

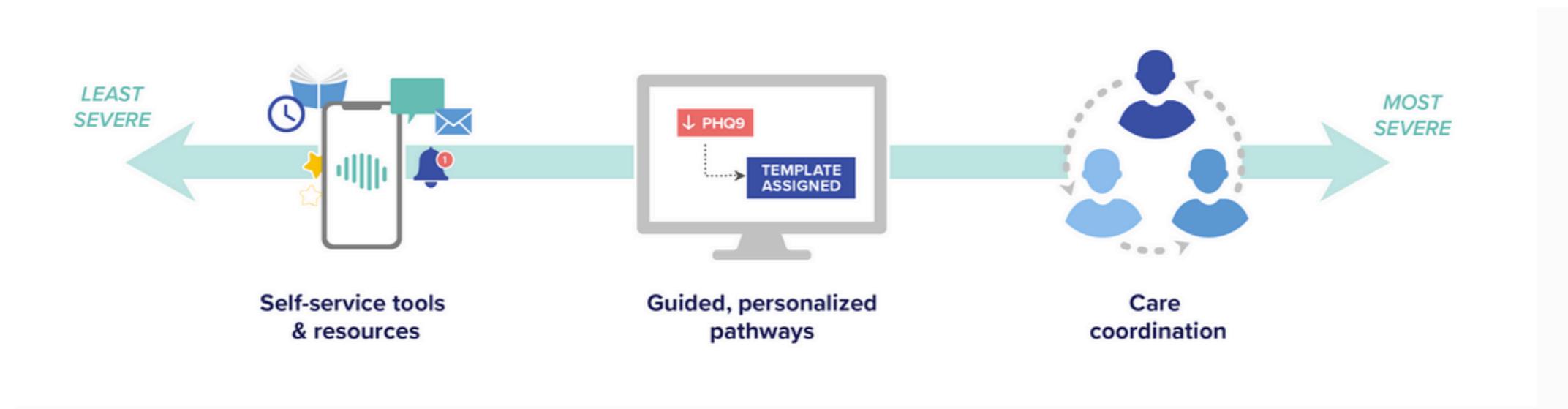
# **NeuroFlow Code**

## **Exercise: Part 1**

**Dr. Rishi Patel**

# Business Impact

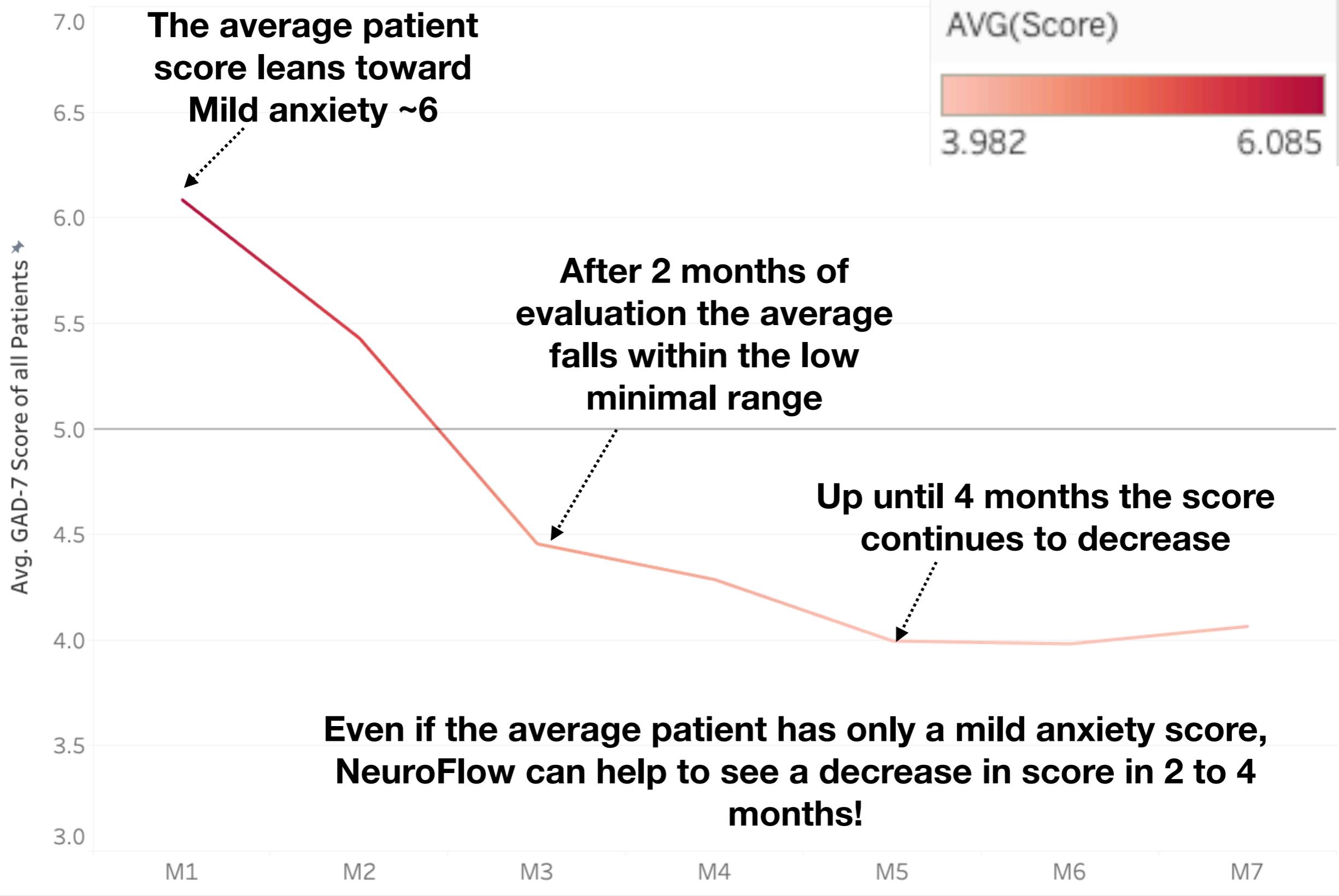
- NeuroFlow provides resources and tools for patients, a template of exercises, and provider care coordination



- For GAD-7 scores, this should result in a steady decrease of patient scores over time (Evaluation months after patient creation date)
  - The average score of all Neuroflow users should decrease over time
  - The fraction of low to minimal range scores should increase across patient evaluation methods, while the fraction of severe scores should decrease
  - Ideally, the standard deviation of scores should also decrease. If the same template is assigned for a given score, then after a certain number of months patients going through the same exercise pathways should have similar severity labels.

## [Interactive Tableau Plot](#)

Average GAD-7 Anxiety Scores vs. No. Months of Evaluation



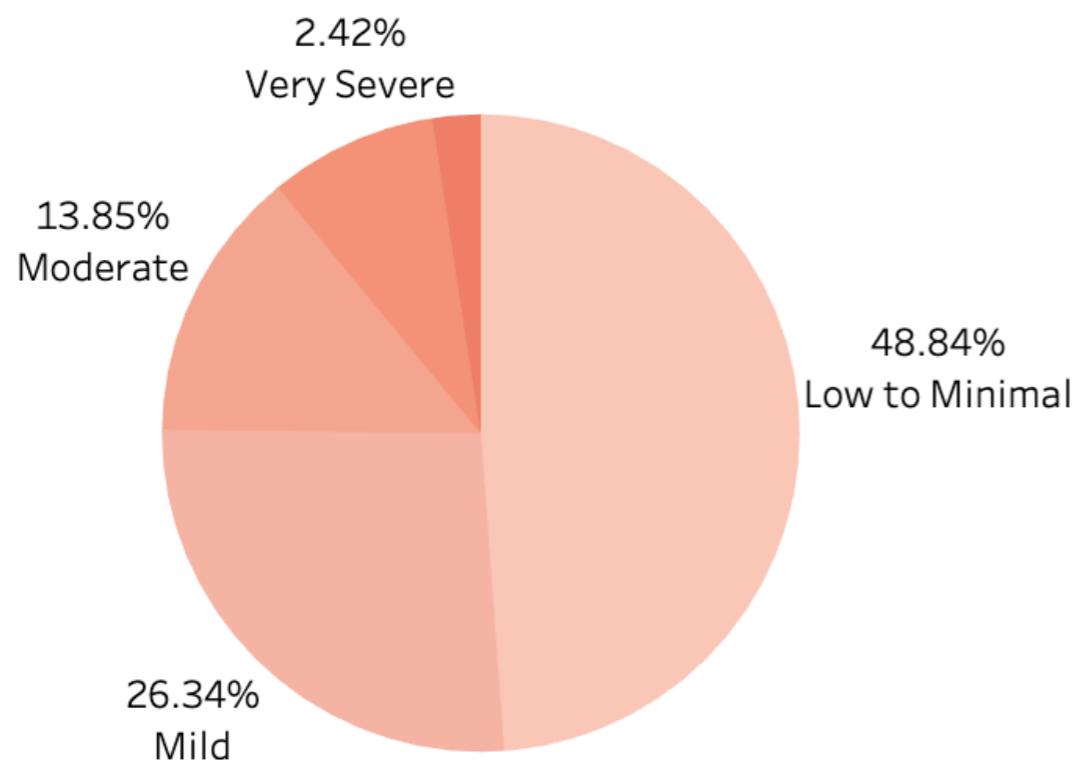
# Breakdown of GAD-7 Scores

GAD-7 Anxiety Score
Low to Minimal
Mild
Moderate
Severe
Very Severe

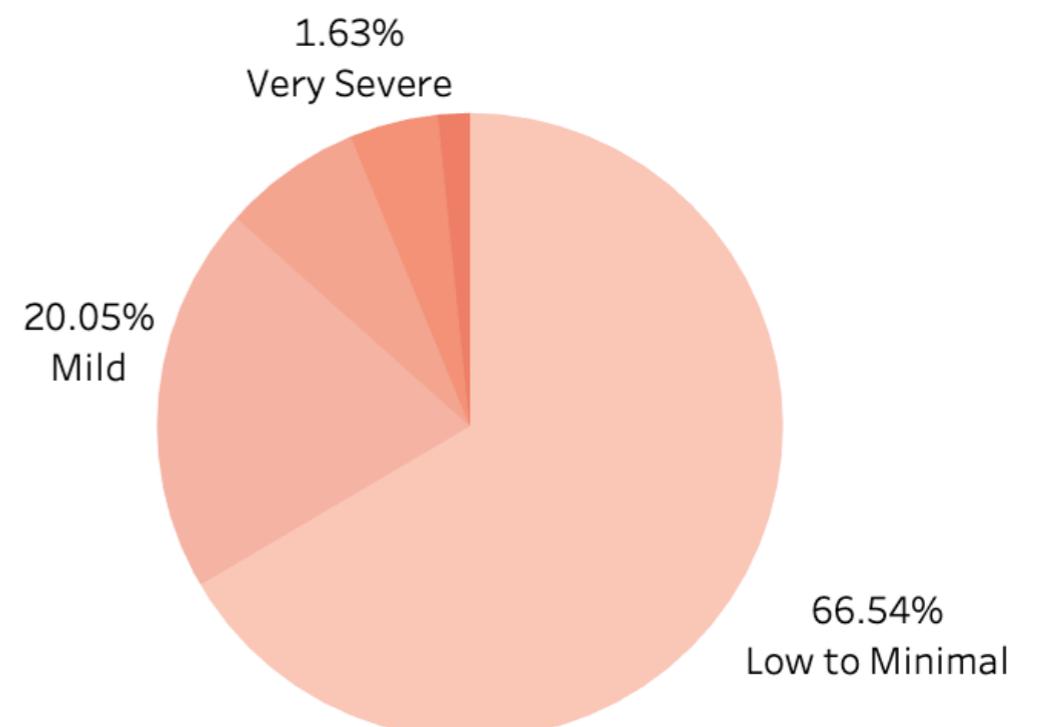
- Substantially lower GAD-7 scores (Low to minimal) after 6 months of evaluation
- Percent of severe patients decreases from 11% to 6%

## [Interactive Tableau Plot](#)

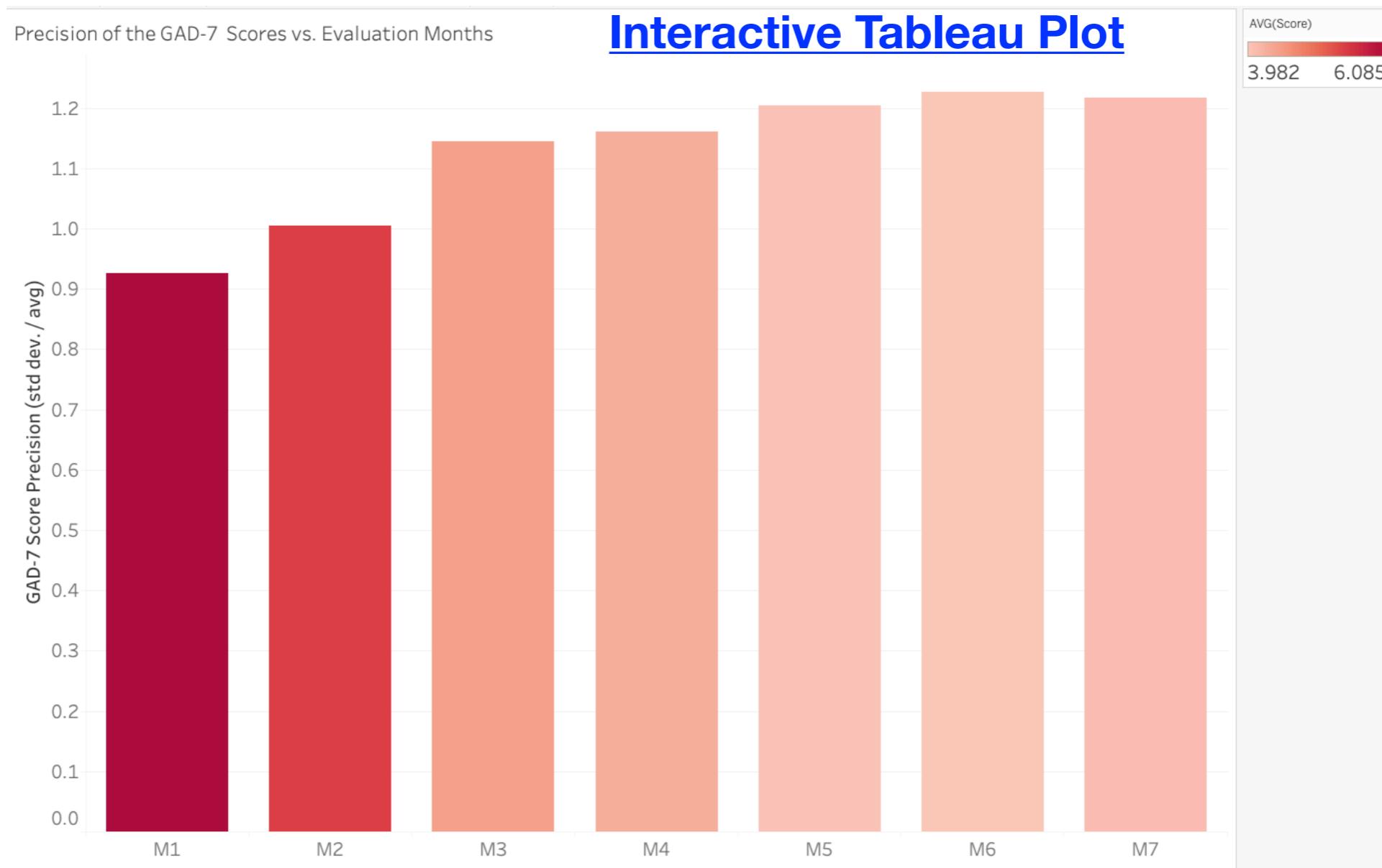
**Evaluation within  
the first month of patient creation**



**Evaluation after  
6 months of patient creation**



# Performance in terms of Precision



- **ASSUMPTION:** Ideally the precision (standard deviation/mean ) should decrease after periods of evaluation
  - This would mean that not only do coordinated treatment plans work on average, but the same/similar plan should work on patients that start with similar GAD-7 scores (or another measure of similarity)
- **The Chart shows that the average and the standard deviation are about equal across evaluation months (Precision is close to 1.0 instead of a value closer to 0).**
  - This is not bad though, it may mean that the scores are not taken very often when the GAD-7 score is close to zero compared to very high scores. So the distribution of scores does not follow the normal distribution!

# Insights For the Provider

- See two main patient patterns based on the charts in the next few slides:
  - **Steady success:** Patient GAD-7 score steadily decreases and sticks to low to minimal range
    - Treatment plan coordinated with NeuroFlow is effective!
  - **Alerts:** Gradual or sudden increase in GAD-7 Score
    - Increase periods of evaluation
    - Send provider NeuroFlow analysis of the patient and start a conversation about an adjusted treatment plan

# Research Treatment Options

[Reference website](#)

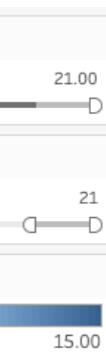
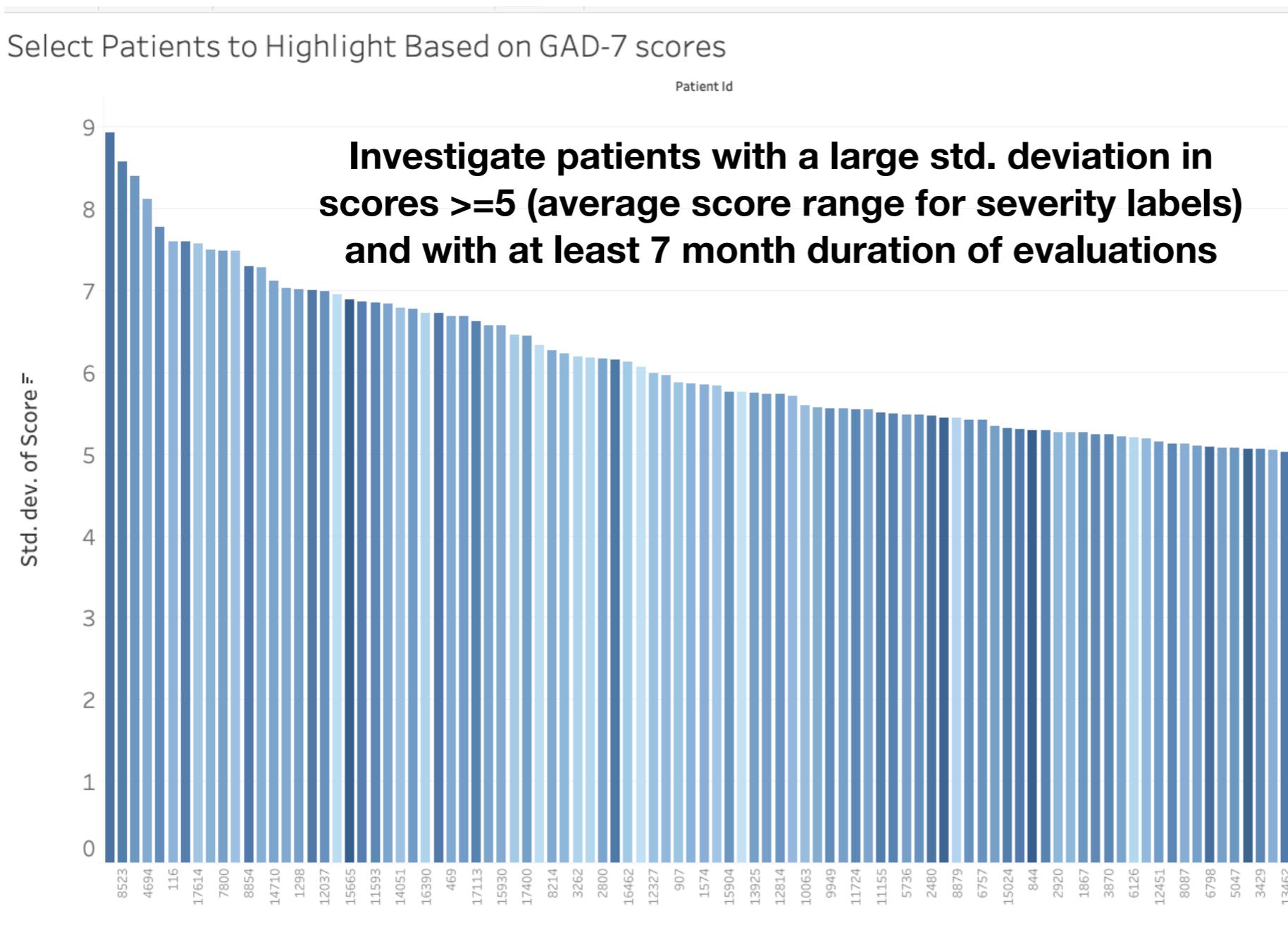
- I assume treatment depends on the score ( looked this up)
  - Mild severity results in repeated follow-ups
  - Only moderate to severe patients receive Cognitive Behavioral Therapy (CBT) and pharmacotherapy
  - Severe patients can be referred to medical or psychology specialists

## PHQ-9 and GAD-7 Scores

PHQ-9 Score	GAD-7 Score	Severity	Proposed Treatment Actions
0 - 4	0 - 5	None	None
5 - 9	6 - 10	Mild	Watchful waiting, repeating at follow-up.
10 - 14	11 - 15	Moderate	Consider CBT and pharmacotherapy.
15 - 19		Moderately Severe	Immediate initiation of pharmacotherapy and CBT.
20 - 27	16 - 21	Severe	Initiation of pharmacotherapy and CBT. Consider specialist referral to psychiatrist.

# Highlighting Patient Progress

- Use individual patient scores over time to highlight:
  - **Improvement** in the score when undergoing treatment
  - **Potential recommendations** when there is a sudden increase in the score
  - Evaluation periods **where therapy could be supplemented** with NeuroFlow exercises

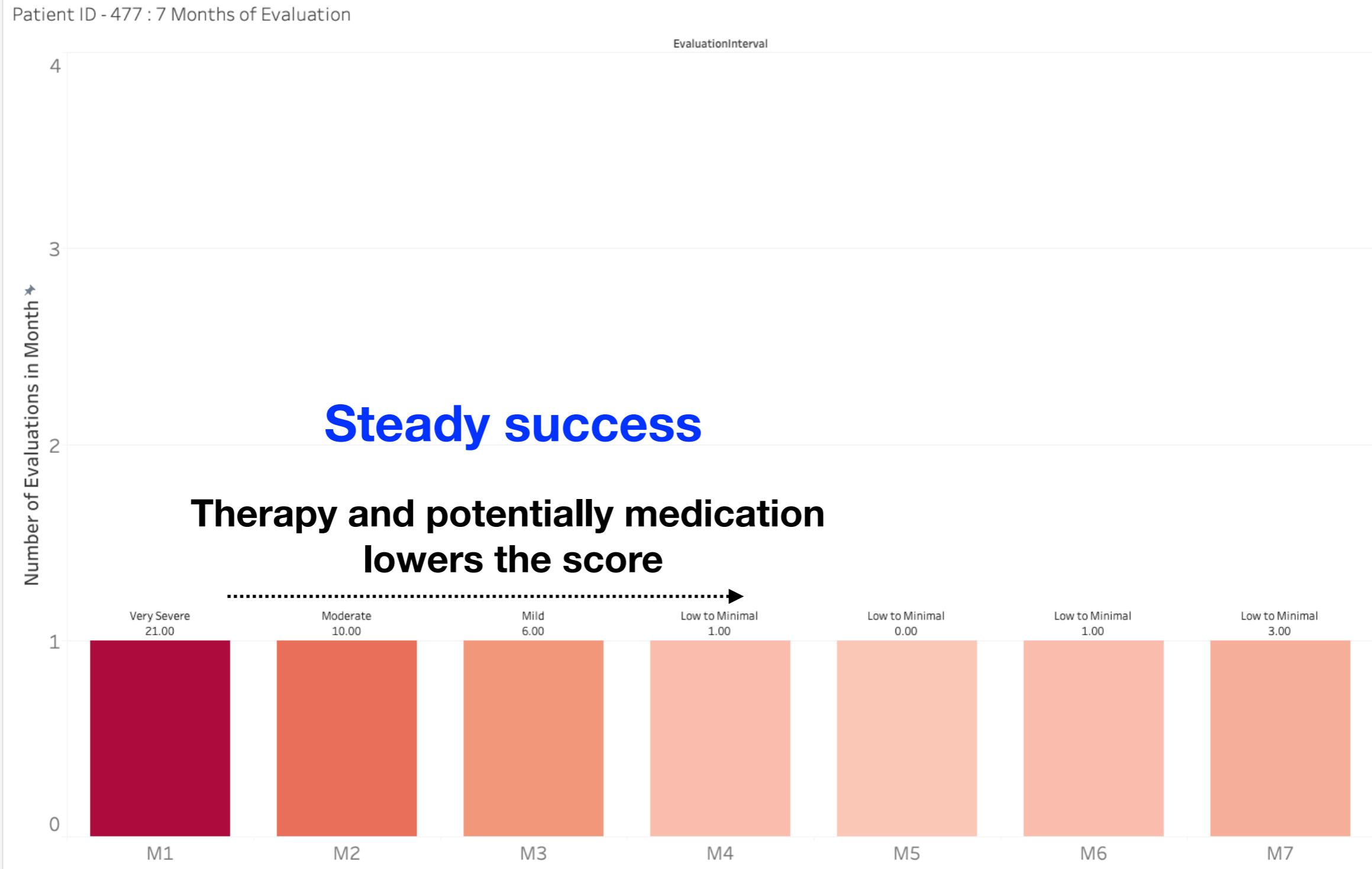


Each patient has to have an evaluation with one score in the severe range

The average score is allowed to be in a wide range to see a variety of trends in patient scores

Interactive  
Tableau Plot

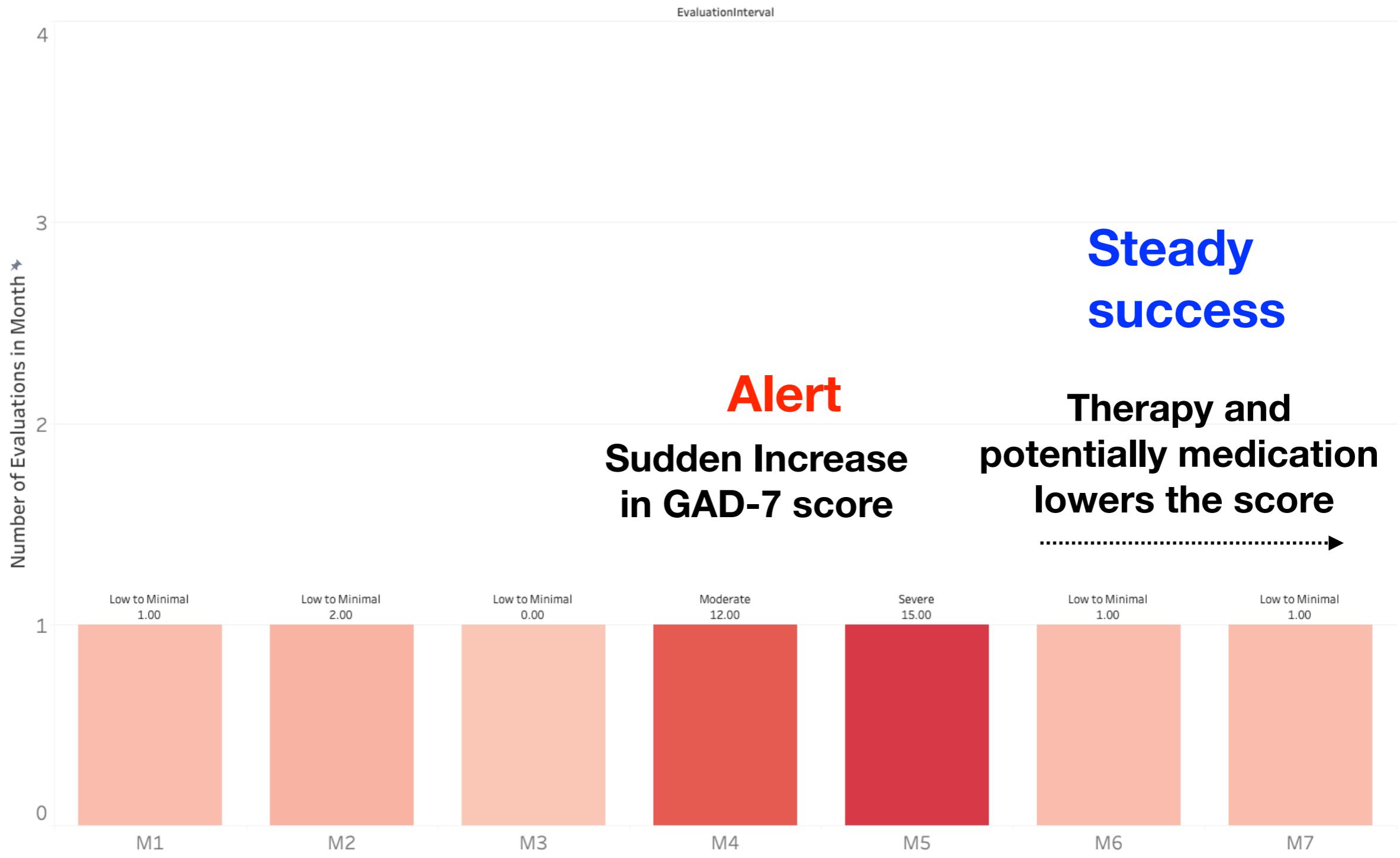
# Specific Patterns: Steady decrease in GAD-7 Score



- Ideal case: First evaluation the patient GAD-7 score is the highest but after 3 months it maintains a low value

# Specific Patterns: Peak in the GAD-7 Score

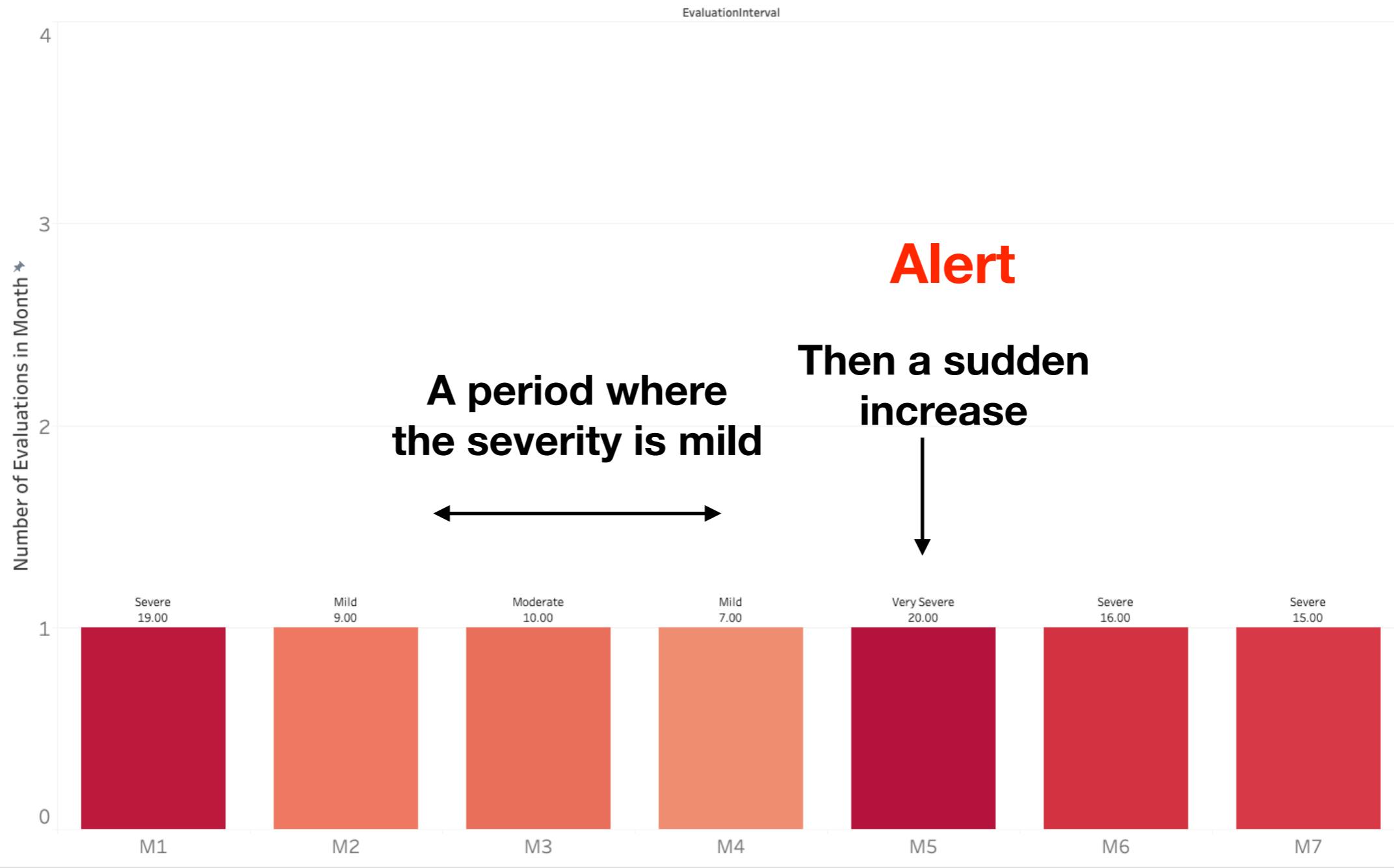
Patient ID - 3262 : 7 Months of Evaluation



- This patient case indicates that something triggers the anxiety after the 3rd month of evaluation and it continues to increase until the next evaluation, then it subsides in the following evaluations

# Specific Patterns: Valley in the GAD-7 Score

Patient ID - 6798 : 7 Months of Evaluation



- Though the GAD-7 score is initially large and declines, something triggers a large increase in GAD-7 score

# Ideas to Improve Outcome

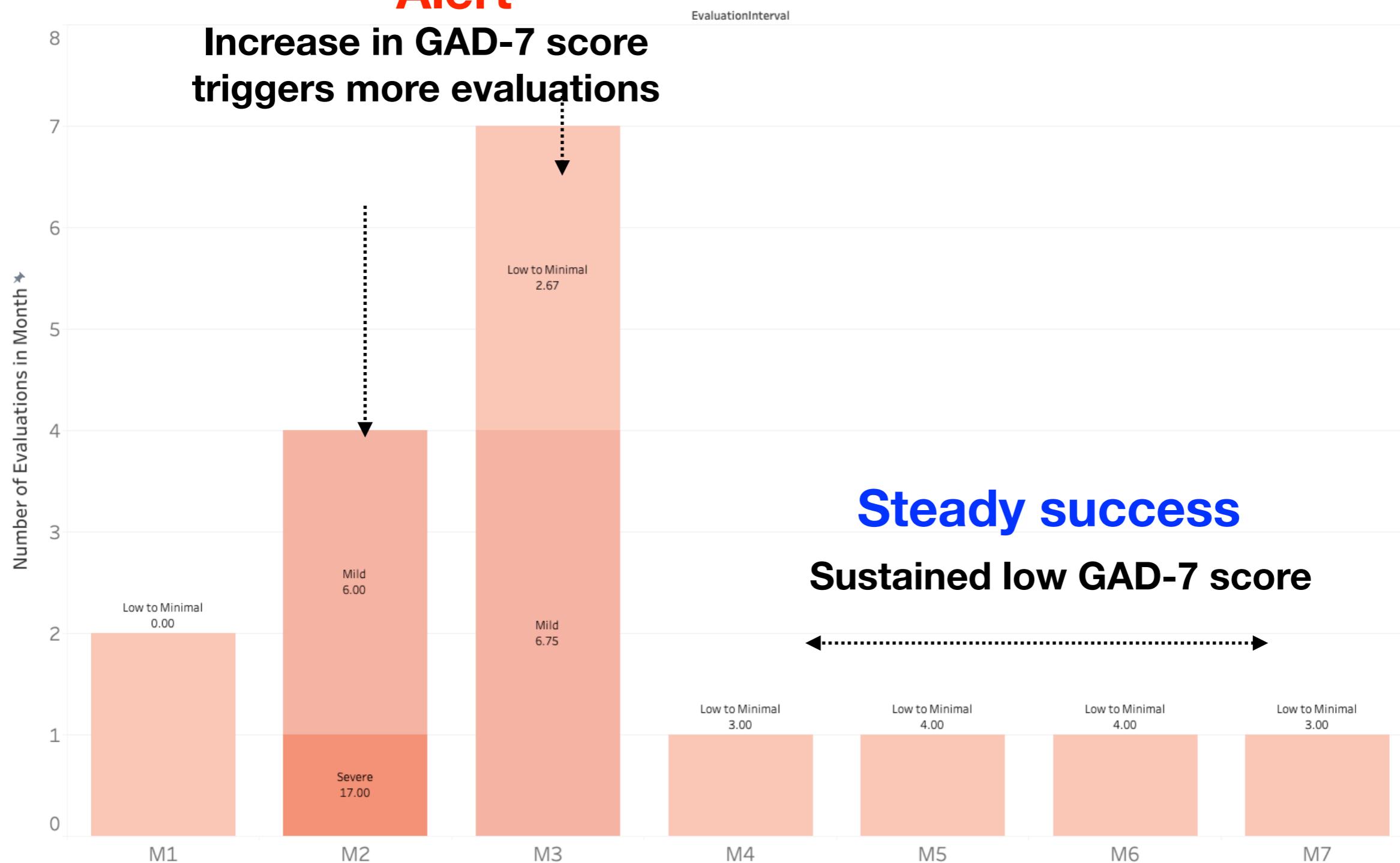
- I found these references useful for understanding the resurgence in the GAD-7 score:
  - Anxiety can resurface in the time while patients are not being monitored: In the patient on the previous slide there is month between the mild score and severe anxiety score.
  - **More evaluations in this period were necessary** and are recommended for the mild severity range on slide 4
  - “Because patients with anxiety disorders are mostly treated as outpatients, they probably receive less attention from clinical psychiatrists than patients with other disorders that require inpatient treatment” [Epidemiology of anxiety disorders in the 21st century](#)
  - In the outpatient time other co-morbidities can surface “Anxiety also presents with comorbidities like depression, phobias, post-traumatic stress disorder, alcohol, and drug dependence.” [Using Generalized Anxiety Disorder-2 \(GAD-2\) and GAD-7 in a Primary Care Setting](#)
  - **ADDITIONAL INFORMATION:** It is also useful to monitor alcohol or potential drug dependence when the GAD-7 score starts to increase

# Supporting Case

Patient ID - 7868 : 7 Months of Evaluation

**Alert**

**Increase in GAD-7 score  
triggers more evaluations**



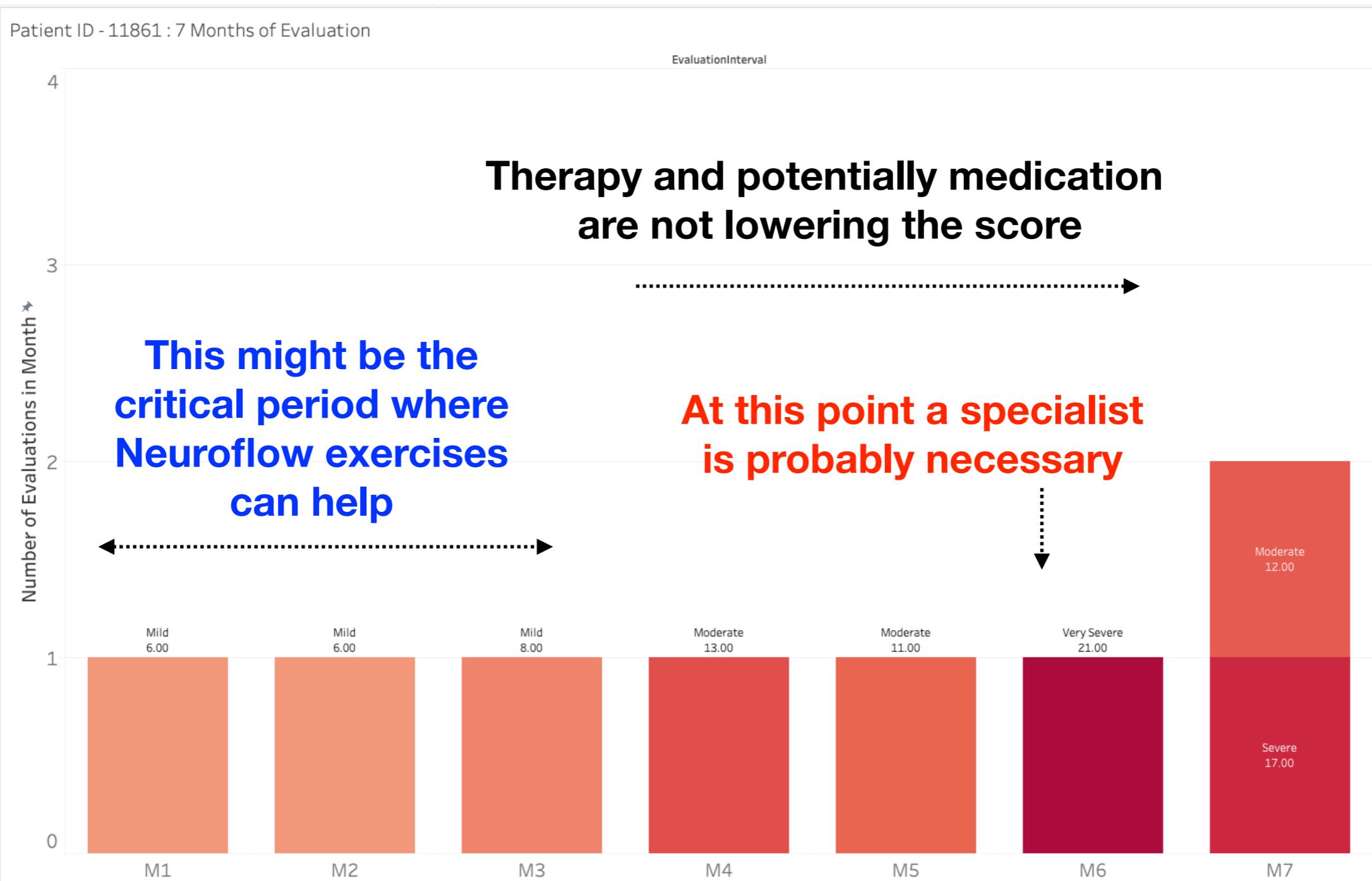
**Steady success**

**Sustained low GAD-7 score**

# Cases with increasing GAD-7 Score

- Cases like the one in the next slide look like “To Be Continued...” charts, there is a steady increase in GAD-7 scores without a decrease, so it begs for more information about the patient:
  - Substance abuse information
  - Emerging conditions like agoraphobia, social anxiety, or depression
  - Bringing in a specialist might be more useful if the patient anxiety score is the same or increasing as opposed to requiring a high score above 15
  - It also makes me wonder about new treatment options that can be recommended by Neuroflow: meditation, writing, self-monitoring sleep habits, or cathartic exercise (running or yoga)

# Specific Patterns: Inflating GAD-7 Score



- The first three evaluations are mild but after 3 months there is a steady increase in GAD-7 score

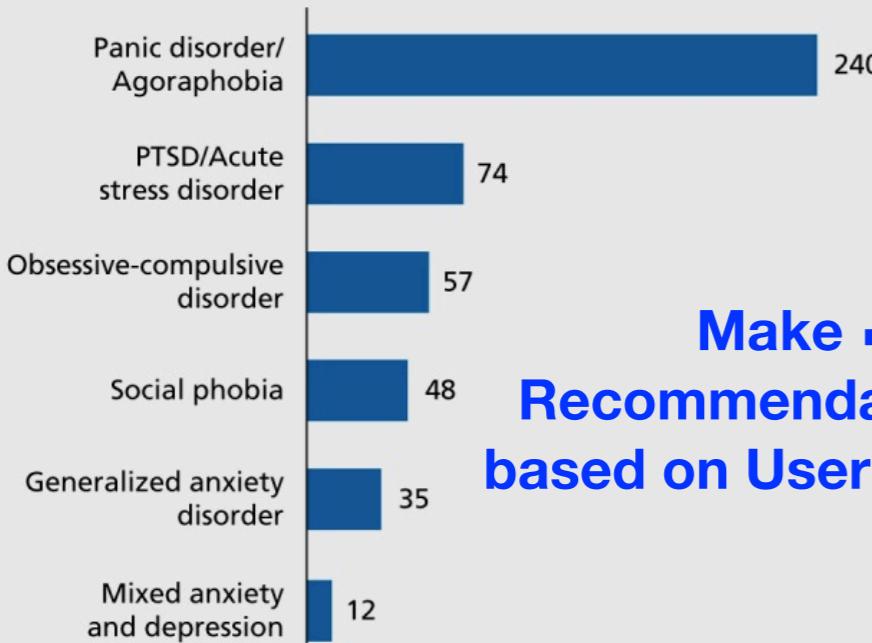
# Insights With More Data

7 questions in GAD-7 provide a rank for key issues:  
nervousness, irritability, restlessness, and levels of fear and worry

Look for  
.....→  
Correlations with other data

- Creating a detailed patient profile by collecting additional data (From the NeuroFlow mobile app):
  - **Focus:** Mark daily tasks you can/cannot focus on
  - **Sleep Tracking:** Length/Quality of sleep, and dreams can be affected by nervousness or restlessness
  - **Leaving home:** locations you feel most safe (furthest distance from home?).
  - **Completing relaxation/group exercises:** Breathing, mediation, yoga or exercise. Patients rank their effectiveness
  - **Common words** in journal entries that would indicate the need for therapy/intervention based on high GAD-7 scores

Create a Patient Profile  
scoring specific diagnoses:  
Can use a Bayesian model or ML Classification



Make .....→  
Recommendations based on User profile



Already Does these!

- Patient Resources :
  - Suggest a plan of exercises and a schedule
  - Prompt user to seek care or take an evaluation
  - Recommend activities (coordinating with provider) targeting a particular diagnosis. Rate the activity to inform future recommendations
- Provider Dashboard:
  - Create alerts for high risk patients (like a jump in GAD-7 score) or trigger words in the journal entries
  - Share user ratings of activities to adjust treatment plans
  - Recommend a cadence for evaluations of GAD-7 or PHQ9

# Knowledge and Insights

- Aggregate quantities like the average GAD-7 score for all patients does decrease over evaluation periods: **NeuroFlow and coordinated treatment work on average!**
  - Behavioral health data may not be like physics data and require a different measure of precision
  - Standard deviation of the GAD-7 score is useful to separate patients with a wide range of scores as opposed to those with very consistent scores
  - **Generalized anxiety can creep up in different ways:**
    - Mild severity scores can be a critical time to monitor upward trends (take multiple evaluations in a month)
    - Sometimes the GAD-7 score plateaus or continues to increase from mild to severe despite treatment. This can be where NeuroFlow monitoring can be tuned to improve outcomes
  - GAD-7 covers 7 items, so **additional pieces of information should try to complement these items:**
    - Patients mark tasks based on how likely they can focus on or complete them. Percentage of total tasks would indicate the level of nervousness and restlessness.
    - Sleep quality and length is also an indicator of nervousness and restlessness.
    - Number of relaxation exercises and (virtual) group exercises completed allow to see how effective they are for different levels of anxiety and in potentially reducing social anxiety