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Proposal of a Functional Prognostic Scale in Mexican Patients with Guillain-Barré Syndrome

Edwin S. Vargas-Cañas[1], Juan C. López-Hernández[1,2]*, Sandra Badial-Ochoa[1], Javier Galnares-Olalde[1], Victoria Martínez-Angeles[3], Elliot Hernández-Angelino[2], David Domínguez-Romero[2], and Raúl Medina-Rioja[2]

[1]Neuromuscular Diseases Clinic, [2]Emergency Department, and [3]Department of Neuropsychiatry, Instituto Nacional de Neurología y Neurocirugía "Dr. Manuel Velasco Suárez", Mexico City, Mexico

ABSTRACT

Background: There is currently no prognostic scale for patients with Guillain-Barré syndrome (GBS) in the Mexican population. **Objective:** The objective of the study was to examine the factors associated with functional prognosis by proposing short-term and long-term prognostic scales. **Methods:** Prospective cohort of patients with GBS at an academic medical center, with neuroconduction study and 6-month follow-up. Through logistic regression, we evaluated clinical and paraclinical variables, and the results are expressed as odds ratios 95% confidence intervals [CIs]). We used a scale to predict poor functional prognosis. The performance of the scale was assessed using the area under the curve (AUC). **Results:** A total of 259 patients (age 46.1 ± 16.1 years) were included in the study; 38.6% had a history of diarrhea, and 42.8% had an axonal variant. The rates of poor functional prognosis were 36.6% and 22.7% at 3 and 6 months of follow-up, respectively. The following variables were included in the univariate logistic regression: age ≥ 70 years, history of diarrhea, axonal variant, and Medical Research Council score. We performed a prognostic scale (0-9 points), with AUC of 0.81 (95% CI: 0.75-0.86) at 3 months, and 0.82 (95% CI: 0.76-0.87) at 6 months, which was higher than the modified Erasmus Guillain-Barré Outcome Score scale at admission (AUC: 0.75. 95% CI: 0.69-0.81 and AUC: 0.78. 95% CI: 0.72-0.83). **Conclusion:** The proposed prognostic scale performs well in discerning poor functional prognosis in short- and long-term frames among Mexican patients. (REV INVEST CLIN. 2024;76(6):253-61)

Keywords: Guillain-Barré syndrome. Prognostic scale. Prognostic. Mexican patients.

INTRODUCTION

Guillain-Barré syndrome (GBS) is the predominant cause of acute flaccid paralysis worldwide and affects individuals in both developed and developing countries. Despite early diagnosis and treatment with intravenous human immunoglobulin (IVIg) or plasma exchange (PE), approximately 20% of patients experience a long-term poor functional prognosis, which primarily involves the inability to walk independently[1]. The pathophysiology of the syndrome involves a misdirected immune response targeting the peripheral

***Corresponding author:**
Juan C. López Hernández
E-mail: juanca9684@hotmail.com

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nerves, which is often precipitated by an environmental factor (typically represented by respiratory or gastrointestinal infections in 70% of the cases), in immunologically susceptible individuals[2]. GBS manifests with certain commonalities across countries; specifically, it predominantly affects the working-age group from 33 to 64 years- old, and it has a higher prevalence in men than in women (male-to-female ratio: 3-2)[2,3]. Notably, the frequency of electrophysiological variants exhibits geographical disparities. For example, acute inflammatory demyelinating polyneuropathy (AIDP) accounts for 90-95% of cases in European nations, the United States, and Canada, whereas axonal variants such as acute motor axonal neuropathy (AMAN) and acute motor-sensory axonal neuropathy are more common in Asian and Latin American countries, including Mexico[1]. These axonal types are often linked to a dire functional prognosis compared with AIDP, with antecedent events of diarrheal correlating with more severe presentations and a poor functional prognosis[2,4]. The recognition of clinical and electrophysiological markers of poor prognosis in GBS patients is crucial in clinical settings, thus incentivizing the development of prognostic scales. The modified Erasmus Guillain-Barré Outcome Score (mEGOS) is the most commonly used clinical tool; it was initially developed for the Dutch population and subsequently validated internationally, although its efficacy varies across different countries for example, in the Mexican population its performance is unknown[5,6].

As previously mentioned, the mEGOS scale is the most widely used prognostic tool worldwide; however, its effectiveness should be assessed in each specific population. It is also important to consider the idea that both the clinical presentation and functional prognosis of patients with GBS can vary between populations. For instance, in the Mexican population, the axonal variant is the most common disorder type, with a prevalence of 45%. Therefore, the development of a prognostic scale tailored to the characteristics of a particular population would be highly clinically useful[4].

The aims of the current study are to describe the short- and long-term functional prognoses in a prospective cohort of a Mexican population diagnosed with GBS, introduce a prognostic scale tailored for Mexican GBS patients, and evaluate its efficacy relative to the mEGOS scale.

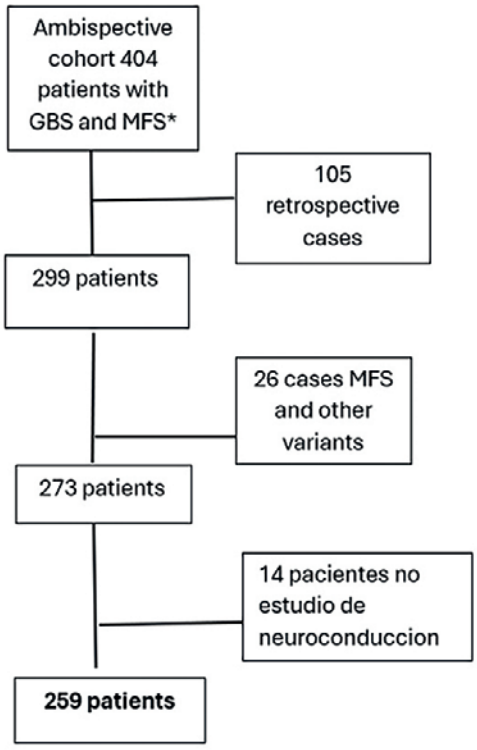
METHODS

This observational and analytical study utilized an ambispective cohort of adult patients (≥ 18 years) diagnosed with GBS, based on Asbury's criteria[7], from a single, third-level medical center in Mexico, from January 2018 to December 2023. We included patients who were diagnosed with GBS, who received treatment with PEs or IVIg, who completed a neuroconduction study, and who had a minimum prospective follow-up of 6 months. We excluded patients diagnosed with Miller-Fisher syndrome (MFS) with no clinical data overlapping with GBS and other variants (facial biparesis with areflexia, pharyngo-cervico-brachial GBS, or Bickerstaff encephalitis) because these patients generally have a good functional prognosis and present without weakness in the lower extremities[2]. We also excluded patients who did not receive treatment (PE or IVIg). The extracted clinical characteristics included age, sex, and the time interval from symptom onset to diagnosis, prior infection (gastrointestinal or respiratory) within 4 weeks before GBS symptoms, cranial nerve affliction, and muscle strength, as assessed through the Medical Research Council (MRC) scale at the time of diagnosis. The score of the scale ranges from 0 to 60 points, and it evaluates the strength of the muscles through the Daniels scale in a bilateral manner in: the deltoids, biceps, carpal extensor, iliopsoas, quadriceps and tibialis anterior. In addition, the GBS disability scale scores upon admission, modified Erasmus Guillain-Barré Outcome Score (EGOS) scale scores, and specific administered treatments were recorded. Hadden's criteria[8] were applied to categorize the neuroconduction findings into electrophysiological variants, and the time period from symptom onset to study completion was recorded.

A poor functional prognosis, which was defined as non-independent walking (GBS disability scale score ≥ 3 points), was determined for short-term (3 months) and long-term (6 months) durations[9].

We developed a prognostic scale model using clinical variables that were previously identified as being prognostic factors in our population of patients with GBS, including age (≥ 70 and < 70 years) and the axonal electrophysiological variant[10,11]. In addition, we incorporated variables from the mEGOS scale, such as a history of diarrhea and the MRC score. The MRC score was categorized into different ranges[5].

Figure 1. Flowchart of included and excluded patients. GBS: Guillain-Barré syndrome; MFR: Miller-Fisher syndrome.



Ethical considerations

This study was approved by the Ethics Committee of the National Institute of Neurology and Neurosurgery Dr. Manuel Velasco Suárez.

Statistical analysis

Descriptive analyses were used to evaluate the distribution of continuous variables through the Kolmogorov–Smirnov test, and the results are reported as the means with standard deviations or medians with interquartile ranges (IQRs); additionally, categorical variables are reported as frequencies and percentages. Clinical and electrophysiological factors associated with poor functional prognosis (such as non-independent walking) were examined through binary logistic regression for both short-term (3 months) and long-term (6 months) follow-up periods, with the findings presented as odds ratios (OR) with 95% confidence intervals. A $p < 0.05$ was considered to be statistically significant.

This study presented the use of a scoring system (ranging from 0 to 9 points) for predicting poor functional prognosis, based on logistic regression outcomes. A higher score indicated a greater likelihood of non-independent walking. The efficacy of the proposed scale and mEGOS in predicting non-independent walking at 3 and 6 months was evaluated through an area under the curve (AUC) analysis.

All of the statistical analyses were conducted through the Statistical Packages for the Social Sciences statistical software, version 22.0.

RESULTS

General characteristics of the population

From an ambispective cohort of 404 patients, 145 patients were excluded from the study, including: 105 retrospective cases, 26 cases with MFS and 14 cases involving other variants with patients who did not participate in a neuroconduction study (Fig. 1). Ultimately, we included 259 patients in the study; the age of the population was 46.1 ± 16.1 years, 72.2% were male, and 38.6% had a history of diarrhea. Aditionally, the MRC sum score at admission was 32.5 ± 17 points;

Table 1. General characteristics of patients with GBS

Variable	n = 259
Age (years), Mean (SD)	46.1 ± 16.1
> 70, n (%)	16 (6.2)
60-70, n (%)	31 (12)
40-60, n (%)	116 (44.8)
< 40, n (%)	96 (37.1)
Gender (male), n (%)	187 (72.2)
Gastrointestinal infection, n (%)	100 (38.6)
Respiratory tract infection, n (%)	62 (24)
Symptom onset at admission (days), median (IQR)	5 (3-8)
GBS disability score	
1.-Minor signs or symptoms, n (%)	8 (3.1)
2.-Walk without support, n (%)	35 (13.5)
3.-Walk with support, n (%)	36 (13.9)
4.-Bedridden or chairbound, n (%)	130 (50.2)
5.-Ventilated, n (%)	50 (19.39)
mEGOS scale, (score), median (IQR)	6 (3-7)
MRC sum score	
> 40 points, n (%)	86 (33.2)
30-40 points, n (%)	58 (22.4)
20-30 points, n (%)	49 (18.9)
< 20 points, n (%)	66 (25.5)
Cranial nerves affected, n (%)	159 (61.4)
Electrophysiological variants	
AIDP, n (%)	108 (41.7)
Axonal, n (%)	111 (42.8)
Equivocal, n (%)	40 (14.6)
Treatment	
Immunoglobulin n (%)	187 (72.2)
Plasma exchanges, n (%)	72 (27.8)

SD: standard deviation; IMV: invasive mechanical ventilation; AIDP: acute inflammatory demyelinating polyneuropathy; IRQ: interquartile ranges; EGOSm: modified Erasmus Guillain-Barre outcome score; AIDP: acute inflammatory demyelinating polyneuropathy.

and the mEGOS score (median) was 6 (IQR 3-7) points. The time from symptom onset to the neuroconduction study was 7 (IQR: 4-10) days, and the frequency of the axonal variant was 42.8%. The most commonly used treatment was the human immunoglobulin scheme (2 g/kg) which was used in 72.2% of the patients. The remaining general characteristics of the population are reported in Table 1.

Functional prognosis

Among 259 patients, 95 (36.6%) and 59 (22.7%) had not recovered their independent walking status at the 3-month and 6-month follow-up visits, respectively. Via univariable logistic regression, we analyzed clinical and electrophysiological variables for non-independent walking, both at the 3-month and 6-month follow-up periods. Age (years) and MRC score were divided into different categories; moreover, we included electrophysiological variables (the AIDP variant, and axonal variant), and history of diarrhea. All of the variables were statistically significant (Table 2).

Prognostic scale model

Through the logistic regression model (Table 2) of the analyzed variables and with respect to, considering the OR (95% CI) results for the outcome (non-independent walking), we assigned a score to each variable, and these data are summarized in Table 3. This score ranged from 0 to 9 points, with a higher score indicating a higher probability of non-independent walking.

An analysis of the AUC, revealed that the performance of the model for predicting non-independent walking at 3 months had an AUC of 0.81 (95% CI: 0.75-0.86, p = 0.001), and at 6-month follow-up had an AUC of 0.82 (95% CI: 0.76-0.87, p = 0.001), (Fig. 2). The performance of the mEGOS scale for predicting non-independent walking at 3 months in our population had an AUC of 0.75 (95% CI: 0.69-81, p ≤ 0.001) and for 6 months, had an AUC of 0.78 (95% CI: 0.72-0.83, p ≤ 0.001) (Fig. 3).

We analyzed the population in the different score ranges of the proposed scale to observe the frequency of non-independent walking. Among the scores of 8-9, at 3-month follow-up and 6-month follow-up, 83.3% and 61% of the individuals, respectively, exhibited non-independent walking (Table 4).

Table 2. Risk factors for non-independent gait

	Non-independent gait			
	Univariable logistic regression			
Variable	3 months follow-up (n = 95)		6 months follow-up (n = 59)	
Age, years	OR (95% CI)	p	OR (95% CI)	p
> 70, n (%)	1.5 (1.0-2.8)	0.047	1.6 (1.2-7.3)	0.044
60-70, n (%)	0.7 (0.3-1.7)		0.6 (0.2-1.7)	
40-60, n (%)	0.8 (0.4-1.4)		0.8 (4.3-1.5)	
< 40, n (%)	1 (ref)		1 (ref)	
Preceding diarrhea, n (%)	2.3 (1.2-4.1)	0.006	2.3 (1.2-4.1)	0.006
Preceding respiratory infection, n (%)	0.5 (0.2-1.1)	0.06	0.7 (0.3-1.5)	
Axonal variant, n (%)	3 (1.8-5.1)	< 0.001	2.6 (1.4-4.7)	0.002
AIDP (%)	0.6 (0.3-1.0)	0.094	0.5 (0.2-0.99)	0.049
MRC sum score				
41-60, n (%)	1 (ref)	< 0.001	1 (ref)	< 0.001
31-40, n (%)	2.8 (1.2-6.9)		3.1 (1.2-3,6)	
21-30, n (%)	7.2 (3.0-17.3)		13.4 (3.6-49)	
≤ 20-0, n (%)	18.8 (8.0-43.8)		29.3 (8.4-102.4)	

OR: odds ratios; CI: confidence intervals; MRC: medical research council; AIDP: acute inflammatory demyelinating polyneuropathy; 95% CI: 95% confidence intervals.

Table 3. Proposed prognostic scale for poor prognosis (non-independent gait)

Variable	Points
Age, years	
≥ 70	1
< 70	0
Diarrhea	
Yes	1
No	0
Axonal variant	
Yes	1
No	0
MRC score	
41-60	0
31-40	2
21-30	4
≤ 20-0	6
Points: 0-9	

DISCUSSION

GBS is a leading cause of acute flaccid paralysis worldwide, and it affects individuals in both developed and developing countries. Despite early diagnosis and intervention procedures using IVIg or PE, approximately 29% of patients experience a poor functional prognosis, with continued dependence on assistance for walking at 3 months post-diagnosis, which decreases to 15% after 6 months. In the cohort that we investigated, these data were slightly elevated, at 36.7% and 22.8%, respectively[5].

Although prognostic scales are invaluable in clinical practice, their effectiveness varies across different populations. In 2007, van Koningsveld, et al. introduced the EGOS, which incorporates age, a history of diarrhea, and the GBS disability scale measured at 2 weeks post-admission. This clinical tool is able to effectively differentiate patients at risk of long-term dependence, demonstrated through analysis of the AUC, which resulted in a value of 0.85 at 6 months.

Figure 2. Performance of the proposed scale for poor functional prognosis at 3 months **(A)** and 6 months **(B)** of follow-up, as determined through area under the curve analysis.

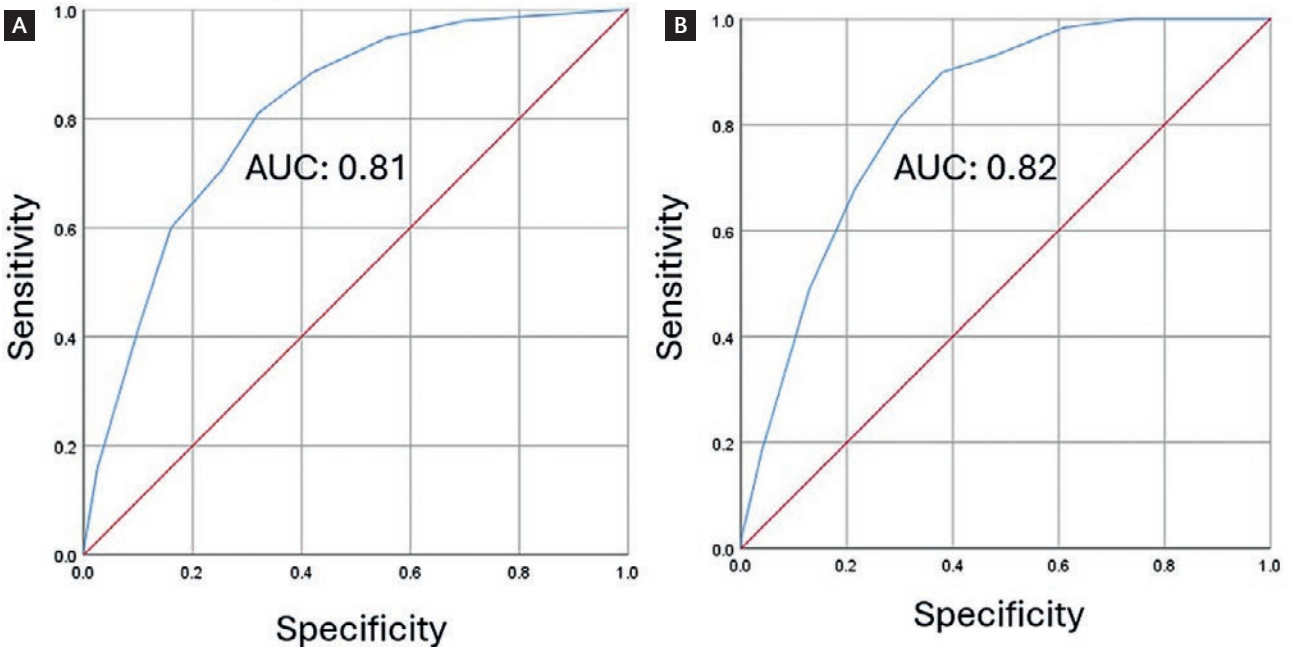
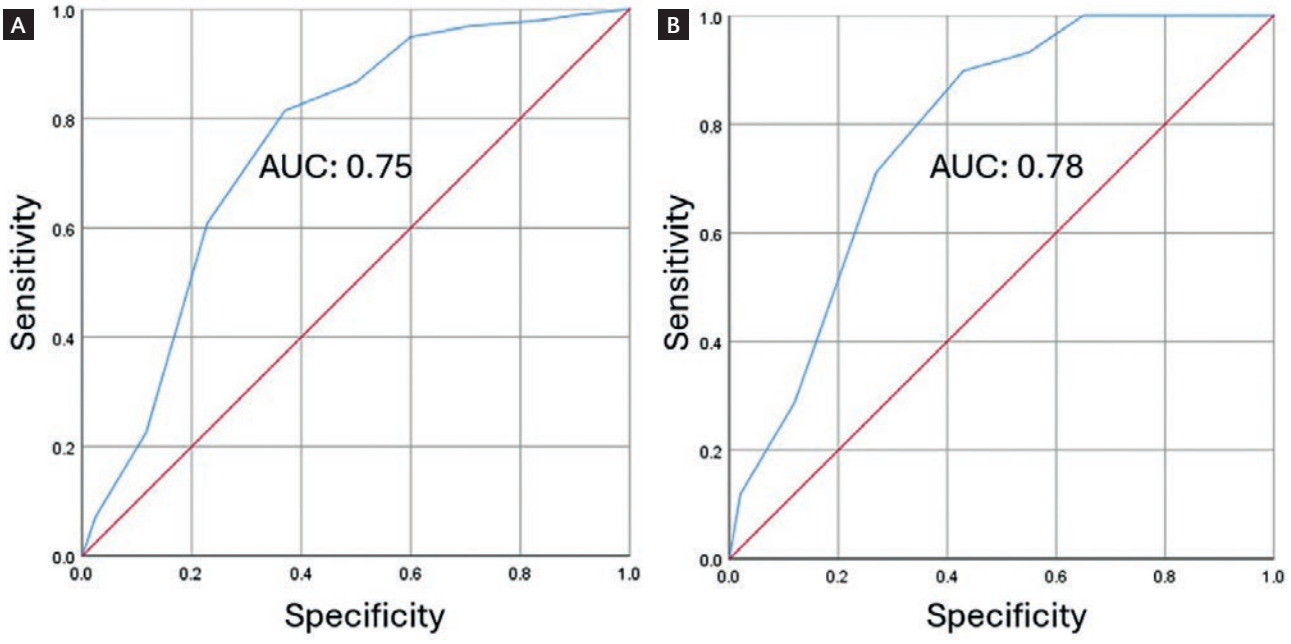


Figure 3. Performance of the mEGOS outcome score scale at admission for poor functional prognosis at 3 months **(A)** and 6 months **(B)** of follow-up in our population, through area under the curve analysis.



However, its application in a cohort of 206 Brazilian GBS patients indicated a reduced predictive ability[12,13]. In 2011, Walgaard, et al. presented the mEGOS, which adjusts the original scale by including the MRC scale scores at admission and after 7 days of hospitalization[5].

At present, mEGOS is widely adopted and validated, particularly in populations with a high incidence of the AIDP variant. In a cohort of 107 patients with GBS in Malaysia, 72.1% had the AIDP variant and 6.6% had the axonal variant. The application of the scale at admission yielded good AUC values of 0.72 and 0.68

Table 4. Proportion of patients with poor functional prognosis (non-recovery of independent gait) at different scores of the proposed scale

Points	3 -month follow-up		6 -month follow-up	
		% (95% CI)		% (95% CI)
0-1	6/80	7.5 (2-1)	2/80	2.5 (0-4)
2-3	12/50	24 (12-36)	4/50	8 (0-16)
4-5	20/46	43 (29-58)	13/46	28.2 (15-42)
6-7	42/65	65 (53-77)	29/65	44.6 (32-57)
8-9	15/18	83.3 (58-96)	11/18	61 (35-85)
Total	95/259		Total 59/259	

95% CI: 95% confidence intervals.

at 3 and 6 months, respectively, and at 7 days AUC of 0.83 and 0.78, 3 and 6 months, respectively[14]. A multicenter retrospective study of 176 patients in Japan (48% with the AIDP variant and 26% with the axonal variant) reported significant correlations between scores on the mEGOS scale (≥ 5, ≥ 6, and ≥ 7 points), both at admission and at 7 days of hospitalization, with higher scores being observed in the functional scale of the GBS at 6 months of follow-up[15]. Recently the mEGOS scale has been validated in different countries, including Spain, the United Kingdom, Germany, the USA, Canada, Argentina (the only country in Latin America), and some Asian countries (Japan, Taiwan, Malaysia, and China), among other locations[6].

The mEGOS, which was developed from a cohort of 394 Dutch patients and later validated in a cohort of 191 patients, is typically applied upon admission and at 7 days of the hospital stay. When deployed within our patient population, the predictive accuracy of the scale at admission was similar to that of previous findings (values of 0.75 and 0.78 for 3- and 6-month prognoses, respectively)5. Notably, the scale's performance improved when it was on the 7th day, with an AUC of 0.84 for both 3- and 6-month outcomes[5].

However, at our institution, we rarely use the mEGOS at 7 days post-admission due to several pragmatic constraints. First, our limited bed capacity requires the early discharge of clinically stable GBS patients, who are then closely monitored through outpatient services. Moreover, logistical delays in treatment administration, such as concerning the scheduling of PEs, often preclude a 7-day evaluation. In addition, we have observed that factors unique to the patient's hospital stay, such as the residual effects of sedation or complications from hospital-associated conditions, may unduly influence the MRC scale score. However, GBS-specific conditions and their treatment can influence the functional prognosis. Some patients who receive treatment with IVIg continue to experience the progression of muscular weakness, and some patients may experience early improvements in muscle strength due to the reversal of electrophysiological functional blocks[16,17].

In Mexico, where the demographic and healthcare landscape of GBS differs markedly from European and North American contexts, we propose the use of a new prognostic scale. This scale accounts for variables such as age, history of diarrhea, and MRC score at admission, with particular emphasis on the axonal variant that is prevalent in our region. Although older age remains a universally recognized risk factor for poor GBS outcomes, the specific age threshold for prognostic use may require regional adaptations[5,18-20]. The aging process and its impact on the functionality of the population are very different from developed countries that in developing countries; therefore, the use of scales that consider age to predict the recovery of functionality should be taken with caution in different countries[21]. In the case of our population, an age of ≥ 70 years was the cutoff point for poor functional prognosis[10].

GBS is caused by an autoimmune process (cellular and humoral) that is directed to the peripheral nerves, and is triggered by some type of environmental agent, moreover, in 70% of cases, it is caused by infectious

agents that result in upper respiratory or gastrointestinal infections (such as diarrhea). A history of diarrhea (in the previous 4 weeks) that may be due to different viral or bacterial infectious agents and is a risk factor for poor functional prognosis[1]. As occurs in the mEGOS predictive model, a history of diarrhea is given a point for poor functional prognosis in our model[5].

Neuroconduction studies are non-invasive and safe procedures that establish the mechanism of damage to the peripheral nerve (demyelinating or axonal types of damage) in patients with GBS, and performing these techniques on one occasion during hospitalization is sufficient[22]. In our population, the axonal variant was the most frequent (42.8%), slightly higher in frequency than the prevalence of AIDP (41.7%), as reported in a study conducted in another Mexican population[1,23]. From a pathophysiological perspective, the axonal variant is due to an autoimmune response caused by molecular mimicry of some structures of the cell wall of the infectious agent *Campylobacter jejuni* against ganglioside molecules located in the peripheral nerve[1]. In a previous study, we reported that patients with the axonal variant had a poorer functional prognosis at 3 months of follow-up than to patients with the AIDP variant, which has been reported in other populations[11]. In a study of 170 patients in China (42.7% with the AIDP variant and 21.7%with the AMAN variant), patients with the AMAN variant had a poorer functional prognosis at both 3 and 6 months of follow-up; in a study conducted in India, patients with the axonal variant had less recovery of independent gait at 6 months of follow-up[11,24]. As in our population, in other populations where axonal variants are more frequent, clinical presentations are more severe, which is reflected by lower MRC scores at admission and, a risk factor for poor prognosis in the short- and long-term time frames[25].

Our scale, which assesses a combination of clinical variables, demonstrates promising AUCs of 0.81 and 0.82 for 3- and 6-month functional prognoses, respectively, thus potentially offering more precise predictions for our population. Nonetheless, we acknowledge the limitations of the scale, including the scale's originating from a single-center observational cohort without external validation. Hence, we advocate for further research to evaluate the scale's effectiveness across multiple centers within Mexico. It is also important to mention another limitation of this study, which is that at our institution, we do not perform culture or serological studies to determine the presence of *C. jejuni* infection in patients with GBS, althought it is related to poor functional prognosis[2,5].

In conclusion, our proposal of the prognostic scale to determine poor functional prognosis in the short- and long-term time periods demonstrated good performance (similar to the mEGOS scale at admission) in our population. However, more studies are needed to assess the performance of the scale in other populations.

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