Developmental & Maladaptive Plasticity Karen Pape, MD ISRN Melbourne 2012





We see what we expect. Expectation drives perception.





We ignore the unexpected. Expectation limits perception. i cdnuolt blveiee taht I cluod aulaclty uesdnatnrd waht I was rdanieg. The phaonmneal pweor of the hmuan mnid, aoccdrnig to a rsecheearr at Cmabrigde Uinervtisy,

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#### Expectations are important.

#### **Old Science**

CNS damage is irreversible. Treatment protocols are based on adaptive neuroplasticity.

#### **New Science**

#### Brain, Spinal Cord & PNS can...

Regrow

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- Reorganize
- Reallocate

#### "The Future is Not What it Used to Be."

#### **Restorative Neurology**

Makes the most of what is there and stimulates further improvement.

The Silent Synapse

Documented at all levels of the central and peripheral nervous systems.

Moral of Story More there than you think Insights from Pediatrics

- . Delay for Recovery
- . Habits Hide Recovery
- . Disuse Atrophy

#### **Delay for Recovery**

Timeline for Recovery 3 - 4 years.

Babies learn to move with damaged, immature neurology.

Early movements are abnormal.

#### **Delay for Development**

Children 4 – 8 years learn novel complex movements with recovered & more mature motor systems.

#### Habit Hides Recovery

First movements dominate as maladaptive neuroplasticity.







#### Will she be able to play tennis?



#### Early Abnormal Movement Patterns are Habits

To uncover normal neurology, do something new.

#### Disuse Atrophy

Brain, efferent motor, muscles, afferent sensory and everything in between is atrophic. "Use It or Lose It" Disuse Atrophy "Use It and Grow It"

Activity Dependent Neuroplasticity

#### **Neonatal SCI**

Difficult mid forceps delivery C1-3 block Quadraparesis

Age 10 days Flickers of Rt hand movement noted by NICU nurse. - Decision to support. **3 Years Later** Ventilator dependant. Off ventilator 1 hour x 2 per day. - Dependent all ADLs.



#### **Decision to Treat**

**Disuse Muscle Atrophy** 

#### **Threshold Electrical Stimulation**

#### Neuromuscular Electrical Stimulation

#### **Threshold Electrical Stimulation**









Pre-TES

5 weeks later

#### TES

# Low level, afferent, sensory stimulation produces rapid change in...

- Awareness
- Muscle Bulk
- Function



5 years

8 years

Function is Improved with Increased Awareness

Passive

**Threshold Electrical Stimulation (TES)** 

Active sEMG Biofeedback sEMG-Triggered Stimulation (ETS)

#### Awareness Improves Strength

Early change + 10 – 20% MVC

### Threshold Electrical Stimulation TES

6 months nightly.





Children have no knowledge of normal. sEMG Biofeedback produces change in minutes.

"That's what dorsiflexion is..."





### EMG Triggered Stimulation ETS

Closed Loop Neurofacilitation Patient raises EMG to Threshold Stimulator completes action





#### Short Term Change

awareness & function
accessory muscle activation
Two Strengthening Protocols
Home based, effective

#### Children Love It

Teaches correct movement.



#### Last Words

Baby is not a small child. Child is not a small adult. TES, EMG Biofeedback & ETS are useful in mild to moderate severity injury. Neither technique overcomes severe spasticity.

#### Incidental Observations TES

Bowel, Bladder & Sexual Function Wound healing, skin integrity Improved local blood flow

## *Thank you.* Karen Pape, MD

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