# The Classification for Early-Onset Scoliosis (C-EOS) Predicts Timing of VEPTR Anchor Failure

Michael G. Vitale, MD MPH

**Associate Chief, Division of Pediatric Orthopaedic Surgery**
**Chief, Pediatric Spine and Scoliosis Service**
**New York – Presbyterian Morgan Stanley Children's Hospital**
**Ana Lucia Professor of Pediatric Orthopaedic Surgery**
**Columbia University Medical Center**

**NewYork-Presbyterian**
Morgan Stanley Children's Hospital

Columbia Orthopaedics

**COLUMBIA UNIVERSITY**
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# Improving the Evidence Base in EOS

*Development of a Research Infrastructure*
*Via four parallel efforts*

**Endpoints** — Development and Validation of a Disease Specific QoL Measure

**Equipoise** — Evaluating clinical equipoise in the field of EOS

**Classification** — Developing an EOS Subgroup Classification Schema to facilitate collaboration and communication

**Consensus Trial Structure** — Determining inclusion criteria, treatment options and outcome measures for future research efforts

# Statement of Purpose

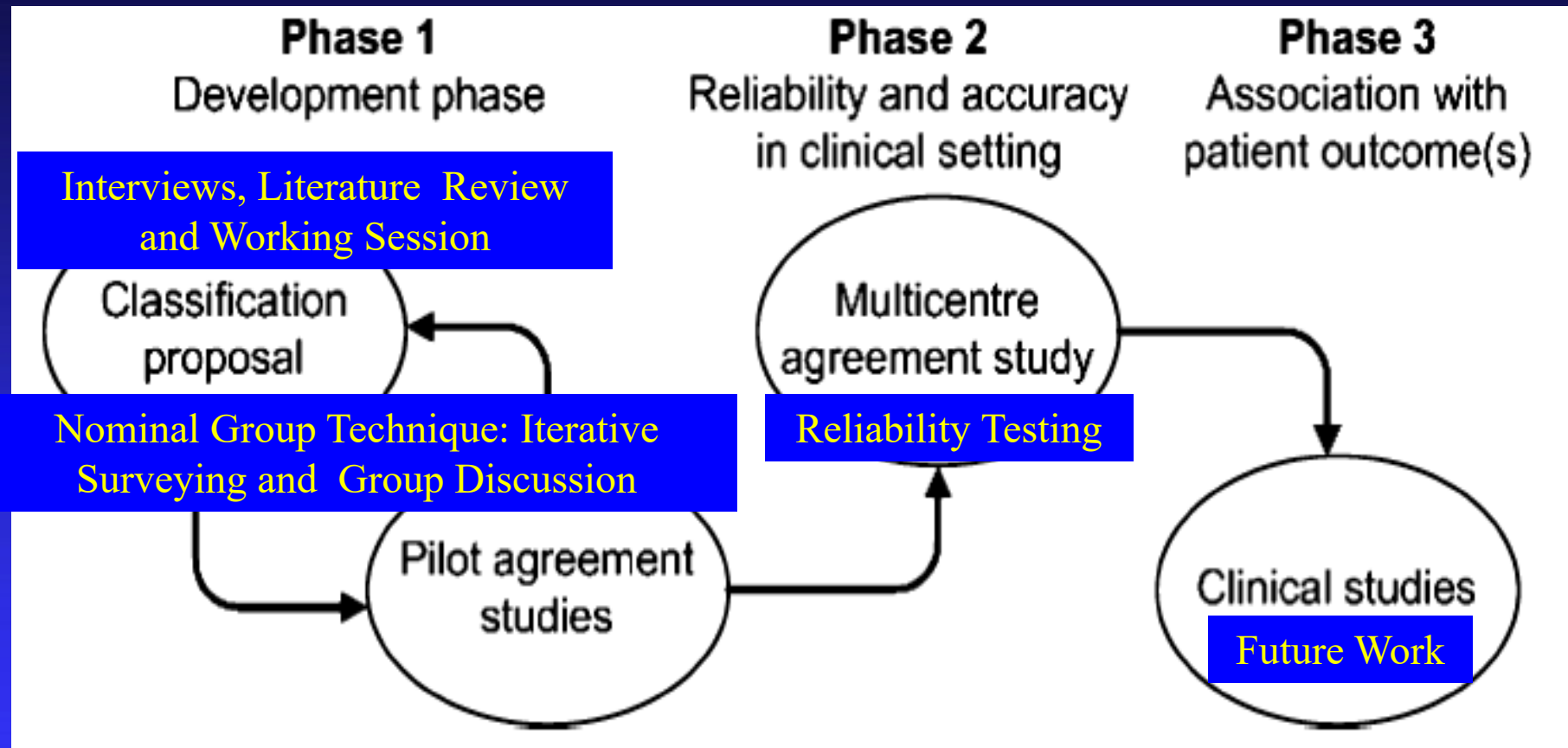To classify EOS patients in order to:

- Predict the disease course of individual patients

- Prognosticate and determine beneficiaries of differing treatment modalities

- Improve communication among EOS providers and facilitate research

# Important 'Philosophical' Characteristics

- **Comprehensive**: Applicable to all EOS pts

- **Practical**: Utilized in daily practice

- **Prognostic**: Predictive of course

- **Guide**: Informs treatment decisions

### An Early Onset Scoliosis 'One Liner'

# Methods: Validation Pathway



**Phase 1** — Development phase

**Phase 2** — Reliability and accuracy in clinical setting

**Phase 3** — Association with patient outcome(s)

Interviews, Literature Review and Working Session

Classification proposal

Nominal Group Technique: Iterative Surveying and Group Discussion

Pilot agreement studies

Multicentre agreement study

Reliability Testing

Clinical studies

Future Work

*Audige L et al. (2005). A concept for the validation of fracture classifications. J Orthop Trauma. 19:404-409*

# Development of the C-EOS

**Group Discussion**

## Proposing Variables

- POSNA – May 2011

**Iterative Survey**

## Assessing Variables
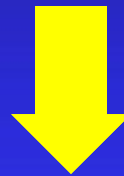
- May-July 2011

**Group Discussion**

## Finalizing Variables

- ICEOS – November 2011

### Validation:
Testing the Classification
2011-Present

hp1

| Etiology | Cobb Angle (Major Curve) | Maximum Total Kyphosis | Progression Modifier (optional) |
|---|---|---|---|
| Congenital/Structural | 1: <20º | (-) <20º | P0: <10º/yr |
| Neuromuscular | 2: 21-50º | N: 21-50º | P1: 10-20º/yr |
| Syndromic | 3: 51-90º | (+): >50º | P2: >20º/yr |
| Idiopathic | 4: >90º | | |

**Highest** ... **Lowest Priority**

**Etiology (In order of priority):**

*Congenital/Structural*: Curves developing due to a structural abnormality/asymmetry of the spine and/or thoracic cavity; includes hemivertebrae, fused ribs, post-thoracotomy, or CDH.

▪*Low-tone neuromuscular*: Patients with SMA, spinal injury, Low-tone CP, and muscular dystrophies

▪*High-tone neuromuscular*: Patients with spastic CP, Rett Syndrome

▪*Syndromic*: Syndromes with known or possible association with scoliosis (including spinal dysraphism)

▪*Idiopathic*: No clear causal agent (can include children with a significant co-morbidity that has no defined association with scoliosis)

**Cobb Angle:** Measurement of major spinal curve in position of most gravity

**Maximum measurable Kyphosis:** between any 2 levels

**Annual Progression Ratio Modifier** *(optional)*:

Progression per year;
min. 6 months between observation

$$\frac{(\text{Cobb @ } t_2) - (\text{Cobb @ } t_1) \times 12 \text{ months}}{[t_2 - t_1]}$$

**Slide 7**

**hp1**        hyp2102, 8/30/2012

# Applying the C-EOS to Clinical Studies

*Utilized Dr. Jack Flynn's (CHOP) data on time to VEPTR Anchor Failure*

## Purpose

To assess C-EOS ability to detect differences in time to failure in VEPTR pts

# Methods

- **Retrospective review of VEPTR anchor failure pts**

- **Classified subjects via C-EOS from Dr. Flynn's *VEPTR Anchor Failure Study* and analyzed survivorship differences**

# Data Characteristics by C-EOS Variable

N=105

| Etiology |
| --- |
| Congenital: 56 (53.3%) |
| Neuromuscular: 33 (31.4%) |
| Syndromic: 8 (7.6%) |
| Idiopathic: 8 (7.6%) |

| Cobb Angle |
| --- |
| 0-20°: n = 0 |
| 21-50°: n = 17 |
| 51-90°: n = 71 |
| >91°: n = 17 |

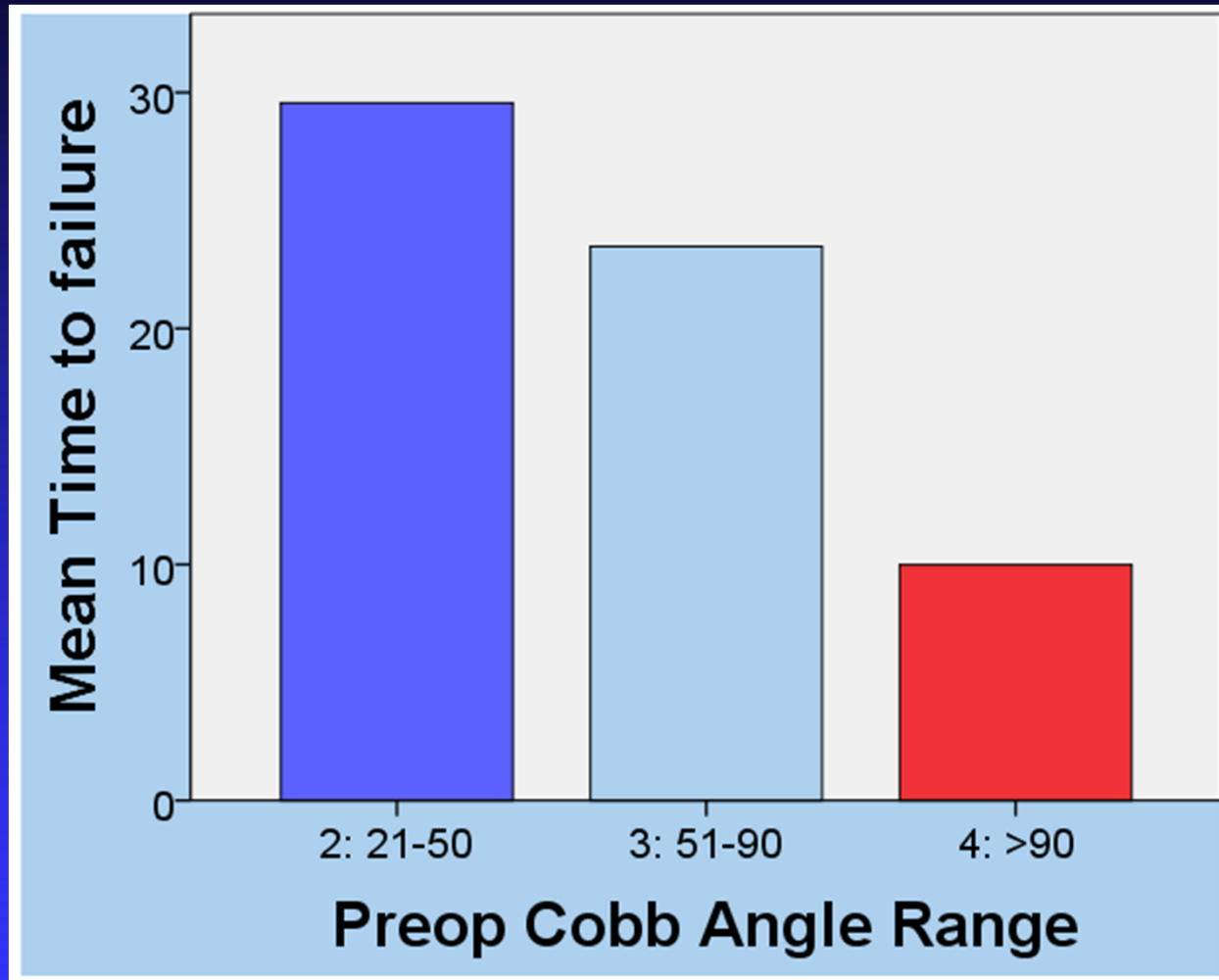| Kyphosis*** |
| --- |
| <50°: 61 |
| >50°: 26 |

## ***Data Limitations

- **Kyphosis only recorded as < or >50 degrees**
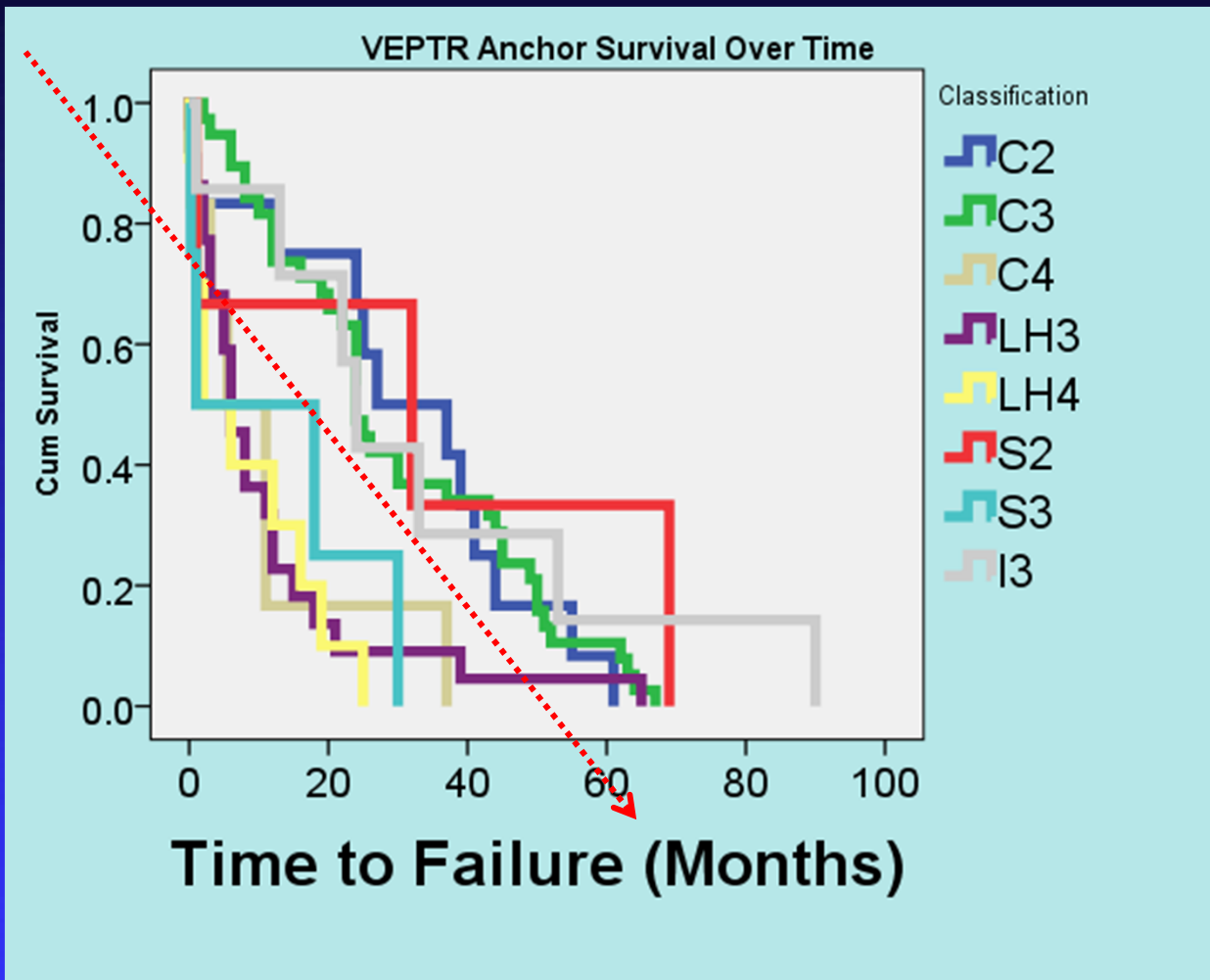  - **Classification necessitates <20, 21-50, >50**
- **18 missing kyphosis**
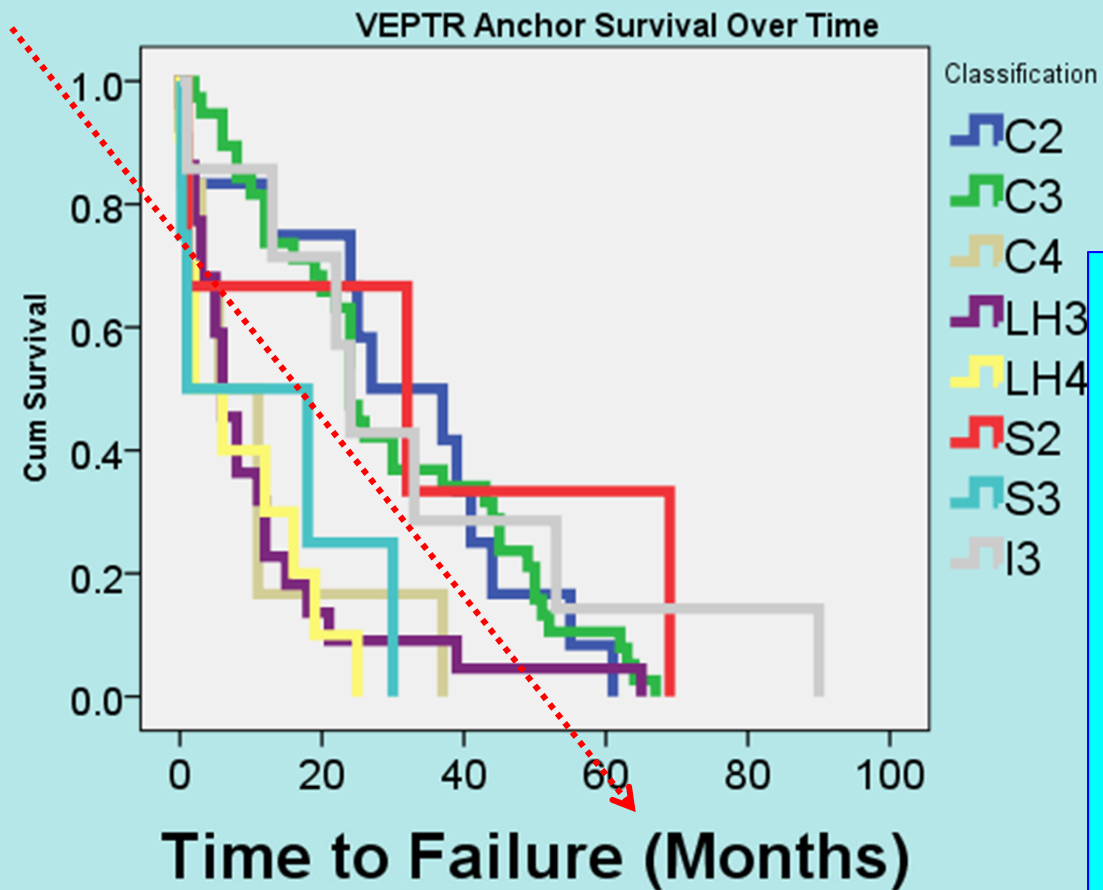
# Neuromuscular Pts Exhibit Rapid Failure
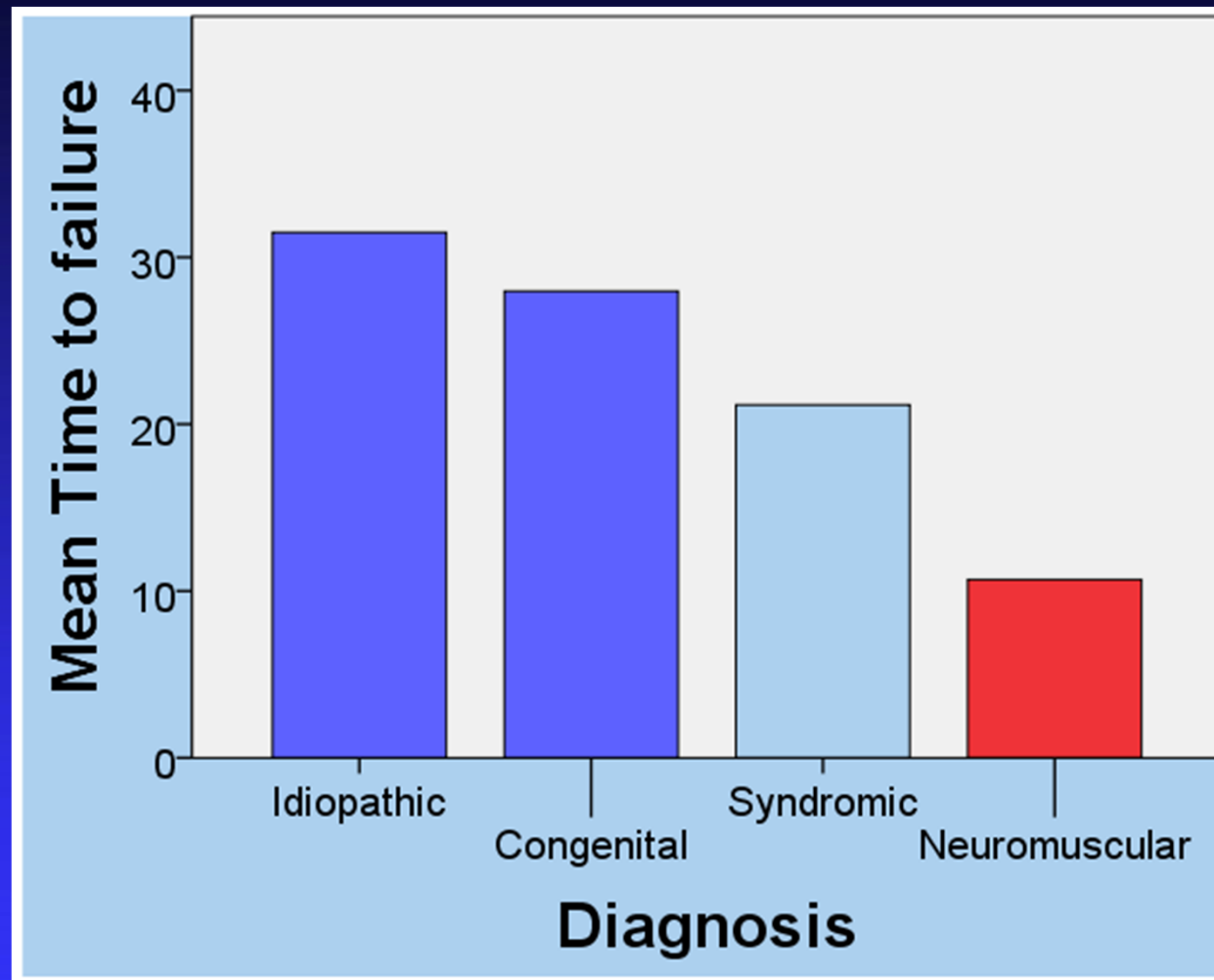
# Curves >90° Pts Exhibit Rapid Failure

# C-EOS Stratified Low Risk and High Risk

# C-EOS Stratified Low Risk and High Risk



VEPTR Anchor Survival Over Time

Classification: C2, C3, C4, LH3, LH4, S2, S3, I3

Cum Survival vs Time to Failure (Months)

**Risk by Classification:**

**Lower Risk of Rapid Failure**
- Congenital (21-50° & 51-90°); C2, C3
- Syndromic (21-50°); S2
- Idiopathic (51-90°); I3

**Higher Risk of Rapid Failure**
- Congenital (>90°); C4
- Neuromuscular (>51-90°); N3
- Neuromuscular (>90°); N4
- Syndromic (51-90°); S3

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# Conclusions

- C-EOS is able to stratify risk of rapid VEPTR anchor failure
    - Supports validity of C-EOS instrument
    - Potential for use in clinical setting


- Neuromuscular etiology and curves > 90° as individual variables at high risk of rapid anchor failure

# Next: 5 Year Out C-EOS Study

**C-EOS applied to min. 5 Yr follow up pts:**

- **Purpose:** Apply C-EOS to identify trends

- **Methods:**
  - Retrospective review of CWSDSG & GSSG database
  - Min 5 year follow-up

- **Endpoints:**
  - Treatment course
  - Complications per Dr. Smith's Growing Spine Complications Classification
  - Change in coronal and sagittal curve over time

- **Status:** Pending data collection from CWSDSG and GSSG Registry
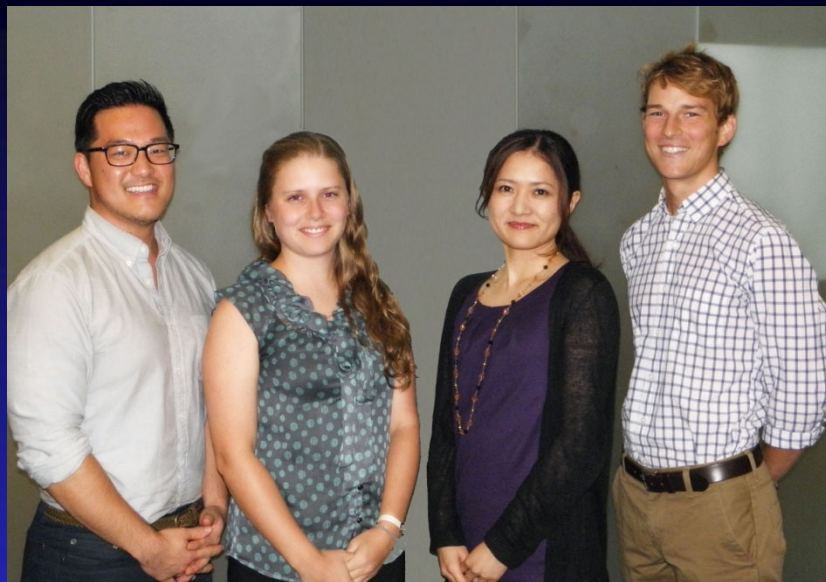
# Thank You

## Michael G. Vitale, MD MPH

## mgv1@columbia.edu