# Measuring up to the challenge of CRPS rehabilitation

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### **CRPS challenges: it's variable!**

No clear single mechanism for development

# Little agreement on possible sub-types (Type I/ Type II, warm / cold) and time course

Bruehl, 2016; Birklein 2015

# **CRPS challenges**

No gold standard diagnostic test

No widely accepted outcome measures

Rehab is primary treatment, but rehab research is lacking

Bruehl, 2016; Birklein 2015; Packham et al, 2012

# COMPACT

# Core Outcome Measurement Set for CRPS Clinical Trials (Greive et al, 2018)

### **COMPACT PRO recommendations** (Grieve et al, 2018)

DOMAIN	MEASURE
Pain	SF McGill Neuropathic scale PROMIS 29
Disease severity	CRPS Severity Scale
Participation	PROMIS 29
Physical function	EQ-5D
Emotional and psychological functioning	PROMIS 29 Single item on suicidal ideation
Self-efficacy	Pain Self-Efficacy Questionnaire
Catastrophizing	Pain Catastrophizing Scale
Self-perception of change	GROC

### Can we correctly identify persons with



# **CRPS** vs. nerve injuries vs. post-traumatic inflammation

### using skin temperature differences?

# Identification of CRPS using skin temperature asymmetry

Previous studies failed to find this to be useful, &/or used \$\$\$ tools, but:

**Didn't account for innervation patterns** 

Didn't account for warm/cold subtypes

Only compared to healthy volunteers, or other fracture patients

Pilot work demonstrated adding a cold pressor test for a consistent thermoregulatory stressor was safe, and inexpensive IR thermometers were reliable (Packham et al, 2012)

### **Measurement points used:**



### Can we correctly identify CRPS vs. nerve injuries vs. posttraumatic inflammation vs. normal differences?

63 persons measured bilaterally in **3 nerve distributions** in the hand (median, ulnar, radial) before and after a cold pressor test (foot in ice water for 30 seconds), for a total of 378 measurements.

16 met the Budapest criteria for CRPS
10 peripheral nerve injuries
8 with recent hand fracture
29 healthy volunteers.

(Packham et al, 2018)



Are there meaningful differences in hand temperatures between sides?

#### Regression modelling of SkTA measures (n=378)

diagnosis post cold pressor test nerve distribution

Were significant predictors (*p*<0.001) explaining 94% of the variance between sides.

ANOVA accounting for nested factors differentiated between diagnostic groups for the magnitude of SkTA p<0.0001



(Packham et al, 2018)

### Does it give us useful information to inform a diagnosis?

### Sensitivity [for a >1.0 °C SkTA]

Pre CPT = 85.1% Post CPT = 76.6% **Rule in** 

# Specificity [for a >1.0 °C SkTA]Pre CPT = 43.8%Post CPT = 68.8%Rule out

# What do persons with CRPS think is important:

a) to represent recovery?b) for their HCP to know?

### **CRPS recovery study**

### How will you know you are better?

- decreased limb pain
- less overall pain and discomfort interfering with daily activities
- better movement & less stiffness
- less medication needed

Some of these are things we don't routinely measure in hand therapy settings



What drove me to start doing research was my search for a common 'ruler' I could share with other health professionals to inform care decisions and decision making for persons with CRPS

# Hamilton Inventory for CRPS was developed using cognitive debriefing

Patient Reported Hamilton Inventory for CRPS (PR-HI-CRPS) Condition-specific patient-reported outcome measure (40 items; rated 0-6) 3 subscales: symptoms, daily activities, coping

(Packham et al, 2018)

### Clinician-based HI-CRPS (CB-HI-CRPS)

14 items rated 0-3 (none, mild, moderate, severe) Addresses sensory, autonomic, trophic and motor signs

(Packham et al, 2012)

### **Question** [concept] list: CB-HI-CRPS

Sensory

Allodynia Hair growth **Trophic Cold hyperalgesia** Nail quality Guarding Skin quality Skin temperature Movement expected given initial injury asymmetry Motor Vascular function: mottling Movement expected given Autonomic time elapsed since injury Sweating (hyperhidrosis or anhydrosis) Muscle tone Edema Incoordination

### **Sample question: CB-HI-CRPS**

#### Cold Allodynia / Hyperalgesia [sensory subscale]:

**Definition:** an exaggerated painful sensation evoked by low-temperature stimulation **Scoring:** 

- 0 = **None** no complaints of pain; may report that tube feels cold.
- 1 = **Mild** patient reports discomfort with cold but no physical behaviours evident
- 2 = **Moderate** patient reports pain, may show a behavioural response such as flinching, grimacing, or vocalizing discomfort
- 3 = Severe patient reports pain and has a clear behavioural response; may decline to be tested

**Testing:** Touch test tube of cold water to skin for 3 seconds. Repeat over 3 different zones within affected area. Rate response as above.

**Instructions:** I am going to touch you with this test tube of cold water; tell me how it feels to you. (*Allow patient to respond then ask*) Does it hurt?

### **Sample questions: PR-HI-CRPS**

I need to concentrate in order to make my affected limbs

move.	Always		Often		Some		Never
					times		
	6	5	4	3	2	1	0

Pain prevents me from participating in activities throughout my day.

Always		Often		Some		Never
				times		
6	5	4	3	2	1	0

#### I still enjoy the things I used to enjoy

Strongly	Agree	Slightly	Neutral	Slightly	Disagree	Strongly
agree		agree		disagree		disagree
0	1	2	3	4	5	6

# Unpublished findings from a pilot trial gives more insights

Characteristics n=39	Mean	SD	Range
Age	45.9	14.4	15 – 76
Duration of injury or pain (in months)	17.9	38.5	1 168
Grip strength (in kgs)	R=24.4	19.2	0 - 63.3
	L=26.6	16.6	0 - 54.7
% of normal grip in affected hand	39.1%	29.7	0-90.1%
Total MPQ score (tMPQ / 100)	38.3	26.4	0 - 93
PRWHE /100	58.2	24.8	0 - 94
PCS /52	20.8	14.8	0 - 50
CB-HI-CRPS /42	11.0	6.9	1-25
PR-HI-CRPS /260	122.2	57.1	0-223

Characteristic	Frequency	Percentage
Gender	M=20	M= 51.3%
	F=19	F= 48.7%
Diagnosis	CRPS = 20	51.3%
	PNI = 11	28.2%
	Fracture = 8	20.5%
Side of iniury	R= 25	R= 64.1%
	L= 14	L= 35.9%
Catastrophizing present	Yes = 11	Yes = 28.2%
	No = 28	No = 71.8%
(PC3>30)	CRPS + Yes = 7	

### **Internal consistency**

Independent rater at baseline CB-HI-CRPS Cronbach's alpha = 0.80

PR-HI-CRPS  $\alpha$ = 0.98 total scale Symptoms  $\alpha$ = 0.95 Daily function  $\alpha$ = 0.95 Coping/Social Supports  $\alpha$ = 0.92

### Reliability

Inter-rater reliability n=30 CB-HI-CRPS  $ICC_{2,1}$ = 0.90 [95%CI 0.81 to 0.95] Test-retest reliability CB-HI [n=21 baseline/1 week same evaluator]  $ICC_{2,1}$ =0.87 [95%CI 0.70 - 0.94]

Test-retest reliability [n=27 baseline/1 week]PR-HI-CRPSICC $_{2,1}$ =0.94[95%CI 0.88 - 0.97]



Do scores on the CB and PR HI-CRPS differentiate between persons with CRPS and those with other diagnoses?



Using a cut-point of >10 / 42 on the CB-HI-CRPS correctly predicts CRPS 65% of the time

Positive predictive value = 65% [95%Cl 49 - 78]

Sensitivity= 68.4 [95%Cl 43 - 87]

**Specificity= 61.1** [95%Cl 36 - 83]

### **Validity Hypotheses**

**Construct validity (structural)** 

*r*=0.72 CB-HI and PR-HI Symptoms

- r=0.67 CB-HI and PR-HI total
- r=0.50 CB-HI and PRWHE Pain

### **Convergent construct validity**

PR-HI-CRPS & PRWHE total scores	r=0.80
PR-HI-CRPS Coping/Social & PCS total score	r=0.73
PR-HI-CRPS Coping/ Social & McGill Pain affective score	r=0.58
PR-HI-CRPS Daily Function and PRWHE disability scores	r=0.67



Assessment techniques

used in

Somatosensory Rehabilitation



### Allodynography

Standardized elements:

1) map created using 15g (#5.18) monofilament

2) person identifies stimuli as
3/10 on NRS for pain [OR pain at rest +1]\*\*



### Allodynography

Start proximal to painful area

Apply monofilament for 2 seconds in 10 s intervals at 1 cm increments

Client indicates 'STOP' when stimulus becomes painful; this area is marked on map

Repeat procedure distally, and at end points of horizontal axis

Measure area using anatomical reference



### **Reliability of Allodynography**

Completed only in consenting participants demonstrating allodynia as defined by a painful response to a static touch with a 15g monofilament

Inter-rater reliability (n=12)

ICC <sub>2,1</sub> = 0.97 [95%Cl 0.90 - 0.99] single measures

Test-retest reliability (n=10) ICC <sub>2,1</sub> = 0.89 [95%Cl=0.59-0.97] single measures

\*\*p<0.001 for both

(Packham et al, 2020)

### **Rainbow Pain Scale**

Colours represent the severity of allodynia as represented by the smallest amount of pressure which elicits a painful response (Spicher et al, 2015; similar to Keizer et al, 2007).



### **Rainbow Pain Scale**

The area tested for the Rainbow pain scale is marked on the allodynography map with a star

**'Colour' category is also recorded** there





### Sample allodynography:

Allodynia after thumb CMC arthroplasty for osteoarthritis

### **Rainbow Pain Scale: reliability**

For this evaluation, we also evaluated the reliability of the screening (i.e. identified as having no allodynia)

Inter-rater reliability (n=24) ICC  $_{2,1}$  = 0.79 [95%Cl 0.57 - 0.90] single measures

Test-retest reliability (n=18) ICC  $_{2,1}$  = 0.82 [95%CI=0.60 - 0.93] single measures

p<0.001 for all

(Packham et al, 2020)

# **Other options developed for CRPS**

#### **Radboud Evaluation of Sensitivity (RES)**

8 items rated on 100mm VAS with anchors of 'No difference' to 'Completely different' comparing the 2 hands

Combination of patient report and psychophysical testing: 6 items have a standardized sensory stimulus provided

Addresses a need for a simple evaluation of sensation?

Packham TL, MacDermid JC, Michlovitz S, Cup E, Van de Ven Stevens L. **Cross cultural** adaptation and refinement of an English version of a Dutch patient-reported questionnaire for hand sensitivity: the Radboud Evaluation of Sensitivity. *Journal of Hand Therapy 2018;* 31(3): 371-380

### **Testing in CRPS or hand injuries**

#### Participant demographics RES-E (n=56)

Variable	Mean	SD	Range
Age	44.8	15.5	15 – 76
Time since injury (mos)	27.2	61.5	1 – 294
Grip strength (kgs)	R=28.9	18.4	0 - 63.3
	L=26.7	15.6	0-60
% of normal grip	44.0	30.2	0 – 100
PRWHE /100	56.3	26.1	0 – 98
RES-E /80	41.8	25.0	1.5 - 80

Key: PRWHE= Patient-Rated Wrist and Hand Evaluation RES-E= Radboud Evaluation of Sensitivity, English version

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### **Participants had variable presentations**

Variable	Frequency	Percentage
Gender	M=27	M= 48.2 %
	F=29	F= 51.8 %
Diagnosis	Fracture = 19	33.9 %
Diagneeie	Tendon = 10	17.9
	Ligament = 7	12.5
	Multiple trauma = 6	10.7
	Nerve = 2	3.6
	Amputation = 2	3.6
	Other = 10	17.9
	Concurrent CRPS = 25	44.6% had CRPS
Dominance	R= 45	R= 80.4 %
Dominanoo	L= 11	L= 19.6 %
Side of injury	R= 26	R= 46.4 %
	1-00	1 = 53.6 %
	00	L = 00.0 70
Hypoesthesia vs	Hypo(Loss)= 30	Hypo= 61 %
Hypoesthesia vs.	Hypo(Loss)= 30 Hyper(Gain)= 13	Hypo= 61 % Hyper=27 %

### **RES-E demonstrated acceptable measurement properties**

Test-Retest Reliability (n=36)  $ICC_{(2,1)}=0.92 [95\%CI 0.85 - 0.96]$  SEM=7.06 (/80)Internal consistency:  $\alpha=0.95$ 

**Construct validity**: *r*=0.61 RES-E, PRWHE (moderate)

**Responsiveness:** Effect size (Cohen's *d*)=0.22 [95%Cl -0.67 to 1.09] for RES ES= -0.35 [95%Cl -0.49 to 1.28] for PRWHE



### **Take-home messages:**

### No 'perfect' solution Address person-centred priorities Consider elements that will foster comparisons

### Lots of work still to do!

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