Organizing Chaos: Development of a Consensus-Based EOS Classification Schema

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Funded by the Chest Wall and Spinal Deformity Study Group

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Introduction:
Improving the Evidence Base in EOS

Development of a Research Infrastructure
Via four parallel efforts

Equipoise	Evaluating clinical equipoise in the field of EOS
Classification	Developing an EOS Subgroup Classification Schema to facilitate collaboration and communication
Endpoints	Development and Validation of a Disease Specific QoL Measure
Consensus Trial Structure	Determining inclusion criteria, treatment options and outcome measures for future research efforts

Introduction: Challenges to EOS Classification

- **Heterogeneous population**
  - Wide range of ages
  - Wide variety of etiologies
  - Variable severity of deformity
  - Co-morbidities
  - Various stages of treatment

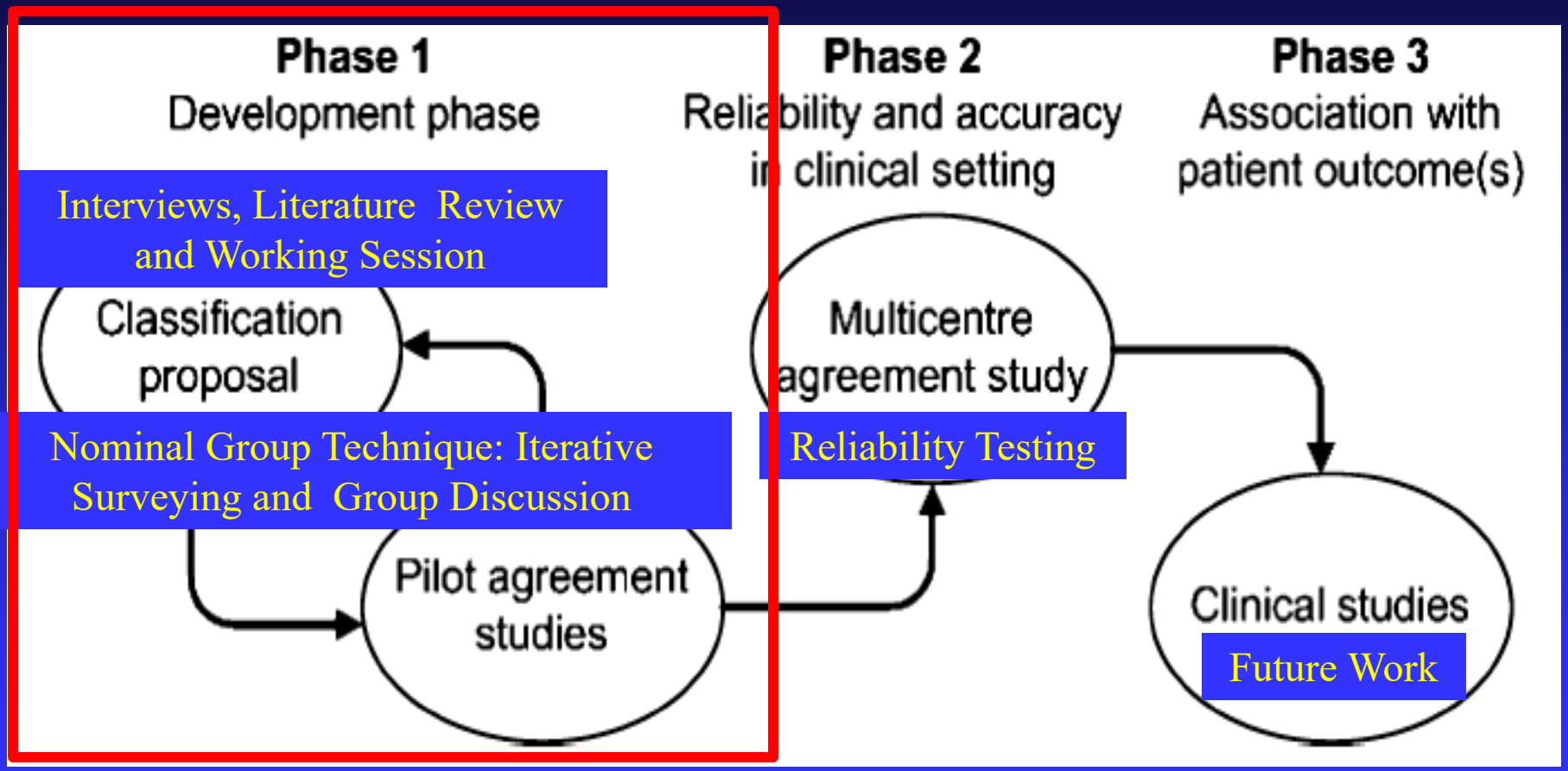
- **Finding a balance between practicality and descriptive ability (i.e. groupers vs. splitters)**

Purpose

To utilize formal consensus methods to develop a novel Early Onset Scoliosis Classification System that will be:

- **Comprehensive: Widely applicable**
- **Practical: Simple enough for day to day use**
- **Prognostic: Predict outcome**
- **Guiding: Direct management**

Methods:Validation Pathway



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

Methods: Development Phase

Group Discussion #1

- POSNA – May 2011

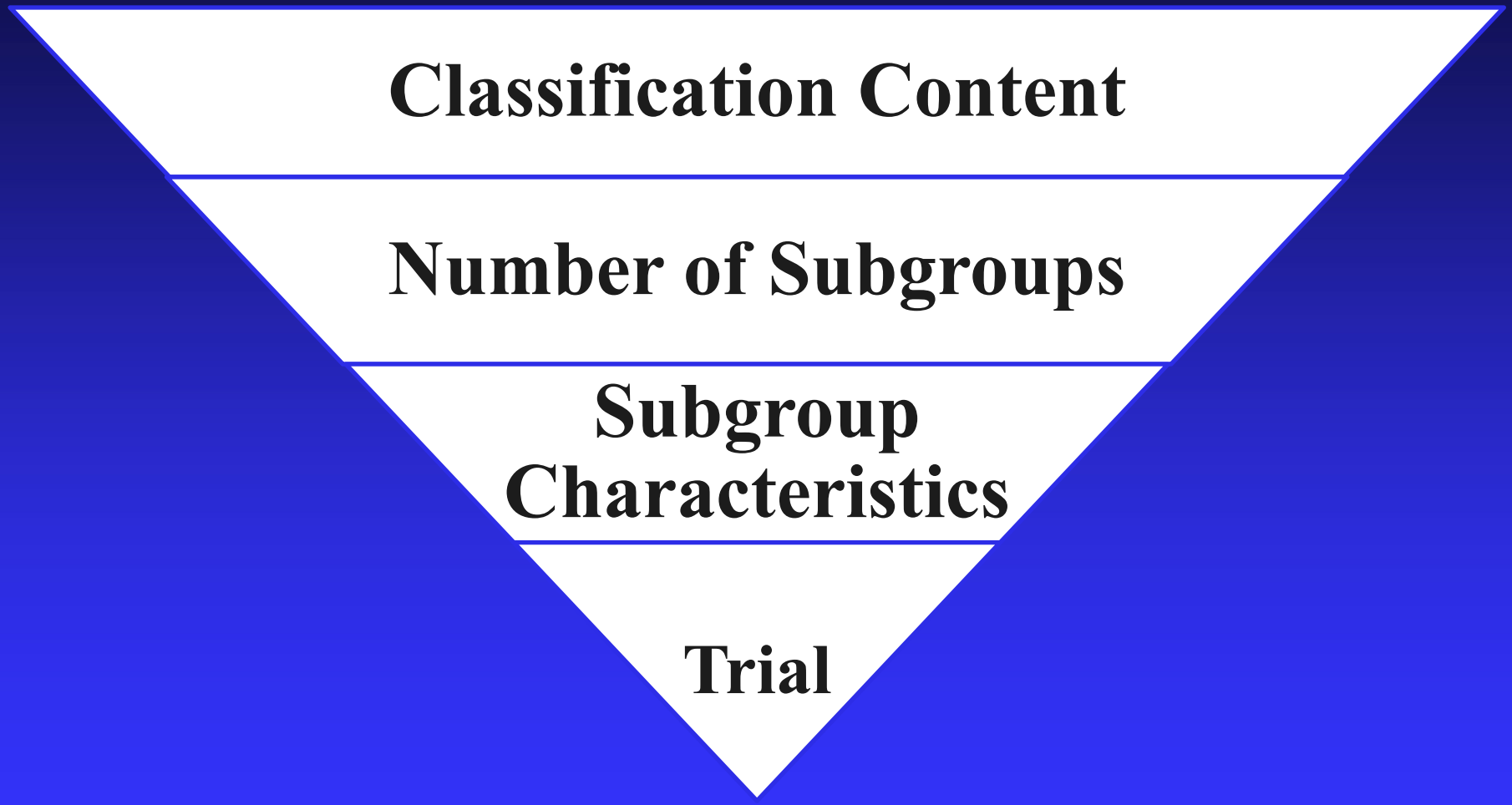
Iterative Survey

- May-July 2011

Group Discussion #2

- ICEOS – November 2011

Methods:
Survey and Discussion Topics



Results

	Not Useful	Useful	Essential	CVR	Sum of Ranks
COBB	0	1	14	0.87	29
ETIOLOGY	0	3	12	0.60	27
KYPHOSIS	0	4	11	0.47	26
AGE	5	0	10	0.33	20
PROGRESSION	3	5	7	-0.07	19
CHEST WALL ABNORMALITIES	2	9	4	-0.47	17
FLEXIBILITY	4	6	5	-0.33	16
OTHER CO-MORBIDITIES	3	8	4	-0.47	16
PULMONARY FUNCTION	3	9	3	-0.60	15
AMBULATORY ABILITY	2	12	1	-0.87	14
NUTRITIONAL STATUS	5	8	2	-0.73	12
MENTAL FUNCTION	10	5	0	-1.00	5
BONE QUALITY	11	4	0	-1.00	4

Results

AGE

- Important treatment implications
- Evidence insufficient to create meaningful subgroupings for this variable a current time

Age will be a continuous classification prefix

Results

Cobb Angle

- Measurement of Major curve
- Four Subgroups:
  - 1 : <=20˚
  - 2 : 21˚ -50˚
  - 3 : 51˚ -90˚
  - 4 : >90˚

Results

Kyphosis

- Maximum total Kyphosis throughout spine
  - Not only thoracic
- Three Subgroups:
  - ❑ - : <20
  - ❑ N : 21° - 50°
  - ❑ + : >50°

Results

Progression Modifier- Annualized

- Minimum of 6 months x-ray follow-up
- Annual Progression Ratio
- **P0** : <10° / yr
- **P1** : 10° -20° / yr
- **P2** : >20° / yr

$$[\text{Cobb at } t_2] - [\text{Cobb at } t_1] \quad x \quad \frac{12 \text{ months /year}}{[\text{months between } t_1 \text{ and } t_2]}$$

Results

Etiology

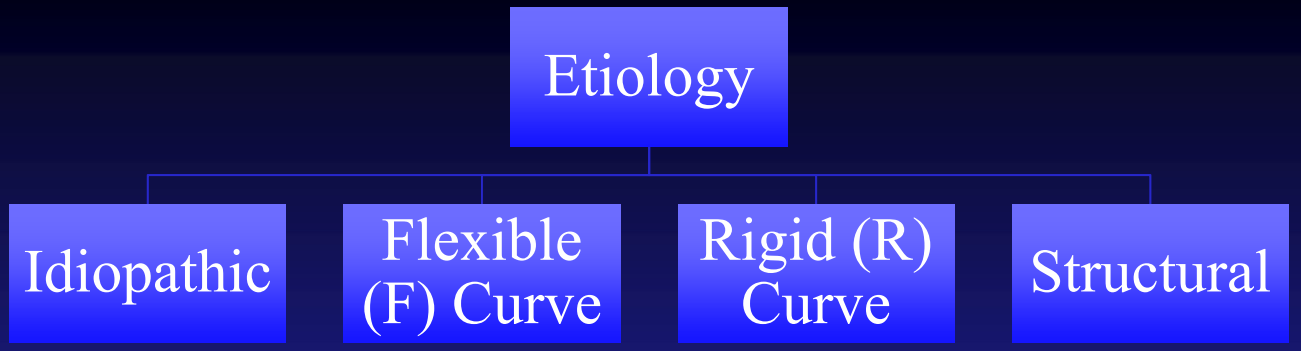
- Most challenging variable to sub-group based on heterogenous patient population

- Has gone through multiple transformations based on study group feedback

Etiology 1.0 At POSNA

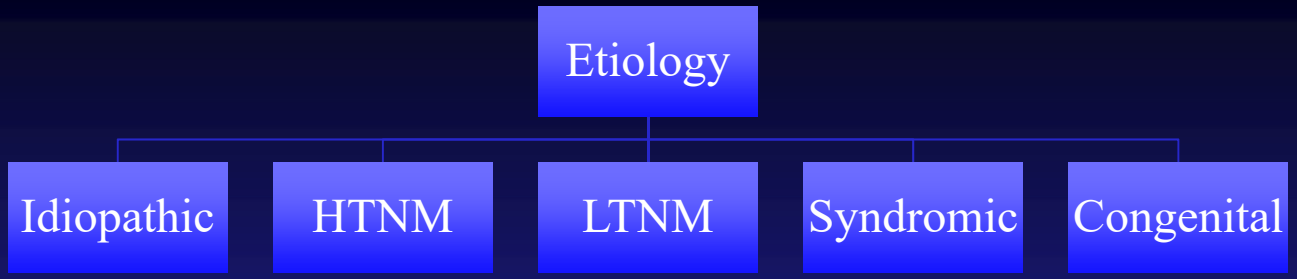
- **Idiopathic: No clear causal agent (can include children with a significant co-morbidity that has no defined association with scoliosis)**
- **High-tone neuromuscular**
- **Low-tone neuromuscular**
- **Syndromic: Patients with syndromes that have known association with scoliosis**
- **Congenital: Curves developing due to a anatomic abnormality/asymmetry of the spine and/or thoracic cavity**

Etiology 2.0
-via Survey



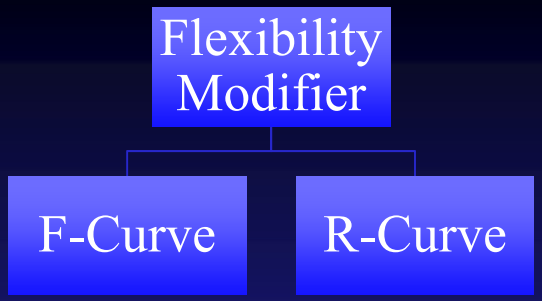
- **F-Curve:** Flaccid or Hyper-Flexible curves
- **R-Curve:** Rigid or Spastic curves
- **Structural:** Curves developing due to congenital or other structural abnormalities of the vertebrae or ribs

Etiology 3.0 At ICEOS



- **Idiopathic: pure and simple idiopathic**
- **Low-tone neuromuscular: SMA, SCI, Low-tone CP, and all MDs**
- **High-tone neuromuscular: Spastic CP, Rett Syndrome**
- **Syndromic: Syndromes with known or possible association with scoliosis (including post-thoracotomy)**
- **Congenital: Curves developing due to a anatomic abnormality/asymmetry of the spine and/or thoracic cavity/rib fusion**

Curve Modifier -at ICEOS



- **F and R Curves are now optional Curve flexibility modifiers**
  - **F-Curve: Flaccid or Hyper-Flexible curves**
  - **R-Curve: Rigid or Spastic curves**

Final Classification

Age [Prefix]	Etiology	Cobb Angle (Major Curve)	Flexibility Modifier (optional)	Maximum Total Kyphosis	Progression Modifier (optional)
Continuous variable	**I**diopathic	**1**: <20º	**F**-Curve	**(-)** <20º	**P0**: <10º/yr
	Syndromic	**2**: 21-50º		**N**: 21-50º	**P1**:10-20º/ yr
	Low-tone NM	**3**: 51-90º	**R**-Curve		
	High-tone NM	**4**: >90º		**(+):** >50º	**P2**: >20º/yr
	Congenital				

5 yo *I2fN* *P2*

Discussion

- Agreed to keep Age prefix, Etiology, Cobb Angle, Flexibility Modifier, Kyphosis, Progression Modifier
- Will ideally help to:
  - Simplify provider communication
  - Facilitate and organize ongoing research efforts
  - Improve outcomes by guiding management

Limitations

- Unable to capture the full clinical picture
  - Some descriptive ability sacrificed for practicality
- Based on a small (expert) group's opinion (N=15)
  - …group consensus still better than one viewpoint

Discussion

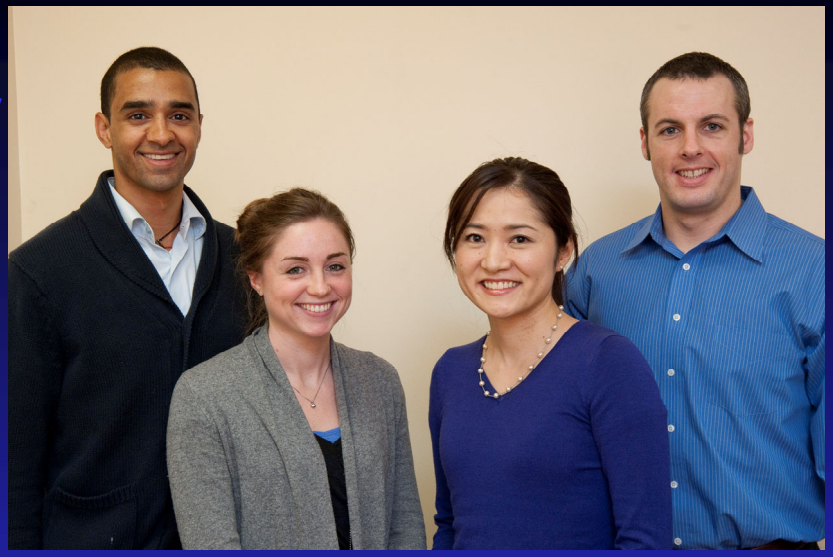
- Keep in mind: This is a work in Progress!
  - We expect it to evolve over time as all Classifications do

- Our hope is that this classification will help standardize EOS management and improve the quality of care for this vulnerable population

Next Steps

- Test intra- and inter-observer reliability of schema
- Assess clinical utility by applying classification to past cases
- Utilize in ongoing research infrastructure efforts

Division of Pediatric Orthopaedic Surgery



Thank You

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