Guide to the successful use of:

SATCo
ECAB
MFS

Assessing Infant Postural Control with Outcome Measures

"During development of sitting and more specifically in pathological conditions in which stability is immature or compromised, lack of a more detailed analysis of trunk control may prevent accurate analysis and/or treatment of the condition."[1]
Saavedra et al. 2012

The intention of this guide is to help the pediatric physical therapist increase appropriate use of outcome measurement tools that accurately assess postural control. The pediatric physical therapist will encounter countless infants who struggle to attain independent sitting and dynamic balance in the early intervention setting, which leads to decreased exploration, play, and advancement of functional mobility. Careful and accurate assessment of early postural development is vital to the successful identification of impairments. Early impairments noted in head righting and vertical control, upper extremity reaching, and balance reactions in sitting can be clues to long term balance impairments. The tools in this guide are supported in the research, have no cost associated with their use, and are easily and quickly administered. This guide can help the therapist make decisions around which tool is most appropriate, how to integrate this information into interventions, and increase evidence-based tracking of the child's progress.

Segmental Assessment of Trunk Control (SATCo)

"Trunk control is tested under 3 different conditions in sitting: maintenance of a neutral vertical posture with no movement (static control), maintenance of the neutral vertical posture during voluntary head or reaching movements (active control) and recovery of the neutral posture after disturbance of balance by a nudge (reactive control.)"[2] *Pin et al. 2018*

Why use the SATCo?

Sitting balance emerges for children developing typically from 2 to 9 months of age. Postural control emerges starting with head control, and then develops segmentally down the trunk to the pelvis. Children developing typically generally attain prop-sitting ability around 5-months of age, and hands-free sitting emerges between 6 and 7-months.

Children with neurodevelopmental disability often present with impaired postural control, atypical head and neck postures, muscle imbalances, and visual impairments that contribute to the delayed onset of independent sitting.[1-4] At times, some of these children may never gain independent trunk control. These children will benefit from a closer look at their static, active, and reactive trunk control level.

Appropriate Population Use:[1-5]

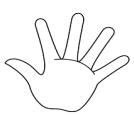
- Infants and young children with neuro-developmental disabilities
- Infants and young children with Spinal Cord Injury
- Infants born pre-term
- Full-term infants

Psychometric Properties:

Reliability[3]	**Inter-rater reliability (95% CI)** **Intra-rater reliability (95% CI)**	ICC = .84 (interval) ICC = .98 (interval)
Validity[3]	**Correlations with p < .01**	r = .883 -.868 with the AIMS r = .773 -.833 GMFM sitting dimension r - .695-.803 PEDI mobility section
Responsiveness[4]	**Effect size (95% CI)**	1.09 (.92-1.25) – large effect size: in a study on SCI recovery in young children

Equipment needed:



x2

Segmental Assessment of Trunk Control (SATCo)

Instructions:[3]

- Place infant/child on the bench with the feet supported on stable surface or the floor
- Pelvis aligned to neutral, with infant hands free
- Upper thighs are strapped to bench for support or manual hand support can be given for *vertical pelvis position* by an extra set of hands
- Therapist provides manual support around the trunk at each testing level:
    1. Shoulder girdle – SATCo level 1
    2. Axillae – level 2
    3. Inferior Scapula - level 3
    4. Lower Ribs – level 4
    5. Below Ribs – level 5
    6. Pelvis – level 6
    7. No Support at Pelvis - level 7 (full trunk control)
- Test each trunk section with your manual support in place at the given level and test 3 different types of control:
    1. Demonstration of **static control** is holding vertical-neutral head for 5-seconds
    2. Demonstration of **active control** at this level is the child's head and trunk remain vertical-neutral while head turns to the left and right via visual cues (an assistant can use a toy, noise, and infants visual tracking to entice the infant to look and turn head fully to the left and right)
    3. Demonstration of **reactive control** is the child's head and trunk return to vertical-neutral after the child has received a "brisk nudge" from an assistant using two fingers at:
        a) front at the manubrium/sternum
        b) from behind at C7
        c) from each side at the acromion.
- End the test when child is unable to maintain or return to vertical-neutral trunk alignment. The child then has attained trunk control above the level at which they lost control, and the therapist can give the child a SATCo score (1-7).

Clinical Application:

The information from this test can describe the trunk control level attained by the child. The score can help the therapist understand static, active, reactive control ability within a level (if full control at a specific level is incomplete). The description, along with the score, can be documented and used to determine interventions and support types for increased exploration in an upright position. Additionally, longitudinal progress can be tracked, although caution should be used as there is no official minimal clinical important difference (MCID) determined for this outcome measure. The MCID is assumed to be 1 SATCo level based on its correlations with the GMFM, although this has not been formally determined in the research to date.[5] The SATCo score can help

determine where manual support from caregivers can best be provided and guide choices around attachments on adaptive equipment when a child needs long term sitting support. Lastly, the clinician can use the information gained around static, active, and reactive control to guide their intervention choices, focusing on each component of postural control as needed.

Documentation Example:

"Mary was tested using the SATCo and scored a 3, indicating she has attained mid-thoracic trunk control and requires manual support at her lower ribs for upright sitting. She presents with impaired sitting balance and decreased ability to transition in and out of sitting, limiting her functional mobility. Mary will benefit from focused, therapeutic interventions to address her trunk and core strength, as well as improve righting reactions in a variety of developmental position to enhance her trunk control. Improving trunk control is vital to advancing Mary's functional mobility, enhancing her peer and family interactions in an upright position, and ultimately improving her cognitive growth."

Client Name: Ref #: Tester Name: Date:	Level of manual support Pelvic / thigh strap used except as indicated	Functional Level Arms and hands in air except as indicated	Static	Active	Reactive	Comments
			Maintain vertical neutral position of head and trunk above manual support level			
			minimum of 5 seconds	while turning head with arms lifted	Maintain / quickly regain following brisk nudge	
	Shoulder girdle Testers hand position may vary from horizontal	**Head control** Arms may be supported throughout			**NOT Tested for Head Control**	
	Axillae	**Upper Thoracic Control**				
	Inferior scapula	**Mid Thoracic Control**				
	Over lower ribs	**Lower thoracic Control**				
	Below ribs	**Upper lumbar Control**				
	Pelvis	**Lower lumbar Control**				
	No support given and pelvic/thigh straps removed	**Full trunk control**				
Fixed spinal deformity? Yes____No____Comments_____						
Limitation of Cervical Rotation __Left__Right Comments_____						

No formal score sheet is needed for this outcome measure.

This example score sheet is provided as a visual for how a therapist might organize scoring procedures.

This example is from: Butler et al. and can be located at:
Pediatr Phys Ther. 2010 Fall; 22(3): 246 257. **doi:** 10.1097/PEP.0b013e3181e69490

Early Clinical Assessment of Balance (ECAB)

"Given the importance of balance ability for functional movement in children with CP, a valid, reliable, and clinically feasible measurement of impairments in postural stability is important for describing when and how postural stability is impaired and monitoring change in children's balance across time."[6] *McCoy et al. 2014*

Why use the ECAB?

The ECAB can assess different components of balance and postural control that are key to the successful acquisition of functional mobility in young children with cerebral palsy (CP). The ECAB is also appropriate to use with children who present with impairments that resemble CP.[7] The ECAB formally assesses head and trunk control, protective balance responses in sitting, maintenance of upright sitting and standing postures, and the child's ability to make postural adjustments.[7]

Postural control and balance are linked to gross motor acquisition, functional mobility, and ultimately influence cognitive growth and school performance.[6,8] Using this tool will assist the pediatric physical therapist with accurate postural control and balance assessment, as well as promote early functional mobility in this population.[6,8]

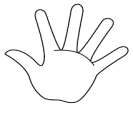
Appropriate Population Use:[6-8]

- Young children with CP 18-months and older
- Young children with clinical impairments that *resemble CP* but do not have a diagnosis:
    i. atypical muscle tone
    ii. impaired righting reactions
    iii. decreased anticipatory postural movements at the head/neck/trunk/legs
    iv. and loss of active range of motion.

Psychometric Properties:

Reliability[9]	**Inter-rater reliability (95% CI)**	.989 (.976-.995)
	Test re-test reliability same and different raters (95% CI)	.987 (.971-.994) & .986 (.971-.994)
Validity[6,9]	**Correlations with p < .001**	r = .97 with GMFM-66 -B & C sub section r = .88 with Pediatric Reach Test
Responsiveness [8,9]	**Effect size (95% CI)**	Effect Size measured by Standard Response Mean (SRM) = **.92** after 6-months of PT intervention Standard of Error (SEM) = **3.6 points** Minimal Detectable Change (MDC) = **10 points** (2-8year-olds)

Equipment Needed:


Instructions:

Score sheet with instructions can be obtained from: https://canchild.ca/en/research-in-practice/current-studies/on-track/on-track-measures by clicking on the Early Clinical Assessment of Balance link and agreeing to the copyright/license agreement. The score sheet includes 13 test items and a starting point can be determined by GMFCS level.

GMFCS Level I & II	Start at item 8
GMFCS Level III, IV, & V	Start at item 1
Child with Hemiplegia/Monoplegia	Start at item 4

Follow the instruction included with each item on the score sheet. The child is not to wear socks, shoes, or orthosis for the test. There are two sections for the test, *Part One* includes 7 items and a total available 36 points and *Part Two* includes 6 items with a total available 64 points. Add the two sections together for the child's total score. A total of 100 points is accumulated for the entire test. Randall et al. found that the test takes 11.6 minutes (SD 4.2) to complete, making this test easy to complete in a single session.[9]

Clinical Application:

The score on the ECAB can be used by the clinician to increase understanding around areas of strength and weakness as it relates to the child's balance and mobility.[6–8] The scores can be tracked over time to better understand both positive and negative changes. Improvement in the score is expected over time due to development alone, however a change of 10-points (MCID) in the score can be thought of as true change beyond developmental growth.[8] A study by Laforme Fiss et al. found the following predicted mean scores per age range (95% CI), and mean score changes that occur between ages 2 and 5, and ages 5 and 12, per GMFCS level.[7] This information can provide a better understanding of expected test total scores and mean changes over-time at specific ages. This is just a guide for your comparison purposes:

Age group	GMFCS I	GMFCS II	GMFS III	GMFS IV	GMFS V
2 years	54.1 (27.1-71.6)	34.2 (27.9-39.6)	27.4 (24.5-30.5)	17.8 (16.0-19.7)	5.1 (3.8-6.2)
5 years	94.5 (93.4-95.4)	73.0 (71.3-74.7)	43.3 (40.8-45.9)	24.1 (22.6-25.6)	6.3 (5.5-7.1)
12 years	98.3 (97.8-98.6)	89.1 (86.6-91.1)	50.1 (46.5-53.6)	25.3 (23.7-27.0)	6.5 (5.7-7.4)
Δ 2-5 years	40.4 (23.2-66.7)	38.8 (32.7-45.5)	15.9 (13.6-17.7)	6.2 (4.8-7.6)	1.2 (0.3-2.1)
Δ 5-12 years	3.8 (2.9-4.9)	16.2 (12.5-19/1)	6.8 (4.0-9.9)	1.2 (0.5-2.2)	0.2 (0.0-0.8)

The graphics on the next page are credited to the authors, LaForme Fiss et al., who performed a clinical trial on developmental trajectories using the ECAB at specific age ranges and at different GMFCS levels.[7] These graphs can be helpful in determining when a child's skill progression might plateau, indicate progression rate as would be expected or unexpected, and guide prognoses.[7] The full article can be accessed at: Phys Ther. 2019 Feb; 99(2): 217–228. Published online 2019 Jan 30. doi: 10.1093/ptj/pzy132

In the future an online calculator will be accessible at: https://www.canchild.ca/en/research-in-practice/current-studies/on-track/on-track-calculator which will allow comparison of scores against age-matched peers and GMFCS levels.

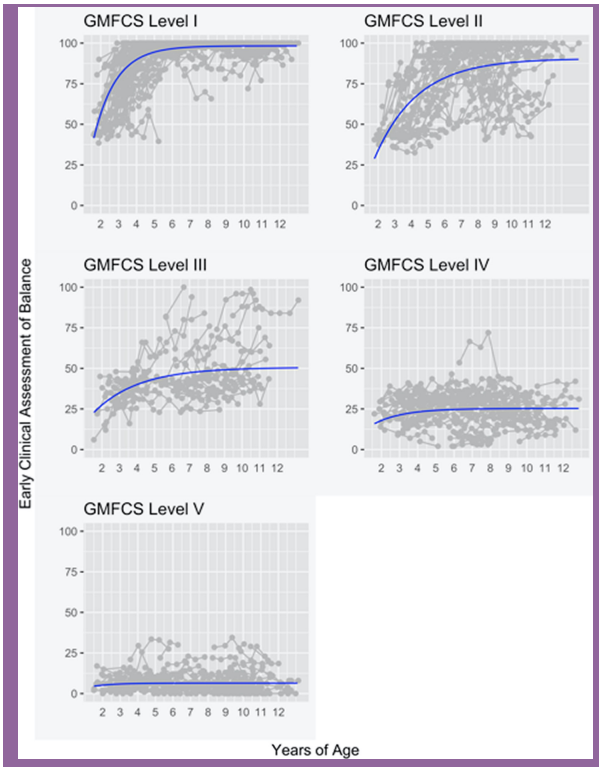


Figure 2. Longitudinal developmental trajectories in Early Clinical Assessment of Balance (ECAB) score by Gross Motor Function Classification System (GMFCS) level. Model 1 was fit for levels I and II; model 2 was fit for level III; and model 3 was fit for levels IV and V. See statistical supplement for details (available at https://academic.oup.com/ptj).

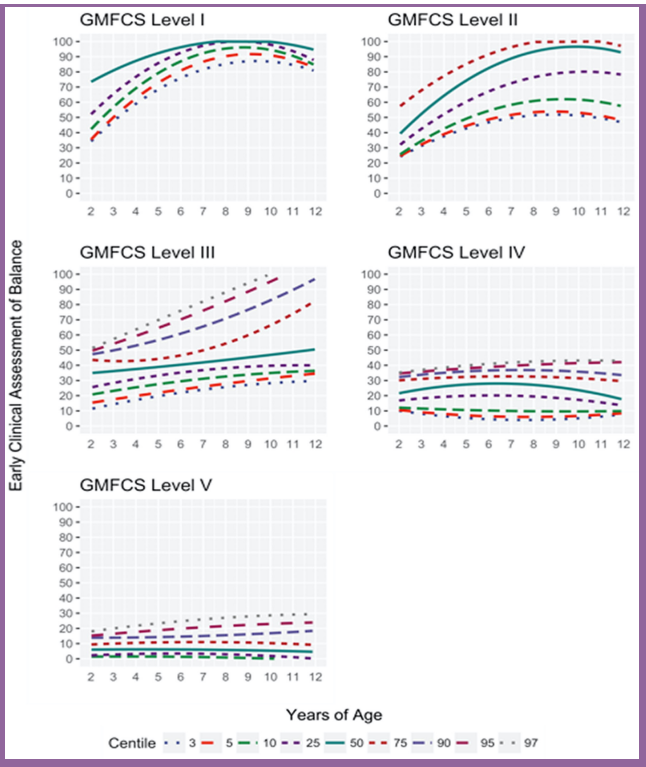


Figure 3. Reference percentiles by Gross Motor Function Classification System (GMFCS) level.

LaForme Fiss et al. 2019

Documentation Example:

"Melody is a 3-year-old child with a diagnosis of diplegic cerebral palsy, GMFCS level II. Using the ECAB today, Melody scores a total of 40-point and is around the 25th%tile when compared to her peers with the same GMFCS level. Melody's strengths and weaknesses are highlighted during the administration of this outcome measurement tool. Melody is rolling from supine to prone and prone to supine, floor sitting functionally, and demonstrates the ability to utilize postural responses through the trunk and upper extremities that allow for exploration of her environment on the floor. Melody is struggling with sitting and standing skills that require a narrow base of support, single-leg stance, and postural adjustments during more dynamic balance activities, limiting age-appropriate ambulation and mobility. Another testing is planned 6-months from now to investigate the progression of the skills that Melody continues to work towards. A score of more than 50-points will indicate change beyond developmental progression."

Muscle Function Scale (MFS)

"Infants with congenital muscular torticollis (CMT) often have an imbalance in muscle function in the lateral flexors of the neck, and the need for valid and reliable assessment tool to determine muscle function is essential." Omhan et al. 2009

"Early in development righting reflexes are expressed through muscular control (ie., the movement against gravity will facilitate the righting reflex). When tilting an infant from vertical to a horizontal position, there is a compensatory contraction of the neck muscles to keep the head in a vertical position." Omhan et al. 2009

Why use the MFS?

The MFS is an "ordinal visual" scale that can be used to quantify and interpret an infant's righting reactions, specifically looking at the lateral flexors of the neck.[10] Infants developing typically demonstrate equal righting reactions bilaterally, rarely showing imbalances.[10] The MFS is intended for use with infants who present with Congenital Muscular Torticollis (CMT), a common impairment seen by early intervention pediatric physical therapists. CMT classically presents as is a shortening of the sternocleidomastoid muscle (SCM) on one side of the neck.[10,11]

The shortening of the SCM causes a head tilt in one direction, along with the infant's chin to be rotated towards the opposite side of the tilt resulting in excessive contraction ability and increased power on the affected side in comparison to the opposite side.[10,11] Muscle contraction is weak on the contralateral side, causing the lateral flexors of the neck to demonstrate an imbalance in muscle function.[11] The pediatric physical therapist can use the MFS to quantify lateral flexor strength for comparison purposes left and right side of the body, and track improvement in contraction ability, strength, and power on the weaker side over time.[11]

Appropriate Population Use:[10,11]

- Infants and toddlers with CMT

Psychometric Properties:

Reliability[10]	**Interrater reliability (95% CI)** **Intrarater reliability (95% CI)**	Group 1: 0.94 (0.92-0.96) Group 2: 0.93 (0.90-0.95) *Group 1 had instructions in words &pictures and degrees for score of 3 and 4. Group 2 had instructions in words, pictures, and with degrees
Validity[10]		Ohman et al. reports construct and content validity is present for the MFS based on expert panel. No other assessment tools are present in the literature for formal comparison
Responsiveness		No studies present in the literature that comment on responsiveness of the MFS

Equipment needed: a mirror

Instructions:

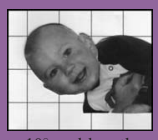
Hold the infant vertical in your arms and then lower the infant to a horizontal position in front of a mirror. Visualize the position of the head as the infant attempts to lift themselves back to vertical, a natural response. Observe for at least 5 seconds to visualize the angle they have achieved, a 5 second hold being required to receive full credit for a score given. Test both sides of the infant, determining the MFS score on each side. MFS scores range from 0 to 5. A score of 0 indicates the infants head is lower than horizontal, and a score of 5 indicates an infant who can lift their head and upper trunk past 75° nearing vertical upright when their body is held horizontal.[10] The image below provided by Ohman et al. can assist in determining MFS of the lateral flexors based on the angle and position of the head in relation to a horizontal line.[10]

Appendix C

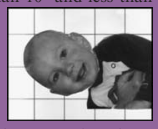
Muscle function scale (MFS) for infants

5. >75° (Head more than 75 above the horizontal line).

4. >45°–<75° (Head more than 45° and less than 75° above the horizontal line).

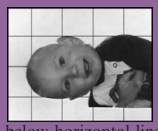


3. >15°–<45° (Head more than 10° and less than 45° above the horizontal line).



2. >0°–<15° (Head more than 0° an less than 15° over the horizontal line).

1. 0° (Head on the horizontal line = 0°).



0. <0° (Head below horizontal line less than 0°).

Ohman et al. 2009

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www.tandfonline.com

Clinical Application:

The MFS score on each side of the neck will provide the therapist with a better understanding of the infant's ability to use symmetrical righting responses.[10,11] When a difference is noted in scores, the scores should be documented and then tracked over time for resolution of the imbalance present. The weaker lateral flexor neck muscle, opposite the tilt-side, will often present with a lower MFS score than the affected side of the neck.[10,11] The elongated muscle is generally weaker.[10,11] Interventions to target the weaker muscle can including righting reactions during rolling, sitting, side-lying, and sitting positions during therapy and daily family routines eliciting muscle contraction and active range of motion practice of the overstretched neck and side body. The APTA's Clinical Practice Guideline (CPG) can provide you with a thorough review of assessment, proper severity grading, and evidence-based practice techniques to employ in your treatment of CMT.[11] The full treatment of CMT is beyond the focus of this guide.

Documentation Example:

"Diego is a 6-month-old baby (adjusted age) who was born at 33-weeks-gestation and presents to physical therapy today with right-sided CMT, severity grade 2, and MFS = 1 on the left and MFS = 4 on the right. Diego presents with a neck rotational preference to the left and a right-sided neck tilt in supine, sitting, and prone positions impacting his midline control, and use of symmetrical movement patterns. Diego achieves full passive and active range of motion (ROM) into left cervical rotation but is significantly limited in PROM and AROM to the right. Diego's passive cervical rotation to the right is 65°, and his active cervical rotation to the right is limited to 45°. PROM and AROM into lateral cervical flexion on Diego's left side are also significantly limited, with 20° achieved past midline passively and a maximum of -15° actively. Diego will benefit from skilled physical therapy treatment to improve passive and active ROM at the neck, increase strength and power of his left lateral flexors, and improve postural control so that he can use both sides of his body equally to explore his environment in an age-appropriate manner."

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