Our mission statement

Meeting the complex needs of people with profound disabilities arising from brain injury

Royal Hospital for Neuro-disability
A national medical charity

www.rhn.org.uk
Our current services

Brain Injury Services
Patients mostly NHSE commissioned
52 patients.
3 wards.

Continuing healthcare Service
Residents CCG commissioned
Specialist Nursing Home – 122 residents.
6 wards.

Specialist Services
55 residents. 4 wards.
Our current services

Total number of patients and residents: **220**

- Patients and residents able to consent to their placement: **48**
- Patients and residents with a feeding tube: **180**
- Wheelchair-bound patients and residents: **217**
- Patients and residents with a tracheostomy: **53**
Why treat Spasticity?

• Affects approximately 1/3 of stroke patients and up to 3/4 of people with severe disability following TBI. (RCP 2009)

• Prevalence in DOC estimated as 59-89% (Martens et al 2017).

• Occurs early after stroke and associated with disability, pain and secondary impairments (Malhotra et al 2011, Cousins et al 2010, Lundstrom et al 2010)

• Assessment and treatment of spasticity recommended by 2016 RCP National Stroke Guidelines.
Why treat Spasticity in DOC?

Sample of 10 DOC patients in specialised treatment programme (Belfast)

100% presented with hypertonia in 1+ limb

45% of joints contracted on admission

Wheatley-Smith et al 2012
Royal Hospital for Neuro-disability
A national medical charity
Why treat Spasticity in DOC?

Sample of 210 DOC patients in specialised treatment programme (USA)

45% presented with severe hypertonia in 1+ limb

54% emerged and moved to inpatient rehab programme

Seel et al 2013
‘Botulinum toxin type A plus therapy was over two and a half times the NICE cost effectiveness threshold value.’

‘…the probability of it being cost effective at the threshold value did not exceed 0.39.’

Effectiveness in PDOC?

**Review**

**Spasticity Management in Disorders of Consciousness**

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How do we get an effective outcome?
Managing Adult Spasticity

• Goal Identification
• Baseline Level of Function
• Secondary Impairments
• Support and Follow Up
• Acuity
  – ? Treatment of ‘evolving’ spasticity?
  – Time since brain injury
Goal Identification

Figure 3. Proportion of patients who achieved their primary goal based on time from stroke to first-ever BoNT-A therapy. (Error bars correspond to lower and upper confidence limits of 95% CI. ROM, range of movement; CI, confidence interval).
Baseline Level of Function

Secondary Impairments

Figure 4. Proportion of patients who achieved their primary goal with BoNT-A therapy based on presence or absence of severe contractures. (Error bars correspond to lower and upper confidence limits of 95% CI. ROM, range of movement; CI, confidence interval.)
Support and Follow Up

Determinants of responsiveness to botulinum toxin, casting, and bracing in the treatment of spastic equinus in children with cerebral palsy

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List of Abbreviations
AROM Active range of motion
GMFSE Gross Motor Function Measure
FAS Functional Assessment Questionnaire
PS IS-5 Functional independence measure
ROM Range of motion
WeeFIM Pediatric Functional Independence Measure

AIM The object of this study was to evaluate the effectiveness of Botulinum toxin A (BoNT-A) therapy in children with cerebral palsy who have spastic equinus and to determine the factors that influence the outcome of the treatment.

METHOD Children were evaluated before and after treatment with BoNT-A using a combination of the Gross Motor Function Measure (GMFCS), the Functional Assessment Questionnaire (FAS), and the Pediatric Functional Independence Measure (WeeFIM). The primary outcome measure was the proportion of patients who achieved their primary goal with BoNT-A therapy, based on intensity of therapeutic input (TI).

RESULTS Thirty-two children were evaluated, with a mean age of 6.3 years and a mean GMFCS level of II (p<0.05). The results showed that the proportion of patients achieving their primary goal was significantly higher for those with higher intensity TI (84%) compared to those with lower intensity TI (68%). The proportion of patients achieving their primary goal for each outcome measure is presented in the table below.

<table>
<thead>
<tr>
<th>Outcome Measure</th>
<th>TI 1</th>
<th>TI 2</th>
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<tbody>
<tr>
<td>Overall</td>
<td>84%</td>
<td>68%</td>
</tr>
<tr>
<td>Pain</td>
<td>85%</td>
<td>75%</td>
</tr>
<tr>
<td>Passive function</td>
<td>91%</td>
<td>82%</td>
</tr>
<tr>
<td>Active function</td>
<td>81%</td>
<td>77%</td>
</tr>
<tr>
<td>Impairment (ROM)</td>
<td>66%</td>
<td>62%</td>
</tr>
<tr>
<td>Involuntary movement</td>
<td>68%</td>
<td>90%</td>
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</tbody>
</table>

Figure 5. Proportion of patients who achieved their primary goal with BoNT-A therapy based on intensity of therapeutic input (TI). (* p < 0.05; Error bars correspond to lower and upper confidence limits of 95% CI. ROM, range of movement; CI, confidence interval.)

Fheodoroff et al 2015
Acuity


- **Early intervention increasingly supported** (Rosales et al 2011, Cousins et al 2010)

- **Later intervention (>1 year) still effective in achieving primary goal** (Fheodoroff et al 2015)
Acuity

Stroke

- Early intervention increasingly supported (Rosales et al 2011, Cousins et al 2010)
- Later intervention (>1 year) still effective in achieving primary goal (Fheodoroff et al 2015)

Rosales et al 2011
Cousins et al 2010

**Acuity**

![Acuity Diagram]

Fig. 1. Evolution of Spasticity after stroke and where botulinum toxin therapy is currently administered; PSS-post-stroke spasticity.

Cousins et al 2010
Acuity

EMG levels during slow stretch of the elbow - whole group analysis

Cousins et al 2010
## UL Function

| UL Passive Function | Strong evidence of decreased disability and carer burden:  
|                     | - Hand hygiene & nail cutting  
|                     | - Washing/Dressing  
|                     | - Limb positioning & splint application  
|                     | Effects lasting at least 12 weeks, often longer.  

| UL Active Function | No RCT showing clear benefit. Systematic review with pooled meta analysis of 4 studies showing small improvement in motor function. General consensus – BoNT does not improve active UL function.  
## LL Function

<table>
<thead>
<tr>
<th>LL Passive Function</th>
<th>Evidence that BoNT helps passive goal achievement including:</th>
<th>Simpson et al 2008, Hesse et al 2001</th>
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<tbody>
<tr>
<td>✔️</td>
<td>- Decreasing carer burden</td>
<td></td>
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<td></td>
<td>- Improving positioning and comfort</td>
<td></td>
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<tr>
<td></td>
<td>- Seating</td>
<td></td>
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<tr>
<td></td>
<td>- Splint application</td>
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<tr>
<td>?</td>
<td>Small trends indicating improvements in gait speed, walking ability, knee swing, efficiency and balance. Differences tend to be modest and variable. Some evidence suggesting no change.</td>
<td></td>
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</tbody>
</table>
# Impairments

| Spasticity | Large body of level 1 evidence  
| - Spasticity will reduce by ~ 1 on MAS, and on EMG  
| - Effects within 2 weeks  
| - Lasting at least 12 weeks, possibly longer  
| PROM | Evidence of improvements in PROM in wrist and LL, lasting 12 weeks. Evidence that BoNT helps preserve PROM in the LL (compared to splinting alone).  
| Pain | Growing body of evidence that BoNT decreases spasticity pain. Indications that there may be a slower onset of symptom relief with longer duration of effect.  
| - Separate anti-nociceptive effect?  
Can Therapy Help?

- Improve BoNT outcomes?
- Prolong BoNT effect?
- Reduce the need for repeat treatments?
- Reduce dose requirements?
Can Therapy Help?

- BoNT
- Novel Therapies
- CIMT
- FES
- PT/OT
- Stretches
- Exercise

Royal Hospital for Neuro-disability
A national medical charity
Systematic review of adjunct therapies to improve outcomes following botulinum toxin injection for treatment of limb spasticity

Patricia Branco Mills¹,³, Heather Finlayson¹,³, Malgorzata Sudol¹,³ and Russell O’Connor¹,³

Rehabilitation Therapies After Botulinum Toxin-A Injection to Manage Limb Spasticity: A Systematic Review

Bianca Z. Kinnear, Natasha A. Lannin, Anne Cusick, Lisa A. Harvey, Barry Rawicki
EBP: BoNT and Rehab Therapies

- Evidence scarce and of low quality
- Low level evidence for multidisciplinary rehabilitation for active function and impairment
- Low level evidence for intensive forced UL use.
- Preliminary evidence to suggest BoNT + stretch more effective than BoNT alone.
- Optimal types and intensity of therapy unclear

Treatment of spastic equinus with BoNT + casting (compared to BoNT alone):

- improves spasticity, PROM and ability
- prolongs positive effects

Treatment of spastic equinus with BoNT + casting:

- Casting prevents equinovarus
- Effects of BoNT needs further Ix
Four weeks of daily stretch has little or no effect on wrist contracture after stroke: a RCT. Horsley et al. (2007)
Stretch had no effect on pain, activity or ROM
Passive ankle DF increased by 13.5 degrees*  
7 day cast
Twelve weeks of nightly stretch does not reduce thumb web space contractures in people with a neurological condition: a RCT. Harvey et al. (2006)
Worn for 8 hours per night, 12 weeks.  
1 degree change in 12 weeks. No sig change. 
Effectiveness of a bed positioning program for treating older adults with knee contractures who are institutionalized. Fox et al (2000)
40 mins 4 x a week  
No change in knee range. BPP is not supported for Mx of knee contractures.
Effectiveness of Stretch for Treatment and Prevention of Contractures in People with Neurological Conditions: Systematic Review. Owen et al. (2011)
Regular stretch does not produce clinically important changes when applied for less than <7/12
Effects of longer programs unknown
Evidence is inconclusive
Regular stretch does not increase muscle extensibility: an RCT. Ben & Harvey (2010).
No change in muscle extensibility. Improved stretch tolerance.
RCT: CIMT + BoNT .v. BoNT alone

- Significantly greater improvements in UL spasticity and arm function in CIMT group at 6 months post injection.

Sun et al 2010

Case Study: CIMT + BoNTA (Chronic Stroke)

- Improvements in MAS, FugyI Meyer, ARAT and AOU- MAL over 1 year period

- No repeat injections necessary

Amano et al 2015
FES – Possible mechanisms for improving anti spasticity effect of BoNT

Immediately stimulate injected muscle:
Increase toxin uptake at NM junction

Stimulate agonist:
Treatment of negative symptom of UMNL ie weakness

Immediate cyclic stimulation agonist/antagonist:
mechanical spread of toxin

Stimulate antagonist:
Reduce tone in agonist through reciprocal inhibition

Wilkenfield 2013
BonT, FES & Walking Speed

Speed is meaningful!

‘Powerful indicator of function and prognosis after stroke’ Schmid et al 2007

- <0.4 m/s Household Ambulation
- 0.4-0.8 m/s Limited Community Ambulation
- >0.8 m/s Community Ambulation

Gait velocity gains that lead to a change in ambulation category result in better function & QoL. Schmid et al 2007

BonT alone assoc with small but sig increase in gait speed ~ 0.044 m/s. Foley et al 2010
PNS, BoNT and Walking Function

- Lack of clear data to indicate that PNS is better than an AFO.
  Wilkenfield 2013

- Indication that PNS + BoNT increases walking speed
  Johnson et al 2002 and 2004
BoNT + post injection ES further improves spasticity and walking (speed, symmetry and stride length) compared to BoNT alone.

Hesse et al 1995
Suggestion that post injection ES may reduce BoNT dose requirements in the treatment of spastic drop foot. Bayram et al 2006

Treatment with low dose BoNT + 3/7 cyclic stimulation of plantar flexors and dorsiflexors compared to high dose BoNT (n=12)

- Same outcomes in both groups (spasticity, ROM, walking speed and patient evaluation of response)

But…

**Figure 1** Course of mean Ashworth Score (*P < 0.05). Error bar = 1 SEM.
Cyclic ES does not increase hand function gains made with the combination of BoNT and task practice

Weber et al 2010
BoNT and Therapy/Exercise
BoNT and Novel Therapies
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