# Identification of Myasthenia Gravis Exacerbations, Crises, and Symptom Burden Using Rules-Based Natural Language Processing Applied to Neurologist Clinical Notes

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## INTRODUCTION

- Myasthenia gravis (MG) is a rare chronic autoantibody-mediated neuromuscular disorder affecting approximately 60,000 individuals in the United States[1]
- MG is characterized by fluctuating weakness and unpredictable deterioration that may require rescue therapies and hospitalization[2]
- Better understanding is needed of real-world neurologist documentation of clinical encounters, particularly with respect to documentation of MG-related symptoms and clinical deterioration for individuals with MG
- Natural language processing (NLP) has been used in analysis of unstructured clinician text[3] but has not been applied to the care of individuals with MG

## OBJECTIVE

- To assess the feasibility of identifying symptoms and clinical deterioration for individuals with MG as documented in neurologist clinical progress notes

## METHODS

### Study design

- This was a retrospective, cross-sectional, descriptive analysis of de-identified neurologist notes

### Data source

- Medical transcriptions from Amplity Insights were used, including the full text from dictated clinical notes covering 150,000 physicians from over 40,000 clinics and hospitals in the United States between 2017 and 2022
- Notes from non-neurologists and notes with non-standard formatting were excluded from the analysis

### NLP model

- A rules-based NLP model, developed using spaCy (an open-source NLP library), was used to create an analyzable dataset
- The performance of the NLP model was assessed against manual annotations using Prodigy

### Analysis

- Rates of individuals with MG with symptoms relevant to MG and documentation indicating clinical deterioration, including worsening, exacerbations, and crises, were calculated
- The NLP model's performance was assessed using the F1 score—the harmonic mean of precision and recall (2 X Precision X Recall)/(Precision + Recall)
- Qualitative analysis of physician documentation was carried out to further categorize clinical deterioration

## RESULTS

- After applying rules to the medical transcription data including excluding notes by providers other than neurologists and for patients without a confirmed MG diagnosis, 5183 notes were available for analysis (**TABLE 1**)
- Ptosis (34.7%), diplopia (30.0%), dysphagia (23.0%), and fatigue (22.5%) were the most frequently reported MG symptoms (**TABLE 2**)
- A total of 3085 patients with MG were identified, with 12.7% experiencing clinical deterioration events (e.g., exacerbations) and 4.3% experiencing MG crises
- Overall, 37.9% of patients with MG reported "any symptom worsening" during the study period (**TABLE 2**)

**TABLE 1. Note attrition**

| Description of notes | Number of notes removed | Number of notes remaining |
|---|---|---|
| **All available notes that were labeled "myasthenia gravis" or "MG" by Amplity Insights** | 0 | 45,414 |
| **Neurologist notes** | | 6557 (100.0%) |
| Notes limited to a single patient and encounter | 37 | 6520 (99.4%) |
| Notes limited to formatting compatible with NLP analysis[a] | 416 | 6104 (93.1%) |
| Notes limited to patients with confirmed diagnosis of MG | 921 | 5183 (79.0%) |

[a]Notes with carriage returns in the middle of sentences or notes configured as a single paragraph (i.e., unformatted) were excluded to avoid misinterpretation.
**MG**, myasthenia gravis; **NLP**, natural language processing.

- Of note, the use of structured MG disease assessments (e.g., MG-ADL) was limited in physician documentation (<5% of notes)

**TABLE 2. Symptoms and clinical deterioration of patients with MG**

| Population attribute, n (%) | Patients with MG (N=3085) |
|---|---|
| **Age** | |
| <40 years | 172 (5.6) |
| 40–64 years | 599 (19.4) |
| ≥65 years | 1083 (35.1) |
| Missing | 1231 (39.9) |
| **MG symptoms** | |
| Ptosis | 1071 (34.7) |
| Diplopia | 926 (30.0) |
| Dysphagia | 712 (23.0) |
| Fatigue | 693 (22.5) |
| Dyspnea | 626 (20.3) |
| Dysarthria | 514 (16.7) |
| Generalized weakness | 350 (11.3) |
| Extremity weakness | 280 (9.1) |
| Face, bulbar, tongue, or oropharyngeal weakness | 232 (7.5) |
| Respiratory distress or respiratory failure | 171 (5.5) |
| Neck weakness | 121 (3.9) |
| Any symptom worsening | 1169 (37.9) |
| **MG clinical deterioration** | |
| Exacerbations | 391 (12.7) |
| Worsening | 138 (4.5) |
| Crises | 134 (4.3) |

**MG**, myasthenia gravis.

- MG clinical deterioration was defined as exacerbations, worsening, or crises, and was documented in 12.7%, 4.5%, and 4.3% of patients, respectively
- Qualitative review of neurologist text yielded five categories of MG clinical deterioration
- **TABLE 3** displays the five categories of clinical deterioration, with examples of neurologist text extracted from the database

**TABLE 3. Clinical deterioration and representative neurologist text**

| MG clinical deterioration | Representative text |
|---|---|
| MG symptom fluctuation | *"He states the dysphagia is worse in the afternoons and evenings."* |
| MG symptom worsening with treatment intensification | *"With increasing problems with dysphagia and dysarthria, she was started on prednisone 10 mg daily."* |
| MG deterioration with rescue therapy or hospitalization | *"Looking through her medical record, she has been hospitalized nearly every month secondary to exacerbations of her myasthenia gravis."* |
| MG crisis requiring mechanical ventilation | *"Impression: a 50-year-old gentleman with refractory myasthenia gravis resulting in recurrent episodes of respiratory failure requiring intubation and mechanical ventilation."* |
| Suspected MG deterioration | *"Shortness of breath is concerning for possible exacerbation of myasthenia gravis."* |

**MG**, myasthenia gravis.

## LIMITATION

- The NLP model was customized to the existing dataset, and the model's performance may differ for other datasets

## CONCLUSIONS

- The neurologist notes contained rich information regarding MG symptoms and clinical deterioration, although the use of structured instruments was limited
- Documentation of worsening symptomatology is common in MG, highlighting the fluctuating nature of the disease
- Prevalence of MG symptoms in this real-world, cross-sectional analysis of physician notes is lower than in longitudinal studies based upon patient questionnaires. Clinical documentation may focus upon symptoms of greatest importance to the practicing physician at the time of the encounter
- Neurologist documentation of MG deterioration includes a spectrum of disease severity. Qualitative expert review of real-world neurologist documentation yielded five categories of clinical deterioration ranging from mild daily fluctuation to deterioration requiring hospitalization or rescue therapies, to MG crisis requiring mechanical ventilation

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### DISCLOSURES

**JP**, **ZC**, and **AB** are employees of Janssen Scientific Affairs, LLC. **JD**, and **XY** are employees of Health Analytics. **PP** was an employee of Health Analytics at the time the study was conducted. **RG** is an advisor for Janssen Scientific Affairs, LLC, and is a speaker and advisor for Argenx, UCB, and Alexion.

### REFERENCES

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AUTOANTIBODY: MG