BOSTON
CHILDREN'S
HOSPITAL

HARVARD
MEDICAL SCHOOL

# Interdisciplinary Pediatric Pain Program
## Dattelner Kinderschmerztage March 16-18, 2017


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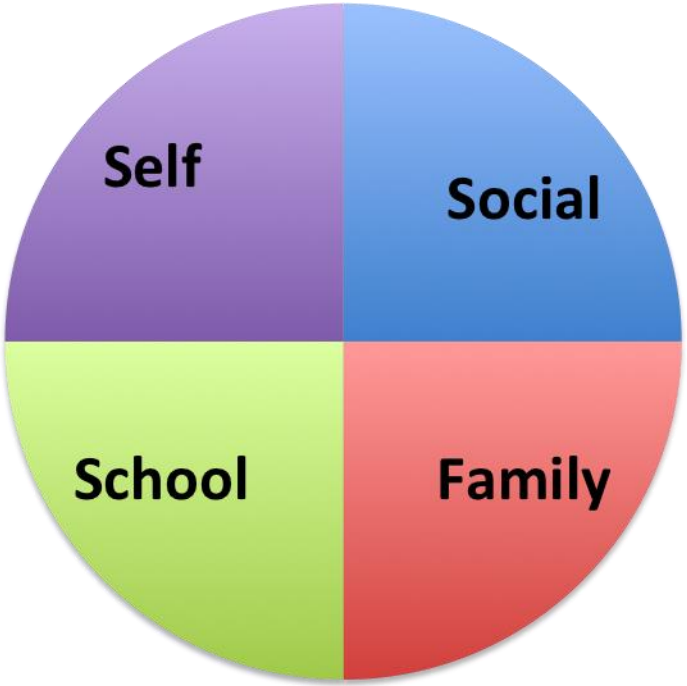
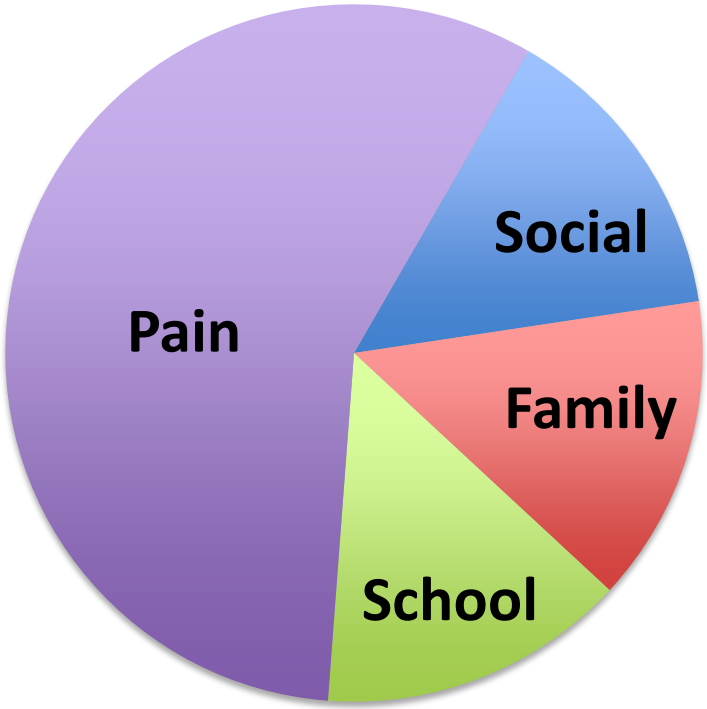
# What is health vs. illness?

# Health and Pain

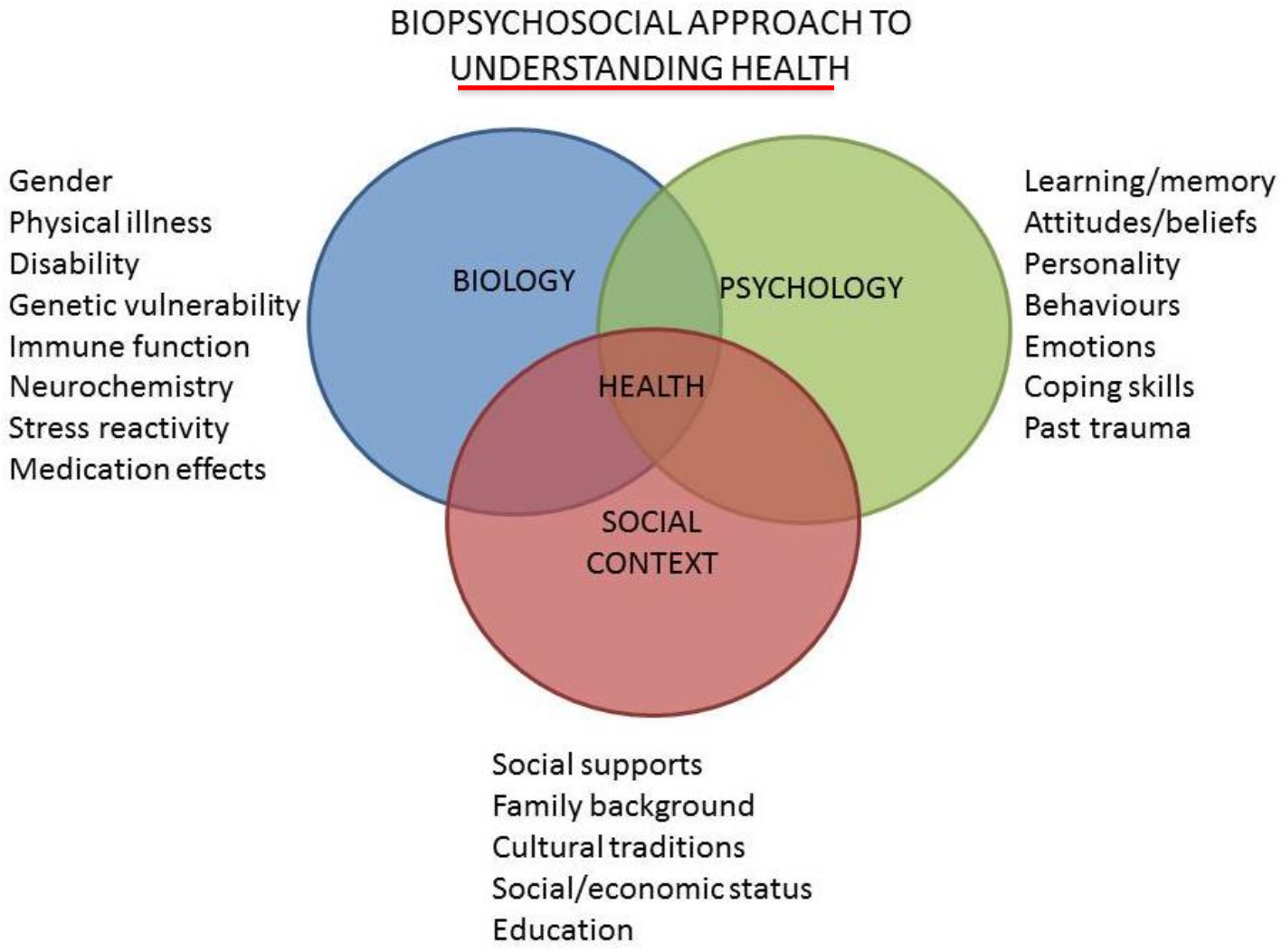
**Mind of a healthy child**




**Mind of a chronic pain child**



# Understanding chronic pain disorders?



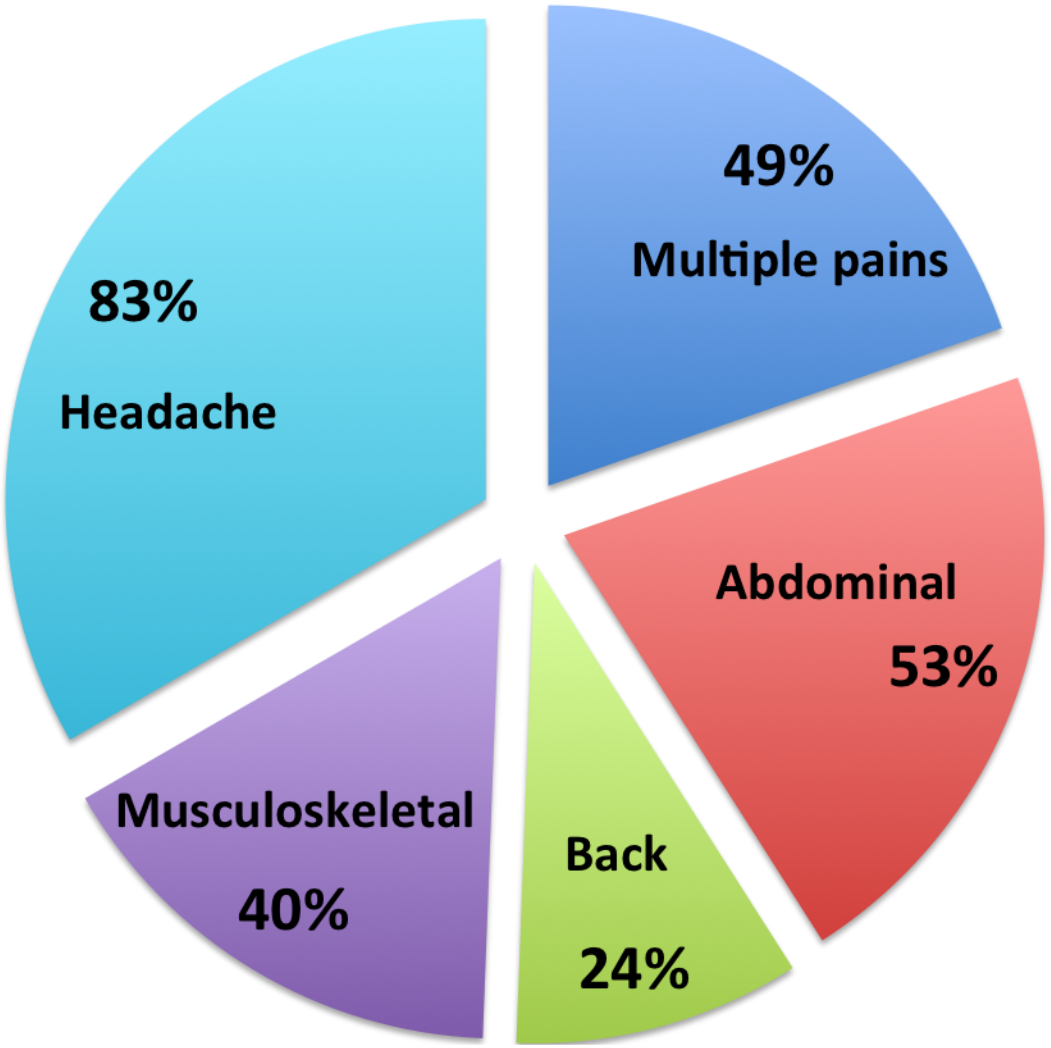
# What is the scope of the chronic pain problem?

*King et al., Pain 2011; Huguet et al, J Pain 20008; Groeneweld et al, Pain 2015; Brattberg 2004; Brna, 2005; Tan 2008; Jones 2007, 2009 Walker 2012*

- **Significant public health concern**
  - **Median prevalence rate 11-38%**
  - **Pain related disability rate is 3-5%**
- **Financial burden to healthcare (aggregated incremental cost in billions of $)**
  - **Chronic pain disorders >ADHD/asthma/obesity**
- **Risk of persistence to adulthood**
  - **HA, FAP, WSP, JFM, CRPS**

# Common Pediatric "Dysfunctional or Primary or Medically Unexplained" Persistent or Recurrent Pain Disorders

*King et al., 2011*



# Definition of chronic pain disorders? Controversies & theories

- **Medically unexplained, (dys-)functional, no objective findings: cause of pain is not apparent or detectable?**
- **Central sensitization e.g., FM, FAP, CDH, etc.**
- **Post-traumatic peripheral sensitization**
- **FAP: e.g., G-hypomotility syndrome**
- **Overuse injury [microtrauma]**
- **Biomechanical risks: malalignment & physical stress**
  - **Hypermobility, *tendonopathy*, PFS, deconditioning, etc.**
- **Psychological disorders**
  - **e.g., Somatization e.g., anxiety, depression, etc.**

# Various BPS-models based on the subspecialty of the treating clinicians & local resources

Outpatient
~3-week
PT/OT, CBT,
Psycho-education
PRN medications

Boston Children's Hospital, USA

Outpatient
4-day CPNB
home therapy
& HEP

Hospital Lapeyronie, France

Inpatient
~3-week
CBT & PT/OT
PRN medications

Datteln, Germany & Bath, UK

Inpatient 2 wk +
outpatient 1 wk
CBT & PT/OT
PRN medications

Cleveland Clinic *Medical* Rehab Program, USA

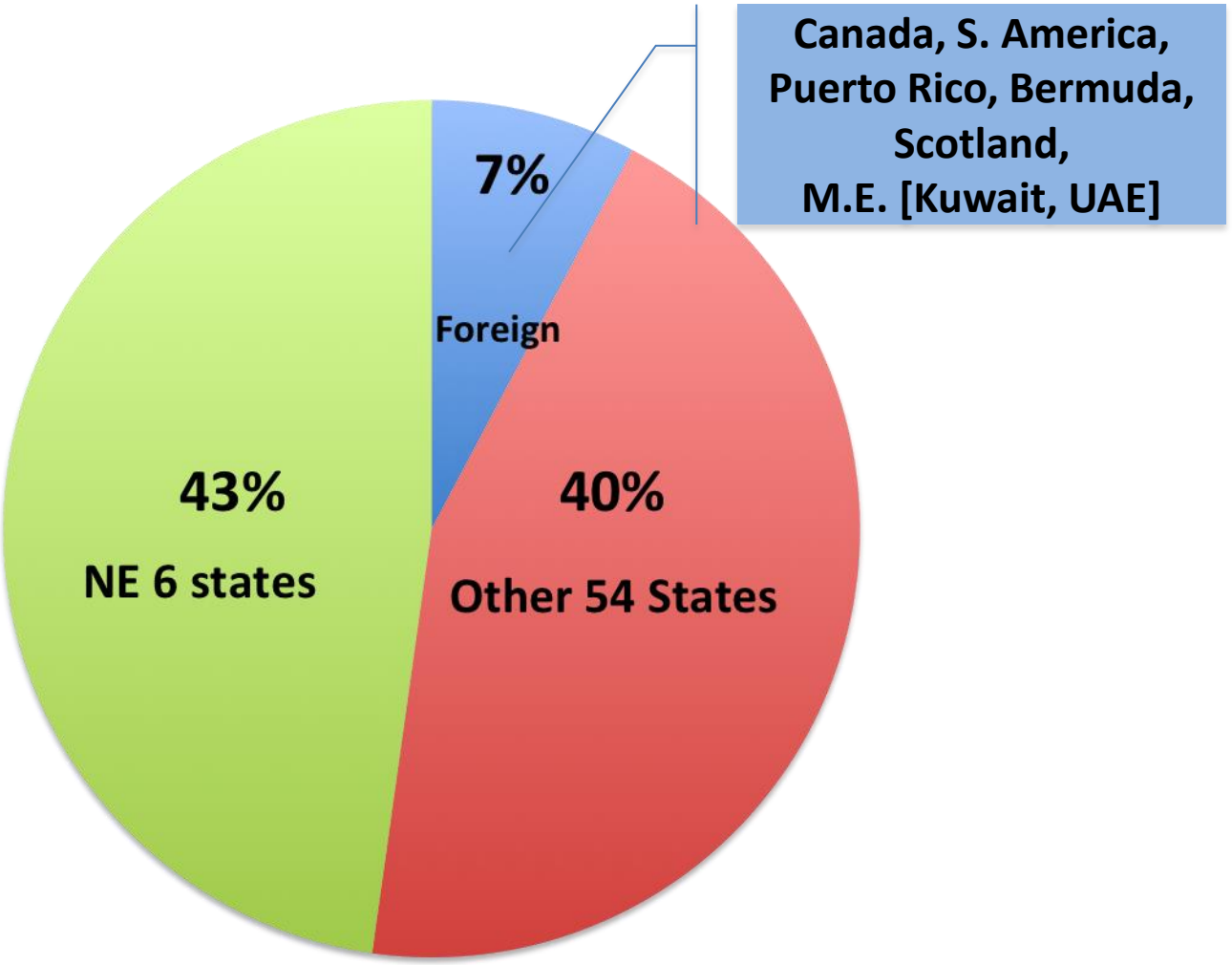
Inpatient 1 wk +
outpatient 2 wk
PT & OT
PRN psychological
No medications

Children's Hospital of Philadelphia, USA

# Pediatric Pain Rehabilitation Center (PPRC) at Boston Children's Hospital

- 2008; diagnoses
- 65-75 patients per yr [3-12 weeks]
- Age 8 to 22 yrs (M:14.3)
- Predominantly female (84%)
- Predominantly Caucasian (93%)
- Staff
  - MD (1 FT, 2 PT), RN (1 FT, 1 PT)
  - Psychologists (3 FT)
  - PT (2 F), OT (2 FT), CA (1 FT)
  - Admin assistant 1 FT
- 6 patients daily treatment:Expanding

# Broad Catchment Area



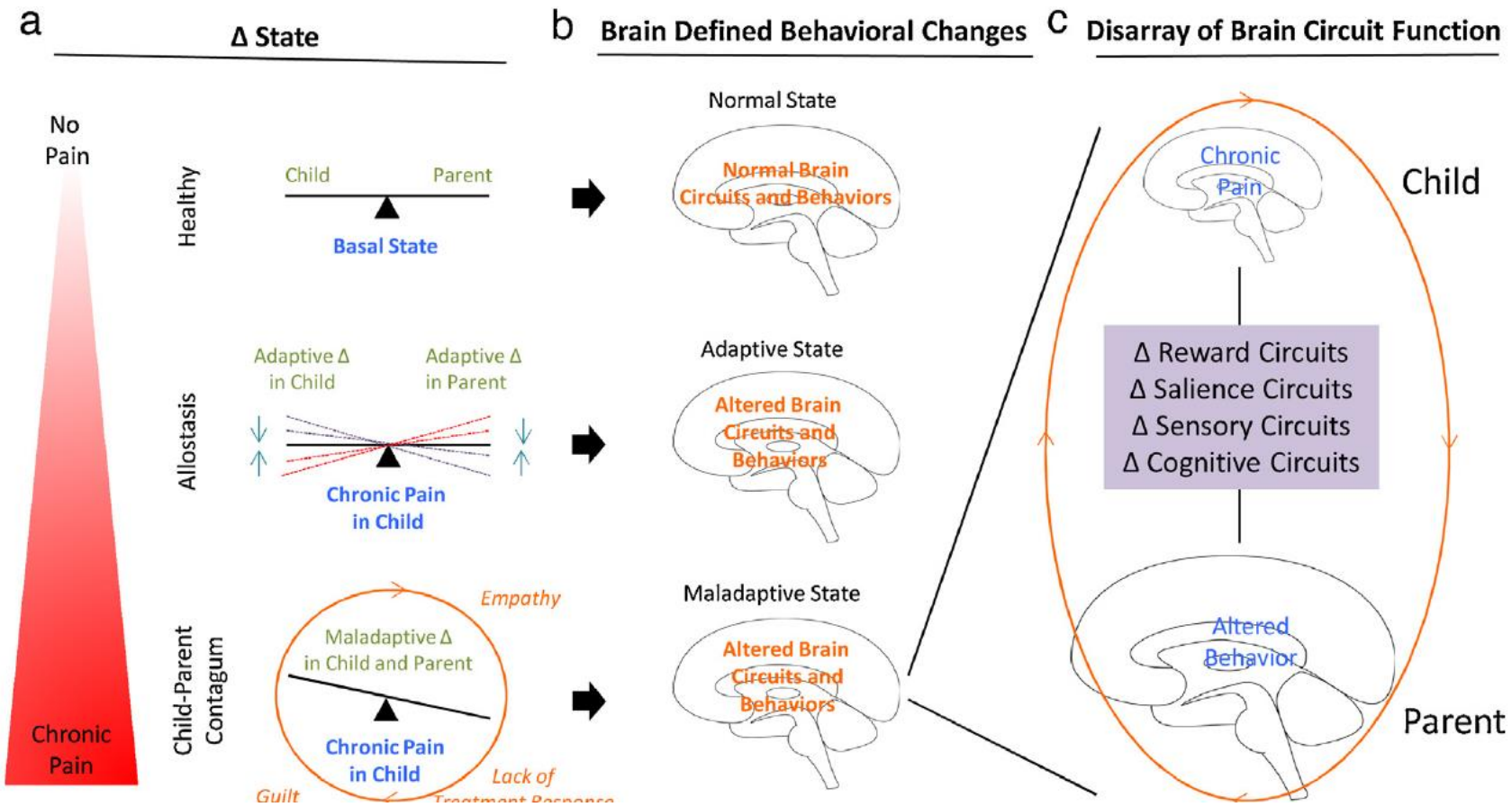
# Biopsychosocial therapeutic strategies


- **Strategies based on *individual characteristics* rather than grouping patients by diagnostic pain categories**
- **Education and goal setting**
  - **Active engagement and independent in self-management**
- **Land/water therapy, conditioning, ergonomics, posture/gait correction, ROM, strengthening, balance, edema control, desensitization, E-stimulation, functional activities**
- **Pacing, activity breaks and prioritizing/planning activities**
- **Wean off assistive devices. Discontinuation of analgesics**
- **Rarely splinting/Botox/manipulation under GA & surgery**

# Circles of engagement: Childhood pain and parent brain

Laura E. Simons[a,b,c,*], Liesbet Goubert[d], Tine Vervoort[d], David Borsook[a,b,e]

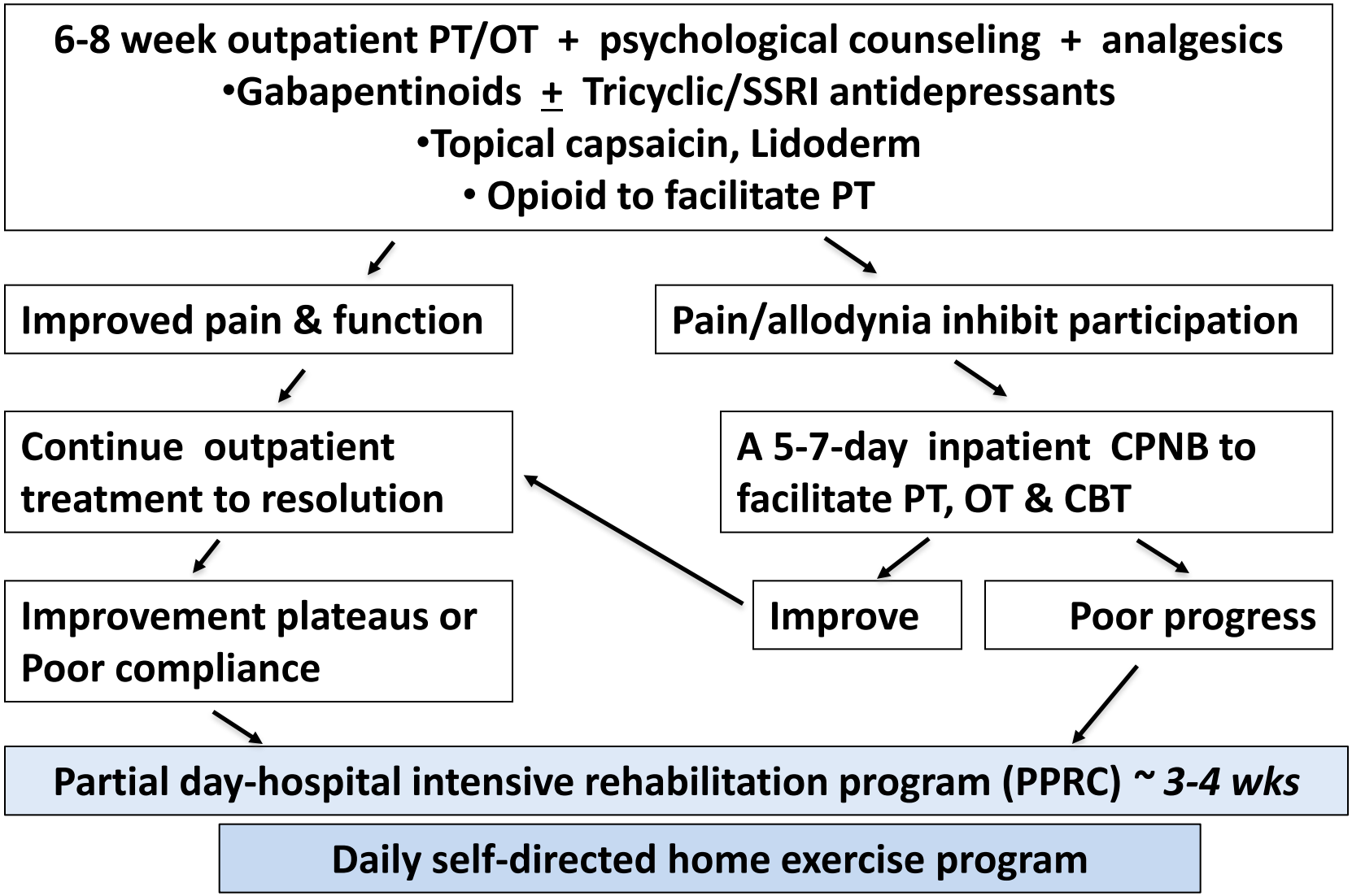
Neuroscience and Biobehavioral Reviews 68 (2016) 537–546



# Biopsychosocial therapeutic strategies


- **Psychological therapy**
  - **individual/family: CBT/operant conditioning**
- **Parents teaching weekly**
  - **Modules of pain/psychology neuroscience, life-style, post-discharge**
- **Self-management (empowering patients): ADL, resume AA-Age**
- **Sleep hygiene: "painsomnia"**
- **Community activities re-integration {e.g., social phobia}**
- **School re-integration (school conference, school visits)**
- **Relapse prevention**
  - **HEP, keep moving, pain management, & school plans**
- **Referral to outpatient PT/OT, individual psych (family), etc.**
- **Follow-up at 1, 3, 6 & 12 months; support PCP/ local team**

# Pre-admission Process for PPRC



# Admission Criteria to PPRC

- **Persistent pain > 3 mo. & causing functional disability**
  - **Pain: functional, medical (stable) or biomechanical disorders**
  - **IDD, JIA, JRA, IBD, EDS, hypermobility, HA/post-concussion syndrome, FAP, developmental discoordination disorder, congenital degenerative spine, post-surgical/trauma neuropathies AIS, idiopathic toe-walking, sports [overuse, gymnastics, LBP] etc.**

## Exclusion

- **Age ≤ 7-8 yrs, active substance abuser, severe ASD, developmental delay, eating disorder (NG/NJ-tube), DCS, active FND [pseudo-sz, syncope], mental illness [active SI/HI, psychosis, conversion?]**

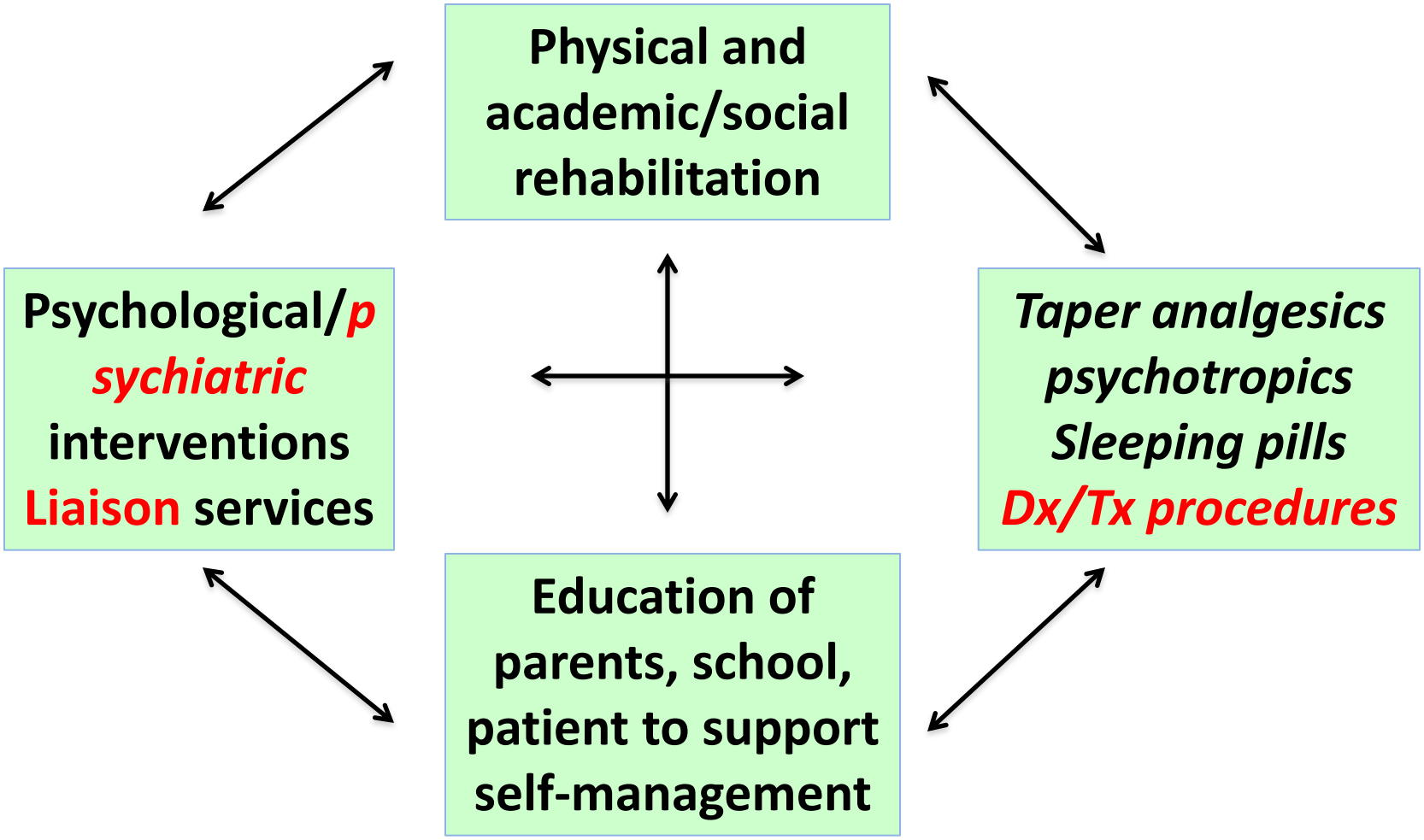
# Admission evaluation: MD, PT, OT, psychology, RN

- **Negative experience with health professionals**
- **Inappropriate beliefs and poor coping strategies (avoidance) despite education**
- **Litigation: Affect willingness to progress**
  - **Afraid to relinquishing social & financial benefits**
- **Overuse of assistive devices & analgesics**
- **Lack of willingness to set goals**
- **Undiagnosed: learning difficulties, ASD, PTSD (abuse disclosure), anxiety, bullying, low self-esteem, SI, etc.**
- **Negative parental distress/dynamics, social influences**
- **Psychological comorbidity [liaison psychiatrist]**
  - **Distress, anxiety, depression, personality disorder, etc.**

# Patient Daily Schedule

| Time | Activity |
|---|---|
| 07:45 | Arrive at the program, warm up in gym |
| 8:00 | Individual PT [primary clinician] |
| 09:00 | Individual psychology [primary clinician] |
| 10:00 | Individual OT [primary clinician] |
| 11:00 | Study time, physician check-in time |
| 12:00- 13:00 | Lunch |
| 14:00 | Group therapy: psychology, PT, OT or TR [music and art therapy] |
| 15:00 -16:00 | Parent(s) presence therapy of PT, OT, TR or psychology |
| Evenings | Home exercise therapy (self-directed exercises) |
| Weekends/holidays | HEP twice a day, 1hr of outdoor physical or community activity |
| *Wednesdays* | Family Education [biopsychosocial model, guide their children] |

# Interdisciplinary PPRC Approach



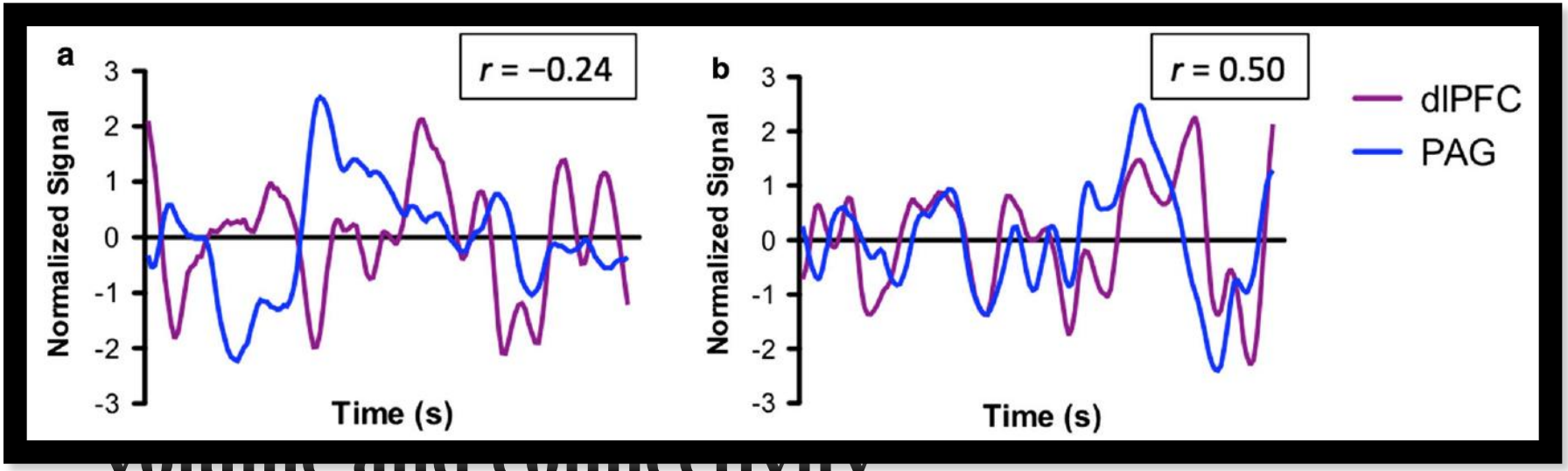
**Is there biological evidence to support**

**this management approach?**

## Rapid treatment-induced brain changes in pediatric CRPS

Erpelding et al., Brain Struct Funct (2016) 221:1095–1111

- **Compared to controls, CRPS fMRI showed**




volume and connectivity

- **Findings correlated with significant clinical improvement**

**Is there clinic evidence to support that the intensive interdisciplinary rehabilitation programs are effective clinically?**

## Systematic Review on Intensive Interdisciplinary Pain Treatment of Children with Chronic Pain

*Hechler et al., PEDIARICS 2015:36 (1);115*

- **Trials from Germany, USA, and Australia**
  - **9 were non-randomized & 1 was RCT**
- **Inpatient or outpatient IIPT rehab centers**
  - **Short-term follow-up of 2-6 months**
  - **Treatment duration in days 16 ± 5 (5 - 27)**
  - **Age 14 ± 1.6 years**
  - **Pain duration: 3 ± 2.8 years**
  - **Diagnoses: MSK, CRPS, HD, FAP, pelvic, & neuropathic pain**

## Systematic Review on Intensive Interdisciplinary Pain Treatment of Children with Chronic Pain

*Hechler et al., PEDIARICS 2015:36 (1);115*

- **Extreme heterogeneity of the measures**
- **Meta-analysis showed positive effect on**
  - **Pain intensity, disability, depressive symptoms**
  - **Cannot fully attributed to IIPT effect because of 9 non-randomized studies**
  - **School functioning and anxiety effect could not be computed**

# What is the most effective model?

***Outpatient***

**versus**

***Inpatient***

**versus**

***In- and out-patient***

**Cost and burden to the healthcare and families**

# Intensive vs. Outpatient Management

**What Does It Take? Comparing Intensive Rehabilitation to Outpatient Treatment for Children With Significant Pain-Related Disability**

Laura E. Simons,[1,2] PhD, Christine B. Sieberg,[1,2] PhD, Melissa Pielech,[1,2] MA, Caitlin Conroy,[1,2] PsyD, and Deirdre E. Logan,[1,2] PhD

Journal of Pediatric Psychology Advance Access published November 20, 2012

***Possible reasons are***

***structured programs offer higher intensity (dose) of treatment to address the complex***

***physical and/or psychological needs***

***and***

***enhances the motivation and adherence to treatment***

# What are the outcomes at PPRC?

# A Day-hospital Approach to Treatment of Pediatric Complex Regional Pain Syndrome

## *Initial Functional Outcomes*

*Logan, CJP 2012 (in press)*

**TABLE 2.** Descriptive Data: Demographics and Pain Characteristics

| Variables | Descriptive Data (Mean/SD, Range/Median, or %) |
|---|---|
| Patient age | M = 14.1 y (SD = 2.5) |
| Patient sex | 89.3% female |
| Level of parent education | Median, college graduate |
| Time since onset of pain at admission | Range, 2-108 mo; median, 8.5 mo |
| Current pain intensity, resting (NRS) | M = 6.6 (SD = 2.5) |
| Worst pain intensity (NRS) | M = 9.0 (SD = 1.7) |
| Patients meeting full IASP clinical diagnostic criteria for CRPS | 64.3%* |
| Affected area (s) | |
| Single lower extremity | 57% |
| Bilateral lower extremities | 12% |
| Single upper extremity | 9% |
| Bilateral upper extremities | 2% |
| Mixed† | 20% |

N=56; Median treatment duration of 3 weeks

*Logan et al, Clin J Pain 2012 (in press)*

**TABLE 3.** Prior and Current Pain Treatments Reported at Admission (n = 56)

| Treatment | Percent or Mean (SD) |
|---|---|
| Current pain medication use | |
| 1 medication | 39.3% |
| > 1 medication | 42.2% |
| Current use of assistive device* | 32.1% |
| Previous emergency department visits for pain (percent of sample reporting any visits; range, 0–10) | 38.3% |
| Previous inpatient admissions (percent of sample reporting any previous admissions; range, 0–15) | 30% |
| No. previous doctors' visits for pain | 8.54 (SD = 7.94) |

*"Assistive devices" defined as crutch(es), wheelchair, rolling walker and/or cane.

*Logan et al, Clin J Pain 2012 (in press)*

**TABLE 4.** Change in Pain Ratings, Medications, and Outcomes at Admission and Discharge

| Variable | Admission | Discharge | *P* |
|---|---|---|---|
| Mean current pain rating (NRS) | 6.5 ± 2.5 | 4.7 ± 3.1 | < 0.001* |
| No. pain medications | | | 0.009* |
| None | 10 (18%) | 17 (32%) | |
| 1 | 22 (39%) | 20 (37%) | |
| > 1 | 24 (43%) | 17 (32%) | |
| Use of assistive device | 18 (32%) | 0 (0%) | < 0.001* |
| FDI | 29 ± 10 | 9 ± 7 | < 0.001* |
| LEFS | 30 ± 15 | 66 ± 11 | < 0.001* |
| COPM performance | 3.2 ± 1.2 | 7.3 ± 1.6 | < 0.001* |
| COPM satisfaction | 2.7 ± 1.3 | 7.2 ± 1.9 | < 0.001* |
| Anxiety (MASC) | 47 ± 13 | 35 ± 19 | < 0.001* |
| Depressive symptoms (CDI) | 12.3 ± 9.2 | 8.9 ± 8.3 | 0.003* |

*Logan et al, Clin J Pain 2012 (in press)*

**TABLE 5.** Change in Objective (BOT-2) Functional Assessment from Admission to Discharge

| Variables | Admission | Discharge | *P* |
|---|---|---|---|
| BOT-2 bilateral coordination | 9.8 ± 4.8 | 15.4 ± 4 | < 0.001 |
| BOT-2 balance | 8.4 ± 5.6 | 15.0 ± 5.2 | < 0.001 |
| BOT-2 body coordination | 36.3 ± 9.7 | 50.7 ± 10.5 | < 0.001 |
| BOT-2 running speed and agility | 8.6 ± 6.2 | 17.0 ± 5.8 | < 0.001 |
| BOT-2 strength | 9.9 ± 4.9 | 17.4 ± 5.3 | < 0.001 |
| BOT-2 strength and agility | 37.8 ± 10.4 | 54.9 ± 11.3 | < 0.001 |
| BOT-2 manual dexterity | 12.4 ± 4.6 | 17.4 ± 4.4 | < 0.001 |
| BOT-2 upper limb coordination | 12.00 (4.61) | 14.8 ± 4.5 | < 0.001 |
| BOT-2 manual coordination | 43.2 ± 8.7 | 52.3 ± 9.4 | < 0.001 |

**P*-values represent the significance of the related samples Wilcoxon signed rank test for the non-normally distributed variables.

BOT-2 indicates Bruininks-Oseretsky Test of Motor Proficiency, second edition.

# A Day-hospital Approach to Treatment of Pediatric Complex Regional Pain Syndrome

## *Initial Functional Outcomes*

*Logan, CJP 2012 (in press)*

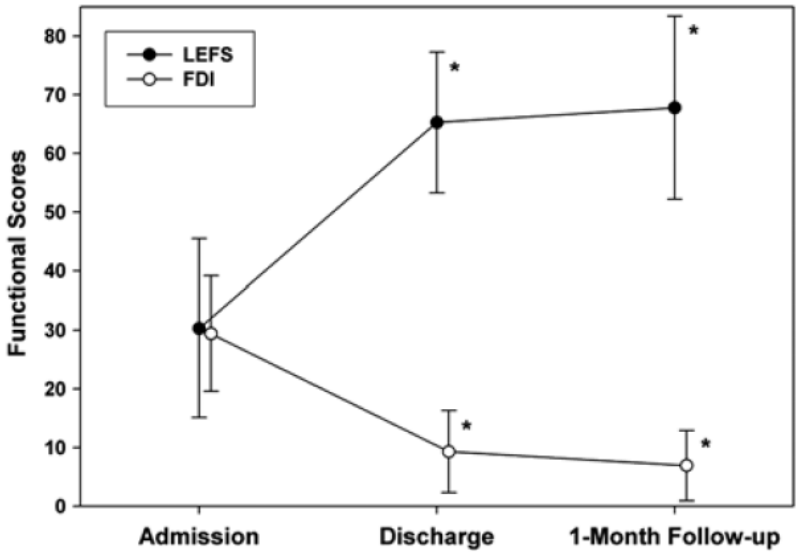



**FIGURE 3.** Self-report of functional abilities from admission to discharge and follow-up. FDI indicates Functional Disability Inventory; LEFS, Lower Extremity Functional scale.

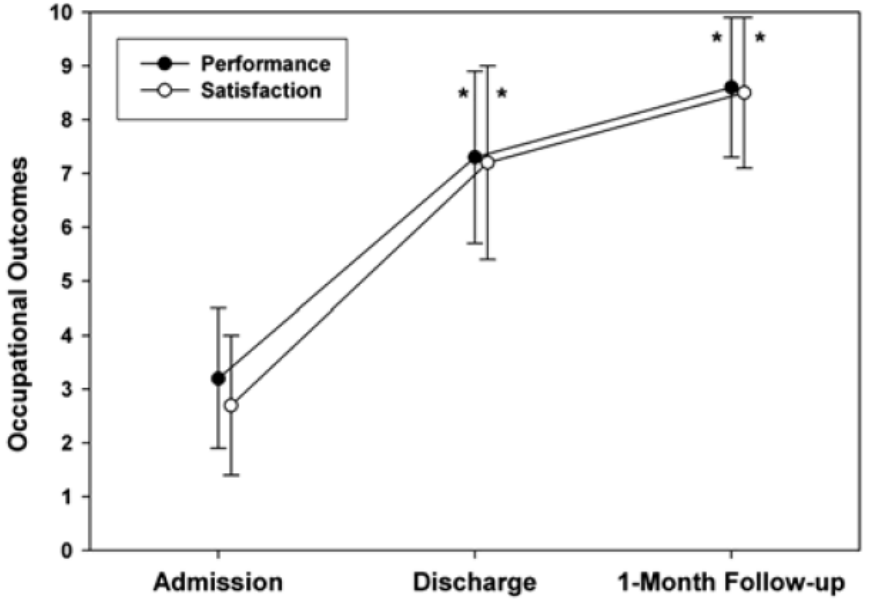



**FIGURE 4.** Self-report of occupational performance and satisfaction from admission to discharge and follow-up.

# Conclusions

- **A combination of intensive PT/OT & CBT is effective**

- **Near complete resolution of disability occurred in most patients and tolerability of residual pain**

## A Day-hospital Approach to Treatment of Pediatric Complex Regional Pain Syndrome

*Initial Functional Outcomes*

*Logan et al., Clin J Pain 2012*

- **3-week program; 56 CRPS, mean age 14 yrs**
- **At discharge, significant improvement in**
  - **Pain I, FDI, LEFS, timed exercises [100ft shuttle, TUG, UDT, 6MWT], COPM P/S, BOT-2 motor proficiency, anxiety/depression, reduction in analgesics use and discontinuation of assistive devices**
- **Functional gains were maintained at 1 month follow-up**

# Outcome Trajectories after one year Intensive Pain Rehabilitation *Simons et al. 2017 (submitted)*

- ***Hypothesized*** **that for both disability and pain there would be at least two groups of treatment "responders" and "nonresponders"**

- **Based on prior work for baseline differences, we anticipated that the nonresponders would have**
  - **higher levels of pain-related distress: Catastrophizing, fear**
  - **higher levels of generalized distress: Anxiety, depression**
  - **lower levels of readiness to change**
  - **higher levels of protective parenting behavior**

# Outcome Trajectories after one year Intensive Pain Rehabilitation *Simons et al. 2017 (submitted)*

- **Over 4.5 yrs, N= 280 consented & completed IIP**
- **Included: 3 pain or 3 disability data points inclusive of BL**
- **Excluded**
  - **N= 9 did not consent to participate**
  - **N= 5 not approached due to a developmental delay**

  **Immediately discharged from the program:**
  - **N= 4 due to psychological reasons**
  - **N= 4 medical reasons**
  - **N= 3 left the program against medical advice**

# Outcome Trajectories after one year Intensive Pain Rehabilitation *Simons et al. 2017 (submitted)*

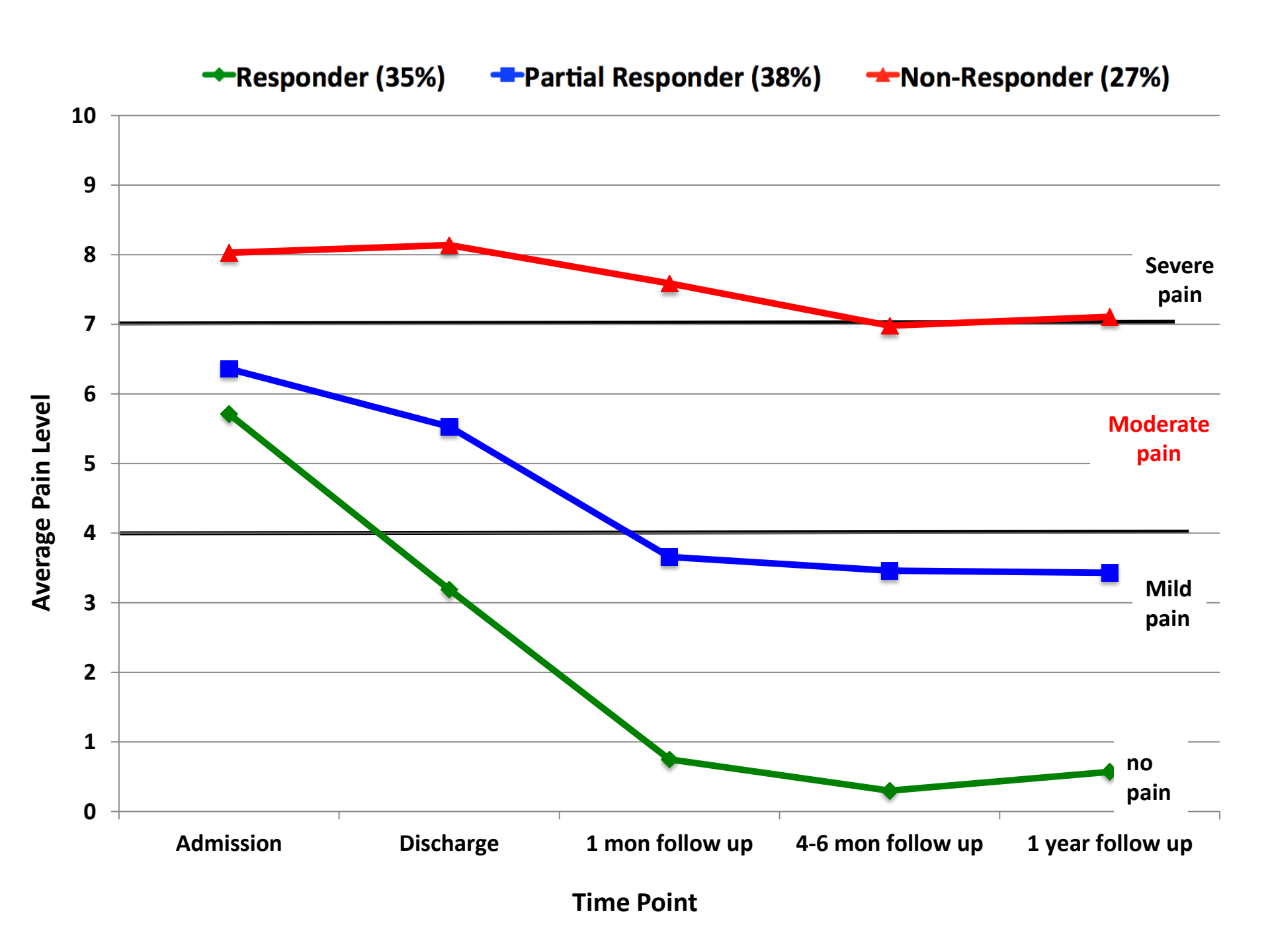
- **N= 253 had 3 pain data points inclusive of BL**
- **N= 194 had 3 disability data points inclusive of BL**
- **Data points collected: BL, 1, 4, & 12 months**
- **Caucasian 92%; 84% females; 14.5 ± 3 years**
- **Neuropathic pain 61%: CRPS 53% + ISFSN 8%**
- **MSK 27%: limb, joints/muscle, diffuse, LBP**
- **HA 6% inclusive of post-concussion syndrome**
- **FAP 6%**
- **Median duration of pain was 10 months**
- **Median length of stay was 4 weeks**

# Outcome Trajectories after one year Intensive Pain Rehabilitation

*Simons et al. 2017 (submitted)*

| | Admission | BL | 1 mo. | 4 mo. | 12 mo. |
|---|---|---|---|---|---|
| Pain | 253 | 253 | 237 | 123 | 99 |
| FDI | 194 | 182 | 173 | 106 | 91 |

**No significant BL differences in pain rating of n=253 and n=27 that were excluded in duration of pain, functional disability pain, age or length of stay**


Responder (35%)
Partial Responder (38%)
Non-Responder (27%)
10
9
8
7
6
5
4
3
2
1
0
Average Pain Level
Severe pain
Moderate pain
Mild pain
no pain
Admission
Discharge
1 mon follow up
4-6 mon follow up
1 year follow up
Time Point

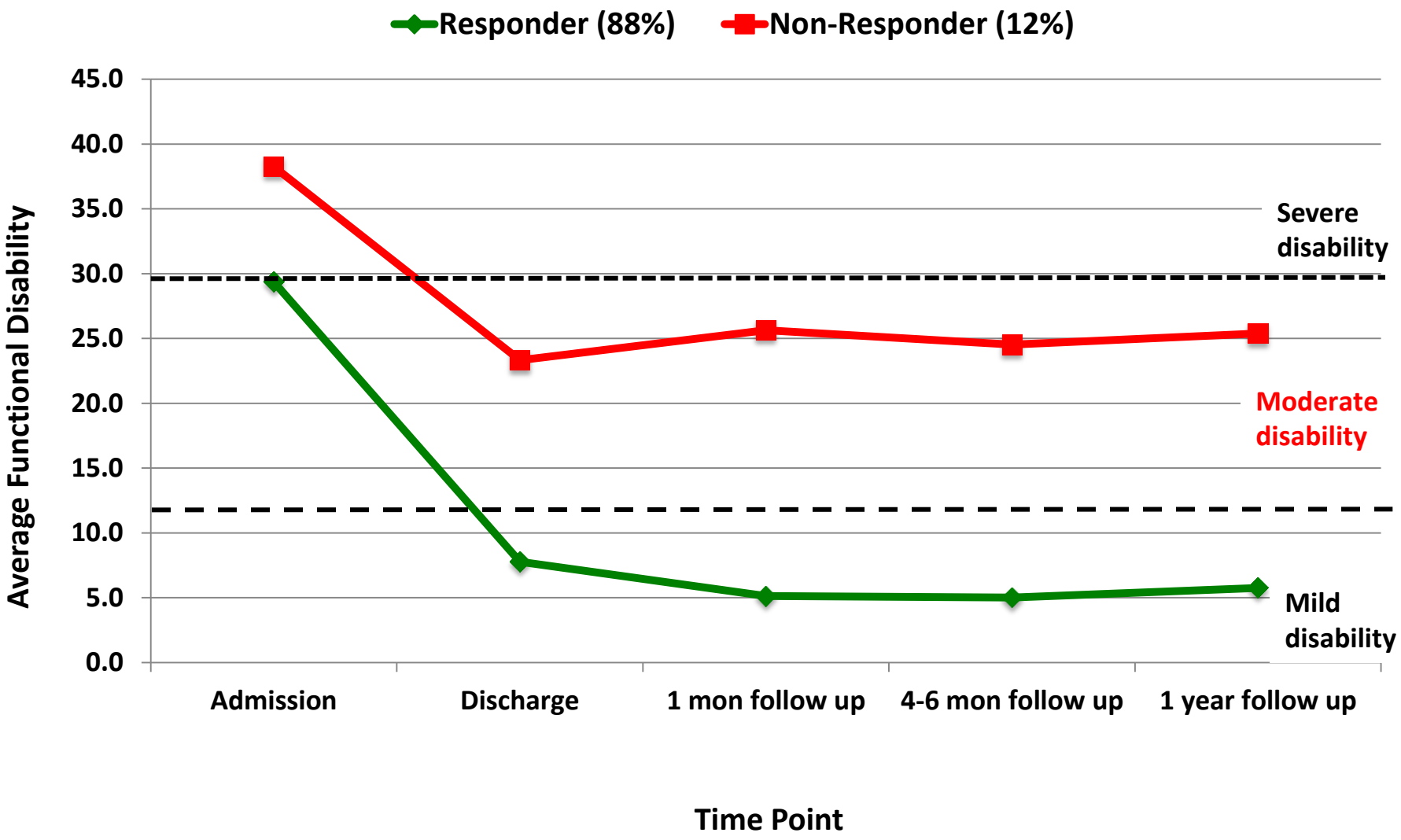

Responder (88%)
Non-Responder (12%)
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Average Functional Disability
Severe disability
Moderate disability
Mild disability
Admission
Discharge
1 mon follow up
4-6 mon follow up
1 year follow up
Time Point

Table 1. **Pain and disability treatment responders by pain diagnosis group**

| | **Functional disability** | | **Pain** | | |
|---|---|---|---|---|---|
| Diagnosis | Responder % (n) | NR % (n) | Responder % (n) | Late Responder % (n) | NR % (n) |
| | | | | | |
| Localized musculoskeletal | 88.2% (15) | 11.8% (2) | 25.0% (7) | 39.3% (11) | 35.7% (10) |
| CRPS | 85.0% (96) | 15.0% (17) | 33.8% (46) | 38.2% (52) | 27.9% (38) |
| **Neuropathic, Non-CRPS*** | **100%** (17) | **0%** (0) | **57.1%** (**12**)[a] | 38.1% (8) | **4.8%** (**1**)[b] |
| Widespread musculoskeletal | 84.6% (11) | 15.4% (2) | 31.8% (7) | 40.9% (9) | 27.3% (6) |
| Back | 93.3% (14) | 6.7% (1) | 33.3% (6) | 27.8% (5) | 38.9% (7) |
| Abdominal | 88.9% (8) | 11.1% (1) | 25.0% (3) | 41.7% (5) | 33.3% (4) |
| Headache | 100% (10) | 0% (0) | 37.5% (6) | 43.8% (7) | 18.8% (3) |

*Note.* a's superscripts indicate that the frequency of cases was significantly higher than expected, whereas b's superscripts indicate that the frequency of cases was significantly lower than expected.
*Idiopathic small fiber sensory neuropathy

Table 2. Multinomial logistic regression results examining the differences between pain responders vs. late responders and pain responders vs. nonresponders (n=173)

| Variable | Responders/Late Responder[a] | | | Nonresponder[a] | | |
|---|---|---|---|---|---|---|
| | Odds Ratio | 95% CI | *P*-value | Odds Ratio | 95% CI | *P*-value |
| *Age and Pain Characteristics* | | | | | | |
| **Age** | 1.06 | 0.89–1.26 | 0.54 | **1.26** | **1.00–1.58** | **0.05** |
| **Pain at admission** | 1.26 | 0.97–1.63 | 0.08 | **2.29** | **1.56–3.37** | **0.00** |
| Duration of pain | 1.00 | 0.98–1.02 | 0.83 | 0.99 | 0.96–1.01 | 0.30 |
| *Functioning* | | | | | | |
| Functional disability | 1.04 | 0.98–1.10 | 0.22 | 1.07 | 1.00–1.15 | 0.06 |
| **Social functioning** | 1.02 | 0.99–1.05 | 0.14 | **1.05** | **1.01–1.08** | **0.02** |
| School functioning | 1.02 | 1.00–1.04 | 0.10 | 1.02 | 0.99–1.05 | 0.17 |
| *Patient cognitive-affective factors* | | | | | | |
| Pain catastrophizing | 1.05 | 0.98–1.12 | 0.16 | 0.99 | 0.91–1.07 | 0.75 |
| Pain-related fear | .97 | 0.93–1.02 | 0.19 | 0.98 | 0.93–1.04 | 0.59 |
| Depressive symptoms | 1.01 | 0.96–1.06 | 0.76 | 1.00 | 0.94–1.06 | 0.98 |
| **Anxiety symptoms** | 1.04 | 1.00–1.08 | 0.08 | **1.02** | **1.02–1.14** | **0.01** |
| **Readiness to change** | | | | | | |
| **Pre vs. Act/Maintenance** | 1.02 | 0.33–3.15 | 0.97 | **9.19** | **1.70–49.6** | **0.01** |
| **Cont vs. Act/Maintenance** | 2.21 | 0.82–5.97 | 0.12 | **9.96** | **2.00–49.6** | **0.01** |
| *Parent cognitive-behavioral factors* | | | | | | |
| Pain catastrophizing | 1.00 | 0.96–1.05 | 0.89 | 0.99 | 0.94–1.05 | 0.77 |
| Protective behavior | 1.47 | 0.68–3.18 | 0.33 | 1.57 | 0.59–4.19 | 0.37 |
| Readiness to change | | | | | | |
| Pre vs. Maintenance | 0.52 | 0.04–6.43 | 0.61 | 0.36 | 0.01–12.1 | 0.57 |
| Cont vs. Maintenance | 1.10 | 0.33–3.65 | 0.87 | 1.05 | 0.22–4.92 | 0.95 |
| Action vs. Maintenance | 0.86 | 0.24–3.02 | 0.06 | 1.06 | 1.06–5.20 | 0.94 |

# Baseline predictors that significantly increases the odds ratio of being in *pain non-responder* group

- **For every year older, OR increased by 1.26**
- **For every 1-point increase in average pain intensity at baseline was associated with a 2-fold (2.29) increased risk**
- **For every 1-point increase in social functioning (*indicating better functioning*) the OR increased by 1.0**
- **For every 1-point increase in anxiety symptoms (indicating worse anxiety), the OR increased by 1.0**
- **For readiness to change, patients whose highest stage of change of either pre-contemplation or contemplation stage had a 9-fold increased risk of being in the pain non-responder group**

# The odds ratio of being in *disability non-responder* group

- **There was no baseline predictors of disability of non-responders versus responder group status**

# Limitations

- **Attrition across time**
- **Missed appointment might be due to**
  - **Still struggling with pain and feel program is not offering pain relief**
  - **Doing very well, geographic distance**
- **Majority Caucasian, female & neuropathic pain**
- **Not enough data engaging parents**
  - **Data collection started in 2013**

# Conclusions -1

**At one year follow-up**

- **For disability, majority of patients improved 88% vs. 12% non-responders**

# Conclusions-2

**At one year follow-up**

- **Pain responders were (73%)**
  - **Complete resolution at 1 month → 1 yr.**
  - **Late resolution to mild at 1 month→ mild at 1 yr.**
- **Non-responders (27%) pain unresolved at 1 yr.**
- **Pain non-responders risks were**
  - **At baseline older in age, higher pain intensity, higher anxiety, fewer social difficulties and lower readiness to change**

# Conclusions-3

- **Late pain responders: No statistical predictors distinguished them from responders**

- **Pain responders had greater social difficulties at BL and diagnosis of non-CRPS (ISFSN)**

# Conclusions-4

- **Contrary to the hypothesis**
  - **Pain related distress of patient/parents was not associated with increased risk of non-responders**
- **Highlights pre-admission interventions may improve outcomes?**
  - **Age: Early treatment**
  - **Readiness to change: Self-management**
    - **Education and preparation for changing beliefs and resistance to change**
    - **Motivational interview**
  - **High anxiety treatment**

# Treatment Failure
## (preliminary studies)

**Regional brain structure differences in learning, motivation, and emotion between treatment responders and non-responders in pediatric CRPS (*Simons et al., Abstr. J Pain*)**

- **Significant differences in non-responders (fMRI study):**
  - **Thinner bilateral cortical thickness**
  - **Subcortical volume less gray matter volume; nucleus accumbens, putamen, pallidum and amygdala**
  - **No differences in somatosensory and motor regions**
- **Significance of the findings:**
  - **Affected area are associated with learning , motivation & emotions**
  - **"dendritic atrophy" present in non-responders**
- **Animal modals of chronic pain showed atrophy of nucleus accumbens → decrease in goal-oriented behavior**

# Interactive Session

## Case Presentation

# #1 Post-traumatic chronic pain left lower extremity

- **14-y-o-f healthy athlete, excellent student. Ankle sprain during soccer 4x within 7/12**
- **Treatment: Aircast + crutches**
  - **PT, Ψ, gabapentin, NSAIDS, TENS, acupuncture, 2% menthol spray**
- **After 4th sprain: pain spread toes → hip**
  - **Stocking distribution, burning/pins-needles, tactile allodynia, skin swelling/color Δ, toenail clipping painful, restricted mobility. Arrive to rehab 3 mo. after the last injury**
  - **Walks 20 min, sleep preserved, & FT school attendance**

# #1 Focal Exam & what is the diagnosis

*Harden RN, et al. Pain. 2010;151(3):870-6*

- **Foot skin temp Δ $3^0$C, discoloration, allodynia, ankle power 3+, ROM deficit, gastroc 1.5 cm atrophic**
- **Budapest criteria +ve, LE CRPS-1**
- **Neurological & rheumatologic consultations were -ve**
- **4-week outpatient PPRC; signs improved**
- **Follow-up visits**
  - **At 3 mo. jumping and running**
  - **At 6 mo. *right* ankle sprain, bilateral symmetrical S&S, worse at night**
  - **At 12 mo. continued HEP and CBT, attended school, had concussion w/o LOC fully recovered and switched from soccer to track-field 5 days/week**

# What is CRPS: Differential Diagnoses

*Borchers &s Gershwin Autoimmunity reviews. 2017;16(1):22*

- **Pathophysiology?**
  - **Inflammatory (neurogenic edema), nervous system sensitization (maladaptive neuroplasticity, glial cells), immune response, or combination thereof**
  - **Avoid immobilization (microgravity)**
  - **Diagnosis of last resort**
  - **Alteration of neuroimaging function/structure**
  - **Primary psychological origin vs. comorbidities**
    - **SSD, fictitious, malingering: Controversial**

Acta Physiol 2008, **193**, 265–274

# Early structural adaptations to unloading in the human calf muscles

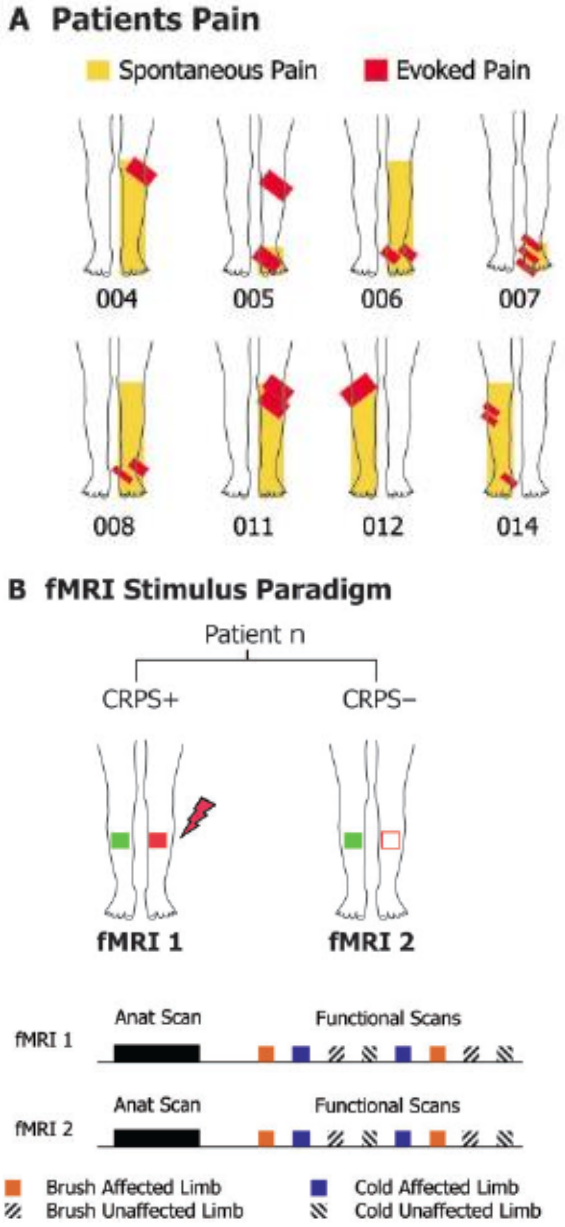
**Conclusion:** These findings suggest that rapid muscle architecture remodelling occurs with lower limb unloading in humans, with changes occurring within 14 days of weight bearing removal. These adaptations, mitigating the decline in muscle PCSA, might protect from a larger loss of muscle force.

doi:10.1093/brain/awn123 *Brain* (2008), **131**, 1854–1879

# fMRI reveals distinct CNS processing during symptomatic and recovered complex regional pain syndrome in children

*Lebel et al 2008*

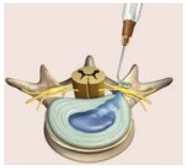
- In the CRPS+ state, stimuli that evoked mechanical or cold allodynia produced patterns of CNS activation similar to those reported in adult CRPS
- In the CRPS+ state, stimuli that evoked mechanical or cold allodynia produced significant decreases in BOLD signal, suggesting pain-induced activation of endogenous pain modulatory systems
- Cold- or brush induced activations in regions such as the basal ganglia and parietal lobe may explain some CNS-related symptoms in CRPS, movement disorders and hemineglect/inattention
- In the CRPS- state, significant activation differences persisted despite nearly complete elimination of evoked pain
- Other changes
- Our results suggest significant changes in CNS circuitry in patients with CRPS



# #1 At 2-yr follow-up from the initial injury?

*Zernikow B, et al. Anesthesiology. 2015;122(3):699-707. Shah RD, et al.. Pain Pract. 2016;16(3):359-69. Wertli MM et al., Pain Med. 2014;15(9):1575-89. Rodriguez MJ et al., Pain Physician. 2015;18(6):621-30.*

- **She has returned to near normal QoL despite the residual pain distress**
  - **ADL, track/field team, academics, social activity**
  - **Pain frequently interrupted sleep and was frustrating**
  - **Continued outpatient psychological counseling**
  - **Parents asked will this condition ever resolve or worsen?**
- **Would you try?**
  - **Anti-neuropathic agents, iv ketamine/lidocaine, etc.**
  - **Invasive therapies: NB, SCS, pulse RF,  etc.**
- **Continue on current therapies?**



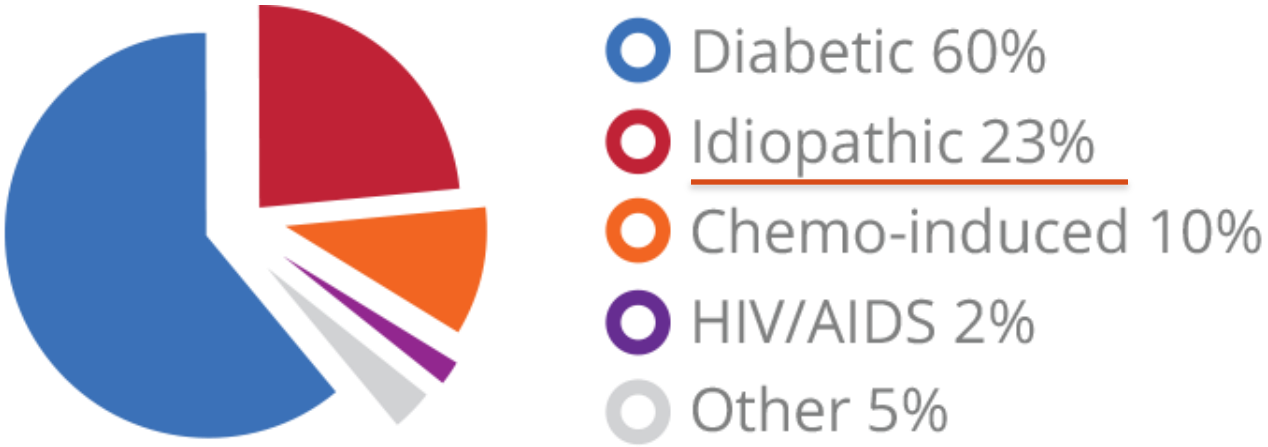
# #1 What is the diagnosis in this patient?

**Idiopathic Small Fiber *Sensory* Neuropathy**

**is a type of peripheral neuropathy that occurs from damage to the small unmyelinated C fibers peripheral nerve fibers in the skin and affect autonomic function. Start in the feet and progress upwards**

**Most common type of peripheral SFN and diagnosis is clinical (QST, IEDF)**

# Estimated 40 million Americans suffer from peripheral neuropathy




# #1 Treatment ISFSN

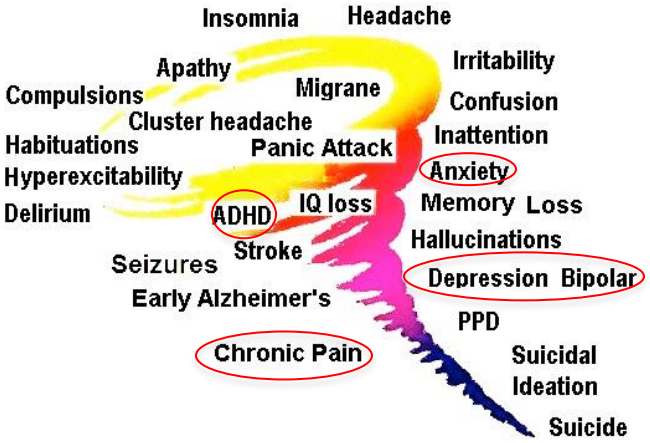
*Hechler T, Kanstrup M, Holley AL, Simons LE, Wicksell R, Hirschfeld G, et al. Systematic Review on Intensive Interdisciplinary Pain Treatment of Children With Chronic Pain. Pediatrics. 2015;136(1):115-27.*

- **Importance of long-term follow-up**
- **Success of interdisciplinary treatment depends**
  - **Trust the providers, acceptance, commitment, and self-directed care**
  - **Graded motor imagery training, mirror therapy?**
- **Open mind and not dismiss patient's complaints provide supportive milieu**
- **Immune suppressant therapy [steroid, IVIG]**

# #2 Chronic Daily Headaches

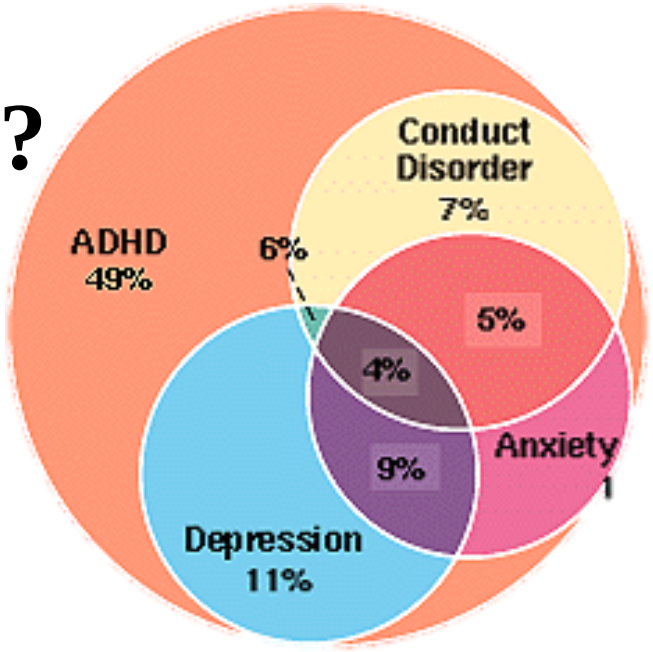
- **17-o-m: Post-concussion headaches [w/o LOC] of 2.5 years duration (no past hx of headaches)**
- **PMH: ADHD, neuropsychological testing x2**
  **Strong family hx of learning difficulties**
- **Concussion clinic (MRI nl.), neurologist; preventive & rescue medications, transient relief, & trials of ADHD medications**
- **Outpatient ψ counseling (anxiety) and PT**
- **Stopped attending school and sports & restricted to home**

# #2 Admission at PPRC




- **Psychologist evaluation**
  - **ADHD + "mild pervasive developmental disorder"**
  - **Reactive depression to functional disability**
  - **Poor family support (LD with parents & sister)**
  - **Up at night, spending > 8 h/ day playing video games**
  - **Poor appetite, weight ↓, poor personal hygiene**
  - **Fatigue, insomnia, & cognitive difficulties**

# #2 Diagnosis and prognosis?

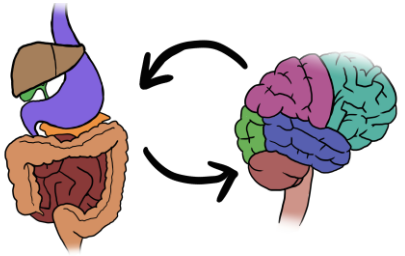



- **Diagnosis is complicated**
- **Prognosis; unknown**
- **PPRC management (4 weeks)**
  - **Getting organized (EF), attentive, self-regulate impulsivity (speech/behavior) and communication**
  - **Video game tapered by 1-2h/day and 2h/ weekend**
    - **Significant resistant, parents were unable to control**
  - **Regular exercise (energy release): started biking**
  - **Gradual integration in school**

# #2 Management & outcome

- **Post-discharge: outpatient PT/Ψ and family counseling**
- **F/U at 1-year; at age 18 years**
  - **Discontinued all medications except for ADHD**
  - **Biking 5 miles daily, 10 miles on weekends**
  - **Attending senior class regularly & active socially**
  - **Transitioned to college; majoring in robotic engineering**
- **F/U at 2-years; age 19 years, he successfully completed first year of college**
- **Younger sister; ADHD & FAP admitted PPRC**

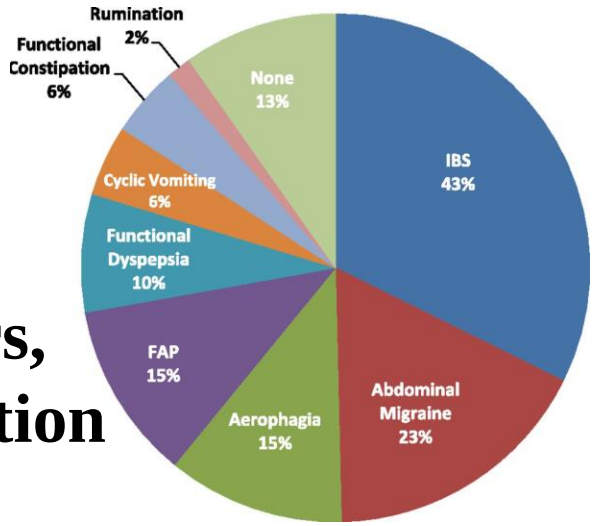
# #3 Functional Abdominal Pain



THE GUT-BRAIN CONNECTION

- 16-y-o-b, persistent upper mid-abdominal pain of 2-year duration after a bout gastroenteritis, vomiting, weight loss, & fatigue
- Intolerant to fried food [hamburger or pizza]
  - Diet restricted to bland rice derivatives
- Outpatient Ψ–counseling & PT for 2 years
- 2 months before admission to PPRC, he required NJ-tube placemnt twice a month for episodic gastroparesis
- Vomited daily and spent 2h on toilet seat [constipation]
- vomiting episodes interrupted sleep nightly

# #3 Past Medical History




- **Abdominal pain started at age 10 years, post-viral gastroparesis, IBS, constipation and headaches**
- **Hospitalized several times for vomiting/dehydration**
- **School attendance poor (was an excellent student), did courses on line/tutoring**
- **History of speech delay and pragmatic language impairment (?ASD/ intellectual disability/ ADHD)**
- **Parents highly educated and 3 older siblings were healthy and doing well academically**

# #3 Investigations

- **XR, US & MRI of abdomen and pelvis; normal**
- **Extensive lab blood and stool results were normal**
- **Upper endoscopy x3 & mucosal biopsies of S/L bowels were normal**
- **Gastric emptying Scintigraphy delayed**
  - **58% at 2h (nl. 35%)**
- **EEG normal**
- **Medication trials**
  - **Cyproheptadine, erythromycin, domperidone, metaclopromide, proton pump inhibitor , H2-blockers, ondansetron, gabapentin, etc.**

# #3 What are the differential diagnoses? What would you do?

- **Executive functioning: ADD/ADHD, processing skill delays, working memory deficits or school is difficulty**
- **Diagnose causes and customization of learning efficiency program not just to address symptoms of challenges**
- **Brain-body integration**
  - **Logic and reasoning is a core skill in problem solving and strategizing**

Clinical Psychology Review 34 (2014) 563–579

Contents lists available at ScienceDirect

Clinical Psychology Review

# Do people with chronic pain have impaired executive function? A meta-analytical review

Reporting Items for Systematic Reviews and Meta-Analyses guidelines. Twenty five studies were included in the review and twenty two studies in the meta-analysis. A small to moderate impairment in executive function performance was found in people with chronic pain across cognitive components, although all studies had a high risk of bias. The current evidence suggests impairment of executive function in people with chronic pain, however, important caveats exist. First, executive function involves many cognitive components and there is no standard test for it. Second, moderators of executive function, such as medication and sleep, were seldom controlled for in studies of executive function performance.

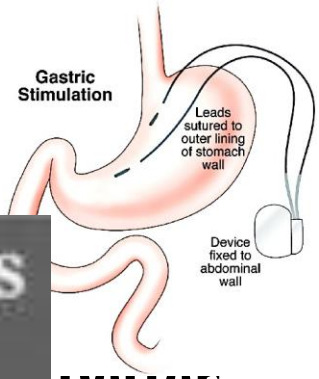
# #3 What are the management options?

- **3-week treatment at PPRC: structured setting**
  - **Woke up late, came in PJ and family insisted on "Kosher" food**
  - **Vomiting ceased, ate "non-kosher" food in cafeteria, weight increased, and returned to school partially**
- **At 2-year follow-up, age 18 years:**
- ***Psychologist report:*** **Coping/functioning/in school full time**
- ***Gastroenterologist report***
  - **Junior in high school, participating in robotics engineering program at a local university**
  - **"He is now 100% asymptomatic" "still in remission", "I am very happy with his progress and follow-up as needed"**

# #3 Long-term Prognosis

- **Premorbid EF, anxiety & reactive depression**
- **G-paresis is documented after EBV, CMV & unidentified suspected viral infections**
  - **Self-limited in most patients, 4-12 mo. but can last for years (dx EGG; no pediatric normative values)**
  - **Mechanism unknown; autonomic dysregulation**
    - **?Damage of interstitial Cajal neurons**
  - **Tachy-/brady-gastria; Gastric pacemaker**
  - **Exercise activates gastric motility thru vagal n.**

# #3 Conclusions




- **Idiopathic g… better prognosis in… se in adolescents**
- **Managemen… unsuccessful… er**
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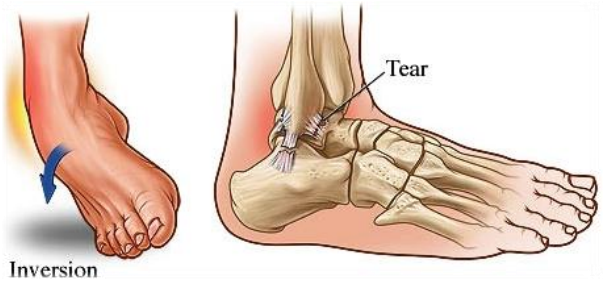
  - **Not dismi… ovider communi… d with better adl…**
  - **Regular c…**

# #4 Post-traumatic persistent foot/ankle pain




- **19-y-o-f, right ankle sprain while hiking progressed to persistent pain over 1 yr**
- **Outpatient conservative treatment failed**
  - **Gabapentin, LSB (transient ↓pain 50%), NWB on crutches**
  - **Inpatient sciatic/femoral CNB for pain & dystonia**
  - **Psychiatric consultation [dx non-epileptic seizures]**
  - **PMH: ADHD & premorbid anxiety/depression**
- **Interrupted 1st year of college/returned home**

# #4 What are the Differential?

- **CRPS [met the Budapest criteria], dystonia initially unilateral, & atypical seizure**

- **At the PPRC she was diagnosed with ASD**
  - **Mother acknowledge she was different than other 3 siblings**
  - **High functioning, oldest, caring for siblings**
  - **Motivated/compliant to get better, resume independent living at college in a different state**

# #4 What are the treatment options?

- **Intensive interdisciplinary rehab**
  - **Amphetamine, baclofen, Sertraline, & Vat D3**
- **Developed bilateral dystonia unresponsive to treatment and was discharged**
- **Referral to Motor Disorder Clinic**
  - **Genetic DYT 1-26 was negative**
  - **EMG-targeted a series of 3 Botox injections**
- **Readmitted to PPRC, added oral baclofen**
- **Intensive PT, feet in neutral, AFO, d/c crutches**
- **Completed first year of college, independent living**

# #5 Multiple Joints Pain Functional Disability

AS MY BODY ATTACKS ITSELF

My journey with autoimmune disease, chronic pain and fatigue

- **A 16-o-y-f, with know Sjogren syndrome & rheumatoid arthritis, multiple joints and muscle pain, and functional disabling following a bout mononucleosis of 3-year duration**
- **Inflammatory markers stable at referral**
- **She looked healthy: Invisible disease**

# #5 Medical history and exam?

- **Musculoskeletal PAS, FM, endometriosis on OCP, FAP, migraines, Raynaud phenomenon, insomnia, fatigue, POTS, Echo (low SF), reactive airways, and anxiety**
- **Missing school, social withdrawal & impaired physical functioning**
- **Medications**
  - **Acetaminophen, amitriptyline, APAP/butalbital/caffeine, celecoxib, citalopram, clobetasol topical 0.05% ethinyl estradiol, fluconazole, gabapentin, hydroxychloroquine hyoscyamine, ketoconazole shampoo, lansoprazole, ondansetron, pilocarpine & topiramate**

# #5 Prognosis & follow-up at 1 year

- **Sjogren's syndrome and JRA have no cure**
- **3-week PPRC management**
- **She took on-line courses, home tutoring and attended 3hr night school [daytime fatigue and napping]**
- **Continued outpatient PT and psych counseling**

# #5 At 3-year follow-up: Age 19yrs

- **Rheumatologist note indicated**
  - **“trialed on multiple immunosuppressive therapies in the past but it has never been clear that these types of therapies make a significant difference in her day-to-day symptomology” but the neuropathic pain and migraine medications seem to help to some degree”**
- **Returned to school for 2 years and then did online schooling due to severe fatigue (partly from multiple meds) and worked part-time**
- **Attending university at age 19 years**
  - **major accomplishment**

# #6 Chronic Abdominal Pain
# Inflammatory Bowel Disorder (IBD)

- **14-y-o-m with ulcerative colitis of 2-yr duration**
- **Refractory to medical Tx, uncontrollable bleeding, colectomy, ileostomy, followed by J-pouch + rectal cuff**
- **Complicated by recurrent pouchitis, cuffitis (revised), wound dehiscence, C. difficile and pancreatitis requiring multiple hospitalizations**

# # 6 Presentation

- **Chronic abdominal pain, daily frequent BM, nausea, premorbid GAD) and reactive depression**
- **Home bound, school absenteeism, and withdrawn from social & sport activities**
- **Strong parental history of anxiety and depression**

# #6 What are the treatment options ?

- **Medical: diet, nutritional supplement, monitor for dehydration and pancreatitis/liver**
- **4-week admission to PPRC and school integration**
- **Outpatient psychiatry, psychology and HEP**
- **Follow-up at 6 months**
  - **Returned to school full time with good grades, socializing, return to recreational sports**
- **Post-discharge**
  - **Multiple visits to ED for dehydration from diarrhea**
  - **One bout of pancreatitis**

# #6 What is the prognosis of ulcerative colitis?


- **Chronic disease; distressing flare-ups/pancreatitis**
- **Anxiety, fear and depression: Worrying about incurable disease & potential risks of complications**
  - **Frequent diarrhea, severe dehydration, & ED**
  - **Mal-absorption: Osteoporosis, low iron, vitamins, etc.**
  - **Risk of spread of autoimmune inflammation to skin, joints, eyes, and mouth mucosa**
  - **An increased risk of colon cancer 10 yrs after onset**
  - **Increased risk of blood clotting**
  - **Liver disease (rare)**

# #7 Ehlers-Danlos Type-3 Hypermobility Syndrome

- **11-y-o-f with EDS-3, osteopenia repeated subluxation/dislocations, and pain. Right foot CRPS-1 treated at PPRC for 3 weeks successfully**

**<u>At age 16 years re-admitted to PPRC for</u>**

- **Chronic pain low back [disc wedging] & joints, insomnia, fatigue, & increasingly mobility deficit**
- **Anxiety, ADHD, learning disability; at boarding school**
- **Multiple fractures [too many to count] due to osteopenia**
- **HTN - unknown etiology**
- **Menstrual migraines, controlled on OCP**
- **Focalin XR, citalopram, amitriptyline and vitamin D3**

# Ehlers-Danlos Type-3 Hypermobility Syndrome

- **Ehlers-Danlos syndrome is a group of inherited connective tissue disorders, caused by various defects in the synthesis of collagen**
- **Affect men, women, all racial & ethnic backgrounds**
- **6 types: most common is hypermobility [joints/skin]**
- **Complications of joint hypermobility include recurrent sprains, dislocations/subluxations→ chronic microtrauma and inflammation**
- **Muscle hypotonia /delayed gross motor development**
- **Genetic testing positive with her, father, sister, other family members**

# #7 Treatment and follow-up

- **PPRC 4-week treatment**
- **Post-discharge**
  - **Multiple dislocations requiring bracing/NWB**
  - **Outpatient PT, psychiatrist, Echo normal**

- **F/U 2-years later at age 18 years still coping well, attends college with independent living**

# Success
# Therapeutic milieu impact


- **Dedicated team [therapeutic alliance]**
- **Rapport, trust and liaison (validation)**
- **Engaging intrinsic motivation**
  - **A goal-oriented, patient-centered counseling for changing behavior and resolve ambivalence**
- **Persuasion: Adherence, compliance**
- **Self-regulation**
- **Internal/external positive reinforcement**
- **Long-term compliance and self-efficiency**

# Failure
# Potential Factors

- **Severe anxiety & depression, personality disorder, severe somatization, PTSD, FNSD**
- **Higher LOC: Integration of somatic and psychotherapeutic modalities for management of mental illness and emotional, cognitive, behavioral and substance use disorders**
- **Learning difficulties, EF disorders**
- **Failure to comply: Avoidance Syndrome**
- **Non-acceptance of diagnosis or treatment [meds, interventions] and looking for pain cure**

# Thank you for your attention


Stop Childhood Pain