation of affected people (Queralt-Tomas, 2015).

Conclusion

The NIHSS, mRS, and mTICI appear to be predictive tools of the functionality of the patient with ischemic stroke, especially in the acute phase. Rehabilitation demonstrates better results in reducing disability and greater participation of affected people.

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Conflict of interest statement:

The authors declare no conflicts of interest.

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Table 1. Analysis of the content of the included articles from Scholar Google. Items shown in order of appearance.

Author and year	Type of Study	Sample	Measures	Results
Kerr et al. 2012	cases and controls	4.712 subjects	mRS NIHSS	NIHSS is a good predictive functional tool in acute stroke patients
Queralt, 2015	longitudinal prospective study	1,678 episodes of stroke	NIHSS Barthel DRGs	The simplification and standardization of all the evaluation processes of dependence is necessary by public administration to avoid repetitions with different instruments and routes from different sources.
Wardlaw et al. 2014	Systematic Review and meta-analysis	5727 patients	Deaths, Fatal intracranial haemorrhage; Symptomatic intracranial Haemorrhage.	Thrombolytic therapy appears to result in a significant net reduction in the proportion of patients dead or dependent in activities of daily living.
Tan Tanny et al. 2013	meta-analysis	378 patients	NIHSS mRS	Intravenous tPA within 4.5 hours represents a cost-effective intervention for acute ischemic stroke.

Manning et al. 2016	Review	45 references	NIHSS mRS TICI	Achieving quality reperfusion of the ischaemic penumbra is critical to success.
Badhiwala et al. 2015	Meta-analysis	2423 patients	NIHSS ASPECTS mRS Odds Ratio	Among patients with acute ischemic stroke, endovascular therapy with mechanical thrombectomy vs standard medical care with tPAwas associated with improved functional outcomes and higher rates of angiographic revascularization
Yoo et al. 2013	Multicenter retrospective study	308 patients	mRS TIMI/TICI NIHSS	mTICI is superior to TIMI for predicting clinical outcome after intra-arterial therapy. mTICI 2b to 3 is the optimal biomarker for procedural success.
Kleine et al. 2017	Retrospective analysis	352 patients	NIHSS TICI mRS	Neurologic outcome is substantially better in TICI 3 than TICI 2b patients, and hospital stays are shorter. Endovascular strategies that consequently strive to achieve TICI 3 may be warranted and cost-effective.

Dargazanli et al. 2016	retrospective analysis	222 patients	mRS TICI NIHSS ASPECTS	Patients with modified TICI 3 reperfusion have better functional outcomes than those with modified TICI 2b.
Lees et al. 2012	Review	50 articles included	mRS NIHSS Barthel GOS EuroQol-5D	The preferred outcome measure for acute trials is the modified Rankin Scale, assessed at 3 months after stroke onset or later.
Malhotra et al. 2017	Review	2 studies included 1467 pactients	mRS	Large-vessel occlusions cause a little more than one-third of acutely presenting Acute ischemic stroke, but are responsible for three-fifths of dependency and more than nine-tenths of mortality after Acute ischemic stroke. At the population level, endovascular thrombectomy has a disproportionate benefit in reducing severe stroke outcomes.
Wilson et al. 2017	Systematic review	13 studies	mRS	This work has provided a foundation from which to address the need for the development of guidelines for health

				economic data and promotion of its importance amongst current and future trialists in the area of stroke
Van Hooff et al. 2014	Prospective study	169 patients	NIHSS mRS	All eight clinical models for outcome prediction after thrombolysis for acute ischemic stroke showed fair predictive value in patients treated according daily practice. The s-TPI had the best discriminatory ability and was well calibrated in this study.
Bruno et al. 2010	Descriptive	50 p atients	smRSq	The smRSq appears to have very good reliability that is similar to that of a structured interview mRS
Bruno et al. 2011	Descriptive	50 patients	SF-12v2 smRSq	The slightly revised smRSq appears to be useful in clinical stroke; it has excellent reliability in person and by telephone, can usually be administered in 1.5 minutes by a wide variety of raters, and correlates with quality of life.

König et al. 2008	Descriptive	5419 patients	Barthel NIHSS	For acute ischemic stroke patients included in controlled trials, easy-to-apply prognostic models based on age and National Institutes of Health Stroke Scale score correctly predicted survival and functional recovery after 3 months. Furthermore, a simple adaptation helps to adjust for a different prognosis and is recommended if a large data set is available.
Ovbiagele et al. 2010	Descriptive	624 subjects	mRS NIHSS mRS	Global disability status 1 week after an index ischemic stroke strongly predicts final 3-month disability outcome. Functioning at 1 week, supplemented by initial stroke severity and congestive heart failure history information, may provide an early outcome guide useful for patient and family counseling.
Berkhemer et al. 2015	Cases and controls	500 patients	NIHSS mRS ASPECTS	In patients with acute ischemic stroke caused by a proximal intracranial occlusion of the anterior circulation, intraarterial treatment administered within 6 hours after stroke onset was effective and safe.

Ganesalingam et al. 2015	Cost-analysis	46 references	QALY NIHSS mRS	Although the upfront costs of thrombectomy are high, the potential quality-adjusted life year gains mean this intervention is cost-effective. This is an important factor for consideration in deciding whether to commission this intervention.
Ganesh et al. 2017	Desceiptive	1403 patients	mRS	Functional recovery continues to occur between 3 months and 1 year post-stroke, but disability by 3 months strongly predicts long-term stroke-related death/dependency. By extending follow-up to 1 year, trials can capture most salient differences in long-term disability and index-stroke-related deaths.
Duarte et al. 2009	Review	41 references	Stroke Rehabilitation Community reinsertion	Stroke rehabilitation maybe improved by multidisciplinary team.

Table 2. Analysis of the content of the included articles from Medline database. Items shown in order of appearance.

Author and year	Type of Study	Sample	Measures	Results
Zhao et al. 2018	Descriptive	89 patients	NIHSS 3-ISS ASPECTS TICI mRS	Over half of acute ischaemic stroke patients can achieve favorable long-term outcomes post-endovascular thrombectomy. Higher baseline NIHSS scores and sICH are independently associated with unfavorable outcome. Overall, clinical practice in this single canter can replicate the long-term outcomes from the published endovascular clinical trials.
Ido et al. 2018	Descriptive	9,620 patients	Mortality	The study indicates that, after taking into account patient differences and lost value, intravenous alteplase is associated with the reduction of long-term mortality and reinforces the importance of the rapid identification and treatment of eligible patients.

Items are shown in order of appearance.

Fair articles	Manniing et al. 2016.
	Goyal et al. 2013.
	Duarte et al. 2009.

Figure 1. Fair results of Downs and Black (1998) Risk of Bias checklist.