Examination of the Preterm Infant Part: Systems Review and Tests and Measurements

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OBJECTIVES

1. To be able to use Guide to Physical Therapy and the ICF as a foundation for examination of the preterm infant.
2. To outline developmental assessments appropriate for use with the preterm infant and identify the strengths and limitations of use.
3. To use tests and measures to formulate evaluation, diagnosis, prognosis and intervention for the preterm infant.

The Guide to Physical Therapy Practice

- Examination
  - History
  - Systems Review
  - Tests and Measures
- Evaluation
- Diagnosis
- Prognosis
- Intervention
History
- Growth and development
- Living environment
- General health status
- Family history
- Medical/surgical history
  - Cardiovascular, GI, musculoskeletal, neuromuscular, pulmonary, etc.
- Current conditions/chief complaints
  - Why is the child seeking PT intervention?
  - Determine eligibility for IDEA?
- Functional status/activity level
- Medications

The Guide to Physical Therapy Practice
- Examination
  - History
  - Systems Review
- Tests and Measures
- Evaluation
- Diagnosis
- Prognosis
- Intervention

Systems Review
- Systems review guides decision making
- Behavioral language in all systems
  - Competencies and challenges
- Determine the risk/benefit ratio—toleration of infant to developmental assessments and interventions procedures
Systems Review

- **Cardiovascular and Respiration**
  - ANS change in response to caregiver handling, environment & test administration
  - Side effects & decreased O2 saturation

- **GI Function**
  - Poor feeders, expend energy with amount of disorganized movement
  - Spitting up, gagging, hiccuping

- **Integumentary**
  - Extreme color changes
  - Skin integrity (hair worn away on head)

- **Neuromuscular**
  - Balance, locomotion, transitional positions

Musculoskeletal

- **Position, balance, flexion/extension, movement**

- **Motoric Stability**
  - Coping/Competency Signals
    - Hands to face
    - Sucking
    - Grasping finger, flexing fingers
    - Bracing body purposely against crib
    - Smooth modulated movement
  - Stress/Challenge Signals
    - Salute
    - Finger splay
    - Extending extremities, arching

Arousal, Attention and Cognition, Communication

- Optimal motor learning and successful feeding = alert organized state (minimal extremity movement)
- FT:
  - Good state control achieved after 37 weeks post conception (Vergara 1993)
  - Healthy FT adopts all state and changes smoothly through the states
  - Newborn can often maintain alert state and attend to visual or auditory stimuli or interact with caregiver
  - Tune out extraneous noise to some extent
Arousal, Attention and Cognition

- Preterm
  - Difficult to calm, moderate facilitation
  - Disorganized sleep for shorter periods of time
  - Poor tolerance to multimodal stimulation in home environment-physiological cost
  - Challenged to assume alert organized state for social interactions or feeds
Risk/ Benefit Ratio?

- Early role may only be to minimize handling and facilitate improved behavioral state regulation through
  - Parent education
  - Environmental and Equipment modifications
  - Transdisciplinary input
  - You may not be able to complete standardized testing

Physical Therapy Practice

- Examination
  - History
  - Systems Review
  - Tests and Measures
    - Functional limitations/Activities
    - Impairment/ Body Structure and Function
  - Evaluation
  - Diagnosis
  - Prognosis
  - Intervention
  - Outcomes

Tests and Measurements

- To acquire additional information to guide evaluation, prognosis, diagnosis and intervention
- Functional Skill Measurements (ICF: Activity and Participation)
  - PT Guide: Standardized testing for neuromotor development
  - Selection based on purpose of the visit, complexity of the patient
  - History and systems review influences tests and measures chosen or decision not to continue with examination
Functional Skills Measurement

- Provides baseline PT Guide information on:
  - 14. Neuromotor Development and Sensory Integration
  - 12. Motor Function (Motor Control / Learning)
  - 21. Home Management (ADL)
  - 24. Play
  - 17. Posture
  - 19. ROM
  - 1. Arousal, Attention and Cognition
  - 23. Ventilation and Respiration
  - 7. Environmental, Home and Work Barriers

- Identifies need for additional tests and measures

ICF Framework

Health Condition - Premature Birth-at-risk

Body function & structure
- Skeletal alignment
- ROM
- Postural Control
- Muscle Performance
- Sensory Organization

Activities
- Routine Care
- Feeding
- Sleeping
- Mobility
- Play

Participation
- Attention / Interaction with parents, siblings, caregivers

Environmental
- Home, daycare
- Multimodal input

Personal
- ANS, Motor, State and Self Regulation

Developmental Assessments

- Standardized testing supplements clinical judgment
  - Distinguish between typical and atypical development to avoid over/under identification of children
  - Indicating need & eligibility for intervention or monitoring
  - Goal planning
  - Efficacy of interventions
  - Motor planning and quality
Types of Tests and Measures

- **Discriminative**
  - Distinguish between children with/without a particular function
  - Used to identify children with developmental delays (Activity limitation)
  - Norm referenced: PDMS, BSID, AIMS, TIMP

- **Evaluative**
  - Measure (evaluate) change over time in response to an intervention
  - Must be responsive
  - Criterion-referenced: GMFM, SFA, PDMS, AIMS, TIMP, BSID

Score Interpretation (Tierman, 2005)

- **Norm-referenced measures**
  - Percentile rank
  - Age equivalent
  - Standard score
    - Based on normal distribution of scores with mean and standard deviation
    - Preferred for identification of developmental delay

- **Criterion-referenced**
  - Percentile score
  - Rasch item difficulty

<table>
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<th>Subtests</th>
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<th>Standard Score</th>
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<td>18m</td>
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<tr>
<td>Total</td>
<td>60 GMAQ</td>
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Discriminative Tests to AideDevelopmental Evaluation and Diagnosis of the Preterm Infant

Alberta Infant Motor Scale
(B-18 months or walking)

Peabody Developmental Motor Scales
(B-7)

Bayley Scales of Infant Development
(B-42 months)

TIMP (B-corrected 4 months)

How do these tools differ?

PDMS / AIMS / BSID / TIMP

- All the assessment tools include examination of supine, prone, sit and stand and transitional movements
- Beneficial to understand how the preterm and full term infant may present differently in each of these positions
- Pair qualitative assessment with administration of test items
- Postural control and symmetry
- Importance of qualitative evaluation of motor skills in addition to standardized testing
  - Many high risk infants can have age appropriate motor performance on standardized testing but depressed motor performance at later ages (Piper et al 1996)

Development of LE Flexion

- LE flexion (caudocephalic)
  - 28 wks hypotonia
  - 30 wks hip flexion developing
  - 34 wks hip flexion and LE flexor tone
  - 36 wks flexor tone dominates trunk and extremities
  - 40 wks flexor and extensor muscles equalized and LE & LE held in flexion (Monterosso et al 2002)
Supine

- Development of posture and mobility
  - Balance between passive and active muscle tone (Monterosso 1992)
  - HFC’s, KFC’s, EFC’s initially provide stability for pelvic girdle
- Positioning for midline, hands to mouth & motor abilities to facilitate self calm

Supine Full Term

- AIMS (Piper and Darrah 1993)
  - Observational measure in supine, prone, sit and stand
  - Measures weight bearing, posture, antigravity movement
  - 90% infants credited
  - 3 months achieve neck flexion with active chin tuck and hands to midline
  - 4-5 months active abdominals with hands to knees
  - 6 months hands to feet

Preterm vs. FT Infant

- Scapular retraction
- Neck and trunk hyperextension
- Unequal activity of trapezius and rhomboid musculature
- Lack of pelvic elevation
- External rotation and abduction (Monterosso et al 2002)
- At risk for asymmetry
Preterm Infants

- Lower tone – Imbalance between active adjustments to changes in posture and passive muscle tone
- Imbalance between active and passive muscle power (Bennett 1997)
- Extension > flexion
  - Decreased/ no contractures
  - Arthrogryposis more at term noted with 7-8% at birth (Kakebeeke et al 1997)
  - Herina (1988) – Knee, ankle joint angles PT < FT
  - Higher active muscle tone in the extensors of the trunk (Bennett et al 1995)

- Movement-wider, less modulated, less variable & less fluent (Kakebeeke et al 1997)
- Movement 80% of sleep time
- Movement is state related
- Energy required to stabilize in new environment due to physiologic and motoric instability

Impact on Activity & Participation

- Decreased ability to complete self regulatory movement patterns
- Poor midline orientation and visual orientation
- Decreased downward visual gaze
- Posterior WS in sitting
- Decreased hand to foot play in supine
- **Examine spinal range of motion**
Prone Development - FT

ATMS (90% credited)
3m: WB hands forearm & chest
4m: WB forearms and trunk (nipple level) hips abducted
5m: WB on abdomen with active chin tuck
6m: WB low abdomen & thighs; legs approaching neutral
- Prone extension doesn’t develop in isolation
- Balanced activation of trunk flexors with spinal extensors - co-activation

Preterm vs FT

- Center of pressure during reaching - small travel path in comparison to FT
- FT showed more medial/lateral than cranial/caudal
- Preterm - no directional preference
  (Fallang et al)

Functional Assessment of Prone

- Indicates need for additional tests and measurements:
  - Tightness on the outer thigh
  - Wide BOS?
  - Shortening of neck extensors?
- Limits trunk rotation and transitional movements (rolling, sit to quadruped)
FT Sitting - 5 months

- Posture
  - Thoracic extension, lumbar flexion
  - Wide base of support in LE's (hips abd/ER)
- WB
  - Buttocks, legs and hands
  - Supports weight on arms briefly in midline

FT - Independent Sitting
Without UE Support

- WB
  - Buttocks and legs
- Posture
  - Increased stability therefore narrower BOS
- Antigravity Movement
  - Arms away from body-play with toy

Preterm vs. FT

Preterm: less able to modulate postural activity-feedback processes dominate (Fallang et al)
Functional Assessment of Sitting

- Anterior weightshift and overuse of hip flexors
  - Indicates need for additional tests and measurements
- Excessive hip flexion/shortening of ilipsoas and adductor brevis (Monterosso et al. 2002)
- Line of gravity anterior = humeral extension/IR & cervical extension (Bierman J 1996)

Preterm Infants

- Decreased coactivation & poor grading of trunk flexors and extensors
- Compensatory strategies to increase stability
  - Spinal extension, scapular retraction, wide base of support, overuse of hip flexors
- Delayed GM, FM, oral motor and visual skills
- *Decreased transitional movements

Transitional Skills- FT

- Repetition, variability in movement patterns
- Variation in postural muscle activity in response to perturbations (Hirschfeld & Forssberg)
- Degree of difficulty of movement pattern
  - Diagonal weight shift
  - Rotation
  - WB position
Transitional Skills - Preterm

- Static supine, sit and stand
- Poor tolerance to sidelying and prone, decreased trunk rotation and UE WB
- Dependent for positioning and stimulation
- Reduction in the degrees of freedom “fixing patterns”- decrease in dynamic normal exploration and variability in process of learning new behavior (Touwen, 1993)

FT - Standing Skills

- AIMS- skills 90% infants credited with prior to independent ambulation
  - Lateral cruising, rotation in standing at furniture, 1/2 knee to stand at furniture, controlled lowering from standing, quadruped to bear to stand (50%)

Comparison Between Preterm & Full Term Infants on the AIMS (Haastert et al 2006)

- Preterm Infants scoring in the bottom 25%: ate tended to fail on 2/4 subscales
  - Items with complex postural control
  - Prone - modified 4pt kneeling and reciprocal creeping
  - Standing
    - standing
    - cruising with rotation
    - stands alone
    - early stepping
    - standing from modified squat
    - standing from quadruped
    - walks alone and squats

- Preterm Infants scoring in the bottom 25%:
Standing

- Early standing
  - Lack of postural control
  - Use of stability patterns
- Transient dystonia
  - brisk deep tendon reflexes
  - Held vertically - extension/ adduction/PP, rigid arms with fisted hands (Fallang et al)

Uses of AIMS

- Observational tool for examination of postural control
- To identify infants with delayed development
- Address rate of motor development with repeated testing
- To identify infants with abnormal movement patterns suggestive of motor disorder

Reliability and Validity of AIMS

- Interrater reliability (.99) (Blanchard et al 2004)
- Test re-test 3-7 days (.95-.99)
- Concurrent validity
  - PDMS 2 (.95-.99)
  - BSID 2 (.93-.97) (APA Topics in Pediatrics)
- Rasch analysis - hierarchy of items according to difficulty (Liao and Campbell 2004)
  - Consistent with order on test form
  - Provide evidence of validity in assessing overall motor ability in infants
  - Ceiling effect in areas with gaps, large jump in ability level between items, after controlled lowering item
  - Low score at 10 mo- not necessarily score low at 15 mo
AIMS
- Fetters (2000)
  - Cocaine exposed infants: AIMS, MAI, PDMS2 @ 4, 7, 15m
  - Scores at the 2nd % = greatest +predictive value at 15m PDMS2
  - Best test properties at 7 mo
- Liao & Campbell (2004) Best test predictive at 7.5-8.5 mo
- Kolobe
  - Preschoolers 4-5 yrs on PDMS2, previous PDMS AIMS 3, 6, 9, 12 mo
  - 5th % had accuracy 10th % predictive properties w/ PDMS. Dx CP
  - Significant correlation between AIMS percentile scores and the 3 GM subscales of the PDMS2

AIMS
- Scores @ 5th % on AIMS correlated w/ BSID-II
- Provides additional information to supplement clinical decision making
- If child < 7 mo, serial testing + clinical judgment
- 5th% > 6 mo correlated w/ children later dx w/ CP

AIMS
- Van Haastart et al (2006) used pediatrician developmental assessments with values of normal, suspect and abnormal to establish cut off points
  - 4 months of age: 30th % most accurate cut off point
    - Sensitivity 77%
    - Specificity 83%
    - Negative predictive value 96%
  - 8 months of age: 5% most accurate cut off point
    - Sensitivity 86%
    - Specificity 93%
    - Negative predictive value 98%
Comparison Between Preterm & Full Term Infants on the AIMS

800 preterm without complications
- Mean AIMS scores of preterm infants lower than full term infants at all ages
- From 12m to 18 months the number of preterm infants that achieved a full score of 58 points increased from 1.5% to 78%
- Test does not discriminate well after 14 months of age

(Avan-Haastert et al 2006)

AIMS Shortcomings?
- Cultural differences when Canadian norms compared to other cultures (Fleuren, Campos)
- Mean percentile scores Dutch/Brazilian infants lower than Canadian norms
- Application of "Back to Sleep" programs may impact development of postural control in infants worldwide (Fleuren)
- Re-norming with global populations indicated due to its international use (Fleuren)

PDMS-2
- Evaluate child’s progress over time
- A research tool to study motor development in populations of children, motor abilities and academic success and effectiveness of interventions
- PDMS-2 manual urges caution when using age equivalents and discourages their use
- Advocates use of percentiles or standard scores
- Familiarity with tool NB for interpretation of scores
Change in Procedures?
(Wiepert SL, Mercer VS, 2002)
- Cross sectional survey of 19 TD 48-68 mo preschoolers
- Administered PDMS, but allowed up to 5 trials for each test item
- Contrasts w/ limit of 1 trial for most items
- Clinically significant changes resulted in TD population w/ increase in trials
- 3 trials optimal except for receipt/propulsion of 5

Change-Continued
- PDMS may not have captured child’s true performance due to limitation of 1 trial
- “All or none” response may explain more frequent detection of motor delays than other assessments
- Performance may be adversely affected by language deficits, limited Eng proficiency, cognitive difficulties, attention, shyness, cultural factors in lieu of true motor delays
- PDMS-2 now includes 3 trials per item which may yield higher results in scoring
- *Variability in administration?

Cultural differences?
(Crowe, 1999)
- Cross sectional survey of 44 TD Native American 2 year olds
- 50% of sample scored below mean on PDMS FM scale= mild-mod delayed
- 25% of sample scored below mean on PDMS GM scale=mild-mod delayed
- Over-identification for children on whom PDMS not normed or underrepresented
- PDMS-2 norms representative of US census
Bayley Scales of Infant Development

- First available in 1969
- Revision in 1993: BSID-II
- 111 items in motor (GM + FM)
- Recent revision in 2005: BSID-III
- Due to new revision, literature detected no comparison studies using BSID-III. Therefore findings include BSID-II only

Uses of BSID-II

- To identify young children with developmental delay
- To assist in intervention planning
- To obtain qualitative and quantitative info for comparison to peers
- Most useful as diagnostic tool as part of multidisciplinary assessment

BSID-II Uses, cont’d

- Scales can be administered independently (Mental, Motor) MDI, PDI
- Used to chart child’s progress over time
- Serves as research tool
Findings of PDMS-2 vs BSID-II (Provost 2004, Connolly 2006)

- Poor agreement and validity between standard scores of the PDMS-2 and BSID-II.
- High agreement and correlation between PDMS-2 Locomotor AE and BSID-II AE.
- Limited concurrent validity between 2 tools.
- Children scored higher on PDMS-2.
- Eligibility determination affected by which instrument used. Qualified with BSID-II only.
- Standard scores should be supplemented with additional information for decision making.

TIMP—Test of Infant Motor Performance

- Assessment of postural control needed for functional movement in early infancy.
- Identifies infants with motor delay before 4 months corrected.
- Documents motor performance over time and evaluative effectiveness of intervention. (Campbell et al)

TIMP

- Discriminates among infants with varying degrees of risk for poor motor outcome based on perinatal medical conditions.
- Predicts 12 m motor performance with sensitivity = 92% and specificity 76% at 3m.
- Limitation: 4m
  - Change in motor performance over time
  - Often enter EI services 3-4m of age
Decision-Making

- Parents come to see you with their high-risk, 7-month-old, age corrected premature infant
- They have concerns for their child’s motor development
- What will you assess?
- Which instrument will you use?
- What additional qualitative information would be beneficial?
- How to decide?

Supine Hands to Feet

Clinical differences- Supine?

- PDMS-2: Brings feet to mouth for play or grabs feet w/hands (both feet must come up, alt or together)>90 degrees, partial credit if raise only one leg or raises legs 90 degrees or less
- BSID-II/III: Child brings 1 or both feet up to hands (above hips) and grasps a foot
- AIMS: Hand contact w/ 1 or both feet, hips flexed 90, knees semi-flexed or extended. Demo chin tuck, lifts legs and brings feet to hands, maintain legs in mid-range, pelvic mobility present, rocks side to side and may roll to side- no partial credit
- TIMP; NA<4 months
Clinical Differences-Prone?

- **PDMS-2**
  - Elevates head and upper trunk 45 degrees and bears weight on forearms for 5 seconds (4 months)
  - Elevates head and stomach by pushing up with arms, bearing weight on palms for 5 seconds (6 months)

Clinical Differences-Prone

- **BSID III**
  - Elevates trunk while prone, forearms, (later item extended arms)
  - Maintains head at least 90 degrees from exam surface for 5 seconds

Clinical Differences - Prone

- **AIMS**
  - Elbows in front of shoulders, active chin tuck with neck elongation
  - Arms extended, chin tuck and chest elevated, lateral weight shift
  - Measures balanced activation of anterior and posterior trunk musculature
Differences in test constructs between assessments?

- Many more items tested on PDMS-2 compared to BSID-II
- Failure of a test item on BSID-II impacts overall score more than PDMS-2
- Combination of gross and fine motor items on BSID-II for Psychomotor Index vs separate GM and FM scales of PDMS-2 yields different findings and results

What does this all mean and what’s a PT to do?

- With use of PDMS-2, supplement standard scores with % scores, confidence intervals and clinical judgment for eligibility determinations
- Correlation exists between AE of PDMS-2 Locomotor subtest and BSID-II AE
- AIMS supplemental info may be helpful in infants birth-18 mo & to assess quality of movement
- BSID-II may be useful tool in children birth-42 mo in eligibility determination
- TIMP:
  - Documentation of motor performance over time in NICU & home setting
  - Predictive on 12 month motor performance
Best advice???

- Include examination of behavioral state regulation through identification of competencies and challenges in multi systems prior to examination and in response to handling
- Continue to use tests and measures, combined with clinical judgment for decision making for all children
- Children with prematurity may be eligible for services not only based on standard scores for developmental delay but based on neonatal conditions and associated complications