

**Centre, reflect, transform:  
A rights-based future for  
neuropsychology**

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2026 APS College of Clinical  
Neuropsychologists Conference



# **Normal Pressure Hydrocephalus (NPH): Patient outcomes following implementation of a "tap-testing" Clinical Guideline**

Dr Jennifer Bradshaw  
Senior Clinical Neuropsychologist  
Austin Health



# Why go to CCN Conferences?

**2019 APS College of Clinical  
Neuropsychologists Conference**  
*Neuropsychology in Partnership*  
**7-9 NOVEMBER** | Barossa Valley

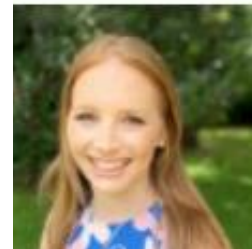
 **APS** | College of  
Clinical  
Neuropsychologists  
*Experts in Brain Psychology*

#2019CCNConference





## Epworth Idiopathic Normal Pressure Hydrocephalus (INPH) Neuropsychology Test Protocol



**Dr Ann Sloan**  
Epworth Healthcare



**Dr Belinda Dridan**  
Neuro Rehab Allied  
Health Network &  
Epworth Health



# Outline

What is NPH?

What is a "tap-test"?

What protocol should I use?

Why have a Clinical Guideline?

What about patient outcomes?



# NPH – The Basics



**Normal pressure hydrocephalus (NPH)** = abnormal buildup of cerebrospinal fluid (CSF) in the ventricles -> "wacky, wobbly, wet".

**Fluid accumulates slowly over time** = pressure inside the head often remains within the *normal* range, despite the enlarged ventricles pressing on surrounding brain tissue.

**Treatable neurological condition** = excess CSF can be drained into the abdominal cavity via a ventriculoperitoneal shunt (VP) shunt.



# NPH – Pathophysiology

Review > J Neurol Neurosurg Psychiatry. 2026 Jan 13;97(2):129-145.

doi: 10.1136/jnnp-2025-336076.

## From the past to the present: evolving theories in the pathophysiology of normal pressure hydrocephalus

Adela Bubenikova <sup>1</sup>, Viktor Procházka <sup>2</sup>, Dominik Vacínek <sup>2</sup>, Kryštof Haratek <sup>2</sup>, Petr Skalický <sup>2</sup>, Martina Laczó <sup>3</sup>, Jan Laczó <sup>3</sup>, Aleš Vlasák <sup>2</sup>, Róbert Leško <sup>2</sup>, Arnošt Mládek <sup>4</sup>, Ondřej Bradáč <sup>2</sup>

Affiliations + expand

PMID: 40738749 PMCID: PMC12911591 DOI: 10.1136/jnnp-2025-336076 [↗](#)

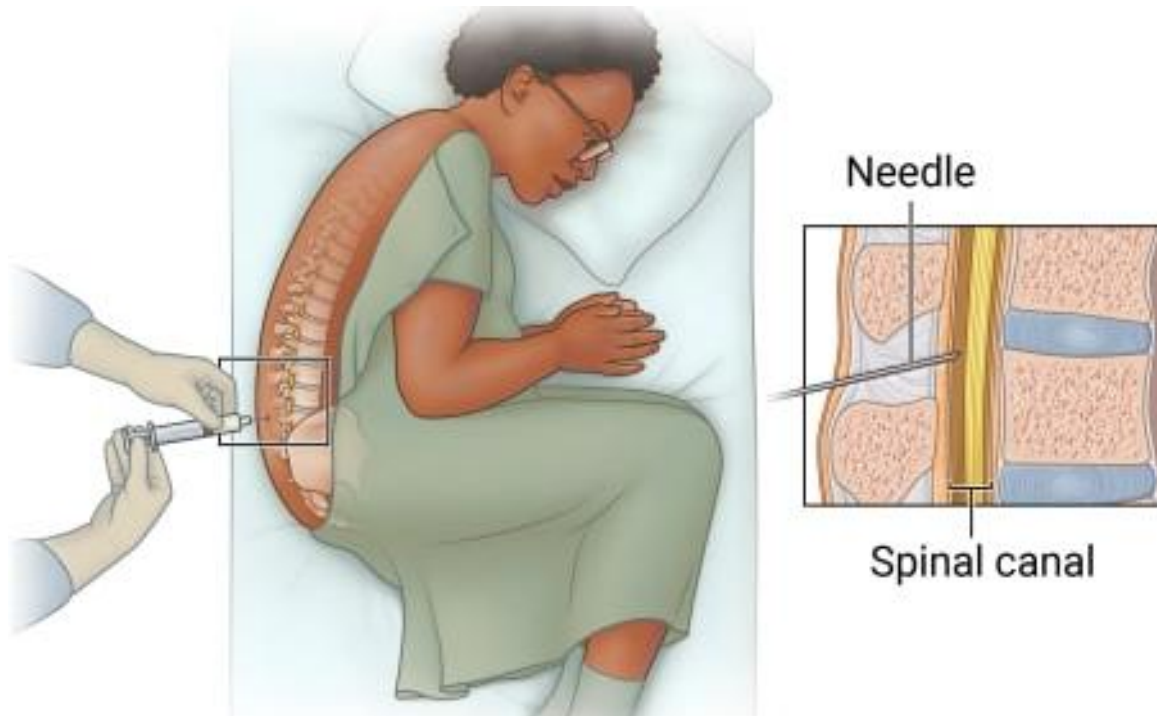
- "Despite extensive research efforts, the precise aetiology and underlying pathophysiological pathways remain indeterminate"
- Refined conceptualisation of the NPH phenotype serves to enhance the predictive accuracy of CSF diversion interventions



# NPH – "Tap Test"

High volume removal of CSF ( $\geq 30\text{ml}$ ) via a lumbar puncture (LP)

To identify subset of patients with NPH who may benefit from a VP shunt



# NPH – Austin Health Clinical Guideline



Extensive  
consultation period  
2020 – 2021



Neurology,  
Neurosurgery, &  
Physiotherapy



Hospital wide  
Clinical Guideline  
published 2021



Standard protocol  
for all tap-test  
referrals



Key resource for  
rotating medical  
staff



Day cases,  
reducing demand  
on inpatient beds



# NPH – Why have a Clinical Guideline?



## DEPARTMENT OF NEUROLOGY CLINICAL GUIDELINE

### NORMAL PRESSURE HYDROCEPHALUS – TAP TESTING PROTOCOL

#### Staff this document applies to:

Ward 6 East, Ward 6 West, and Ambulatory Care Centre medical, nursing and allied health staff involved in the clinical management of patients with suspected idiopathic normal pressure hydrocephalus.

#### Related Austin Health policies, procedures or guidelines:

[Nursing management of patients with hydrocephalus and shunts](#)

[Cerebrospinal fluid collection](#)

[Lumbar Puncture Imaging Guided \(Radiology\)](#)

How much  
CSF is  
needed?

What  
happens if  
the LP fails?

What is the  
time interval  
before the  
post-tap test?

What  
measures  
are used?

What is a  
significant  
change?

Structured Clinical Guideline essential for uniform clinical management





# NPH – Tap Test Protocol

|                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Pre-admission</b>       | <ul style="list-style-type: none"> <li>Baseline examinations (where possible): <ul style="list-style-type: none"> <li>Neurological examination</li> <li>Diagnostic neuropsychological assessment (to ascertain the presence of any comorbid conditions potentially impacting cognitive performance).</li> </ul> </li> <li>Liaison Nurse to plan for day admission to Ambulatory Care Centre (ACC).</li> <li>Liaison Nurse to confirm availability of relevant medical, physiotherapy and neuropsychology staff, prior to admission.</li> </ul>                                                                                                                                                                                                                           |
| <b>Admission</b>           | <ul style="list-style-type: none"> <li>Planned day admission to ACC at 0830.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Pre-Tap Evaluation</b>  | <ul style="list-style-type: none"> <li>Neurological examination &amp; Consent completed by Registrar.</li> <li>Physiotherapy to complete Video Consent form.</li> <li>Pre-tap cognitive and physical measures completed by clinical neuropsychologist and physiotherapist, respectively (see Appendix 2.)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Tap-Test</b>            | <ul style="list-style-type: none"> <li>High volume LP (30mls) in ACC, once pre-tap measures are completed.</li> <li>Registrar to record details of Tap-Test (see Appendix 2).</li> <li>Physiotherapist and neuropsychologist notified by medical team when Tap-Test completed.</li> <li>If bedside LP in ACC is unsuccessful, referral made by medical team for imaging-guided LP. <ul style="list-style-type: none"> <li>If this is likely to cause significant delay in post-tap assessment, discharge patient home with plan to re-admit for imaging-guided LP and post-tap assessment on separate day.</li> <li>Liaison Nurse to notify physiotherapy and neuropsychology of plan to re-admit and confirm availability prior to re-admission.</li> </ul> </li> </ul> |
| <b>Post-Tap Evaluation</b> | <ul style="list-style-type: none"> <li>Post-tap cognitive and physical measures completed by the neuropsychologist and physiotherapist, respectively (see Appendix 2). <ul style="list-style-type: none"> <li>No sooner than 30mins post LP.</li> <li>No longer than 3 hours post LP.</li> </ul> </li> <li>If no immediate improvement is observed, a further re-test is recommended within 24 hours, if at all feasible.</li> </ul>                                                                                                                                                                                                                                                                                                                                     |
| <b>Results</b>             | <ul style="list-style-type: none"> <li>Video recording of gait is sent to referring doctor for review and storage by the Physiotherapist.</li> <li>Tap-Test Data Collection form completed and signed by medical, neuropsychology and physiotherapy clinicians, then scanned to SMR – Diagnostic tab.</li> <li>Results communicated with referring doctor by medical team.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                    |

9:00 Pre-tap NP  
9:45 Pre-tap PT  
10:15 Transfer to ACC  
11:00 High volume LP  
12:30 Post-tap NP/PT  
3:30 Discharge

Guideline includes:

- Consent procedures
- CSF volume
- CT - Guided LP process
- Timing of post-tap ax
- Data storage
- Results communication



# NPH – Tap Test Protocol

## Tap-Testing Protocol:

### Test Selection:

Studies vary in the range of tests selected for the pre- and post-tap assessments.

Measures selected for the current tap-testing protocol have been selected based on consistency and comparability with other tap-test protocols (e.g., 'The Epworth Idiopathic Normal Pressure Hydrocephalus Neuropsychology Test Protocol', Dridan & Sloan, 2019; Graff-Radford & Jones, 2019).

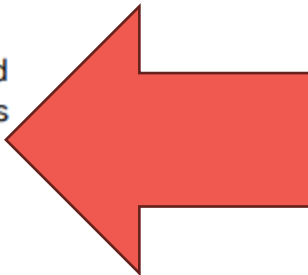
In addition, selection of the cognitive measures has been guided by the specific psychometric and normative properties of the tests, in addition to the demonstrated predictive sensitivity of specific tasks re: shunt responsiveness (Liouta et al., 2017).

#### **Physical Measures:**

- Time taken to walk 10 metres, turn 180° & return to the start\* (*mins/secs.*)  
\* If unable to walk 10 metres, this component is replaced with the 'Timed Up and Go' (TUG) test.
- The average number of steps needed to turn 180° (x2 trials)
- The average number of steps needed to turn 360° (x3 trials)

#### **Cognitive Measures:**

- Digit Span and Coding Subtests: Aged Scaled Score (Wechsler Adult Intelligence Scale, 4<sup>th</sup> Edition)
- Verbal Fluency (Delis-Kaplan Executive Function Systems: D-KEFS). Pre-Tap: 'F-A-S' (Total). Post-Tap: 'B-H-R' (Total)
- Category Fluency (Delis-Kaplan Executive Function Systems: D-KEFS). Pre-Tap: Animals/Boy's names (Total). Post-Tap: Items of clothing / Girl's names (Total).
- Halstead Reitan Finger Tapping Test (Reitan, 1985)



Selection of the cognitive measures guided by psychometric & normative properties and predictive sensitivity of the specific tasks re: shunt responsiveness



# NPH – Tap Test Data Form

|                                                                                                                   |                                                                                                                                                                                                   |
|-------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <br><br><b>NPH Tap-Test Data</b> | U.R Number .....<br>Surname .....<br>Given Name(s) .....<br>Date of Birth .....<br><div style="text-align: center; border-top: 1px solid black; padding-top: 5px;">AFFIX PATIENT LABEL HERE</div> |
|-------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

**1. Tap-Test Details**

Date of Tap-Test ..... Location (specify) .....

Cerebrospinal Fluid (CSF)

☐ Opening pressure (specify cmH<sub>2</sub>O) .....

☐ Fluid removal volume\* (specify ml) ..... (\*Recommended volume 30ml)

☐ Time CSF collected (specify hr/min) .....

Consent

CSF Tap-Test ☐ Yes ☐ No

Video-taping of Gait\* ☐ Yes ☐ No (\*Video-recording consent completed with physiotherapist)

Name ..... Signature .....

Designation: Medical Date ...../...../.....

**2. Cognitive Measures**

| Test                                  | Pre-Tap<br>Date .....<br>Time ..... | Post-Tap<br>Date .....<br>Time ..... | RCI*: Improved at 95% CI                                 |
|---------------------------------------|-------------------------------------|--------------------------------------|----------------------------------------------------------|
| 1. Digit Span                         |                                     |                                      | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| 2. Coding                             |                                     |                                      | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| 3. Letter Fluency                     |                                     |                                      | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| 4. Category Fluency                   |                                     |                                      | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| 5. Finger Tapping (Dominant hand)     |                                     |                                      | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| 6. Finger Tapping (Non-dominant hand) |                                     |                                      | <input type="checkbox"/> Yes <input type="checkbox"/> No |

\* RCI = Reliable Change Index - Improvement at 95% confidence interval (CI) on one or more tests = "Cognitive Responder"

Cognitive Outcome ☐ Positive Tap ('Cognitive Responder') ☐ Negative Tap (No Improvement)

Name ..... Signature .....

Designation: Neuropsychology Date ...../...../.....

**3. Physical Measures**

| Test<br>(Enter results and take video-recording of gait, with patient's consent) | Pre-Tap<br>Date .....<br>Time ..... | Post-Tap<br>Date .....<br>Time ..... | Improved (Yes / No)                                      |
|----------------------------------------------------------------------------------|-------------------------------------|--------------------------------------|----------------------------------------------------------|
| 1. Time taken to walk 10m, turn 180° & return to the start* (mins/secs.)         |                                     |                                      | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| 2. The no. of steps needed to turn 180° x2 (averaged)                            |                                     |                                      | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| 3. The no. of steps needed to turn 360° x3 (averaged)                            |                                     |                                      | <input type="checkbox"/> Yes <input type="checkbox"/> No |

\* If not able to walk 10m, complete TUG (Timed Up and Go test)

Physical Outcome ☐ Positive Tap ('Physical Responder') ☐ Negative Tap (No Improvement)

Name ..... Signature .....

Designation: Physiotherapy Date ...../...../.....

NPH Tap-Test Data

Mxx.xx

Standard Data Collection Form

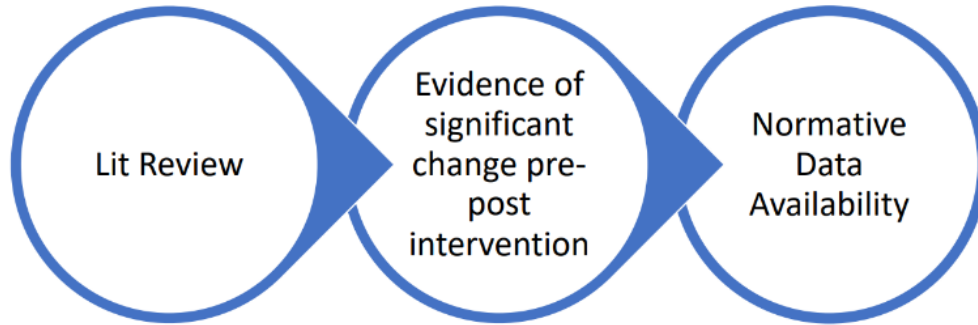
Completed by:

- Medical
- Neuropsychology
- Physiotherapy

Scanned to Medical Record



# NPH – Cognitive measures



## Epworth Idiopathic Normal Pressure Hydrocephalus (INPH) Neuropsychology Test Protocol

### Baseline Dementia Diagnostic Work up

Include thorough assessment of memory, praxis, visuo-spatial, language, executive functioning, mood, and neuropsychiatric symptoms.

| Pre-LP                                         | Post-LP                                             |
|------------------------------------------------|-----------------------------------------------------|
| Finger Tapping (R & L)- Halstead Reitan        | Finger Tapping (R & L)- Halstead Reitan             |
| Phonemic Fluency (Letter F, A, S) - DKEFS      | Phonemic Fluency (Letters B, H, R)- DKEFS           |
| Category Fluency (Animals, Boys' names)- DKEFS | Category Fluency (Clothing and Girls' names)- DKEFS |
| Coding and Digit Span- WAIS-IV                 | Coding and Digit Span- WAIS- IV                     |



# NPH – Finger Tapping Task





# NPH – What is a significant change?

Table 7

Excerpt with worked example from Hinton-Bayre's spreadsheet with items to be interpreted circled

| Insert test name                            | Baseline (X) | Retest (Y) | Jacobson | Chelune | Temkin | Iverson | Maassen | Charter | McSweeney | Crawford |
|---------------------------------------------|--------------|------------|----------|---------|--------|---------|---------|---------|-----------|----------|
| 1 Digit Span (SS) Coding (scaled score)     | 12           | 14         | 1.149    | 0.805   | 0.790  | 0.791   | 0.752   | 1.025   | 0.992     | 0.990    |
| 2 DKEFS - Letter Fluency (raw score)        | 11           | 14         | 1.906    | 1.524   | 1.494  | 1.496   | 1.473   | 1.646   | 1.626     | 1.623    |
| 3 DKEFS - Category Fluency (raw score)      | 13           | 21         | 1.169    | 1.230   | 1.236  | 1.236   | 1.202   | 0.650   | 0.621     | 0.615    |
| 4 Finger Tapping - Dominant (raw score)     | 10           | 21         | 1.653    | 1.879   | 1.964  | 1.979   | 1.537   | 0.842   | 0.484     | 0.475    |
| 5 Finger Tapping - Non Dominant (raw score) | 29           | 31         | 0.447    | 0.340   | 0.343  | 0.343   | 0.246   | -0.852  | -0.933    | -0.918   |
| 6                                           | 30           | 32         | 0.472    | 0.271   | 0.270  | 0.270   | 0.320   | -0.641  | -0.600    | -0.593   |

(See Hinton-Bayre and Kwapil in Bowden (2017) for further details on RCI)

**STEP 3:** Interpret the reliable change index. If one or more tests significantly improves at the 95% confidence interval then the individual would be classified as a 'cognitive responder'. For the above example, you may formulate it something like this:

*"Verbal (semantic) fluency improved following the LTT, with 95% confidence. Psychomotor speed improved with 90% confidence. The other measures did not change significantly from time one to time two when taking into consideration test reliability and practice effects"*

The person in the above example would be classified under the Epworth Protocol as being a 'cognitive responder' to the lumbar tap test.

Interpret RCI from Baseline to Re-test for each measure

If *one or more* tests significantly improves at 95% CI = 'cognitive responder'

No significant change on other measures, considering test reliability & practice effects



# Patient Outcomes: Sample (2021-2026)

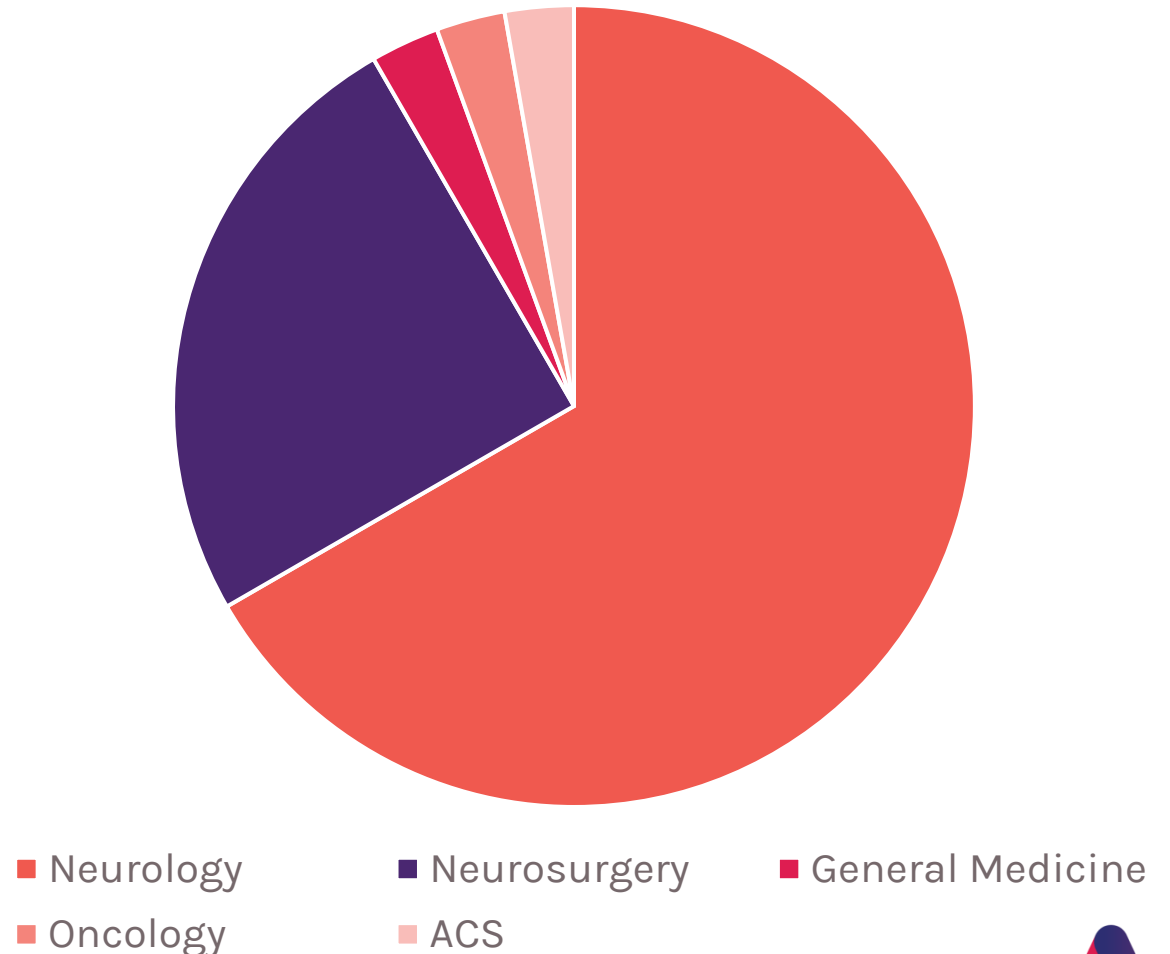
N = 35 (22M; 13F)

Average age = 73y 6m (58 – 88y)

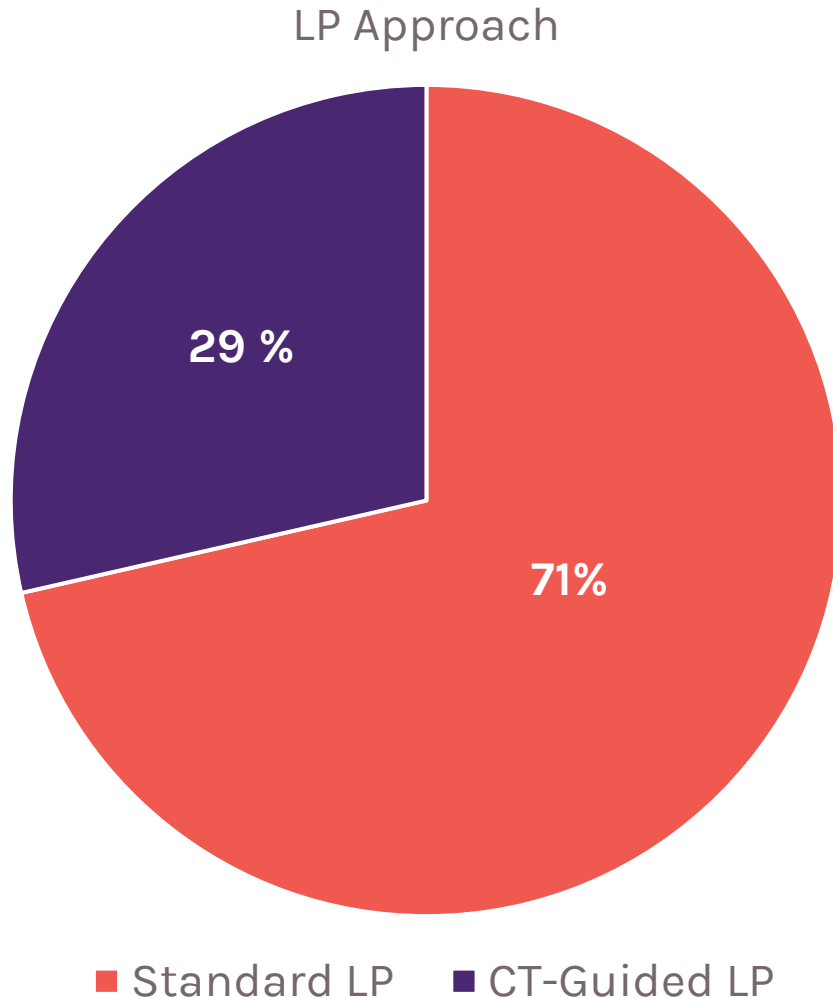
NP Baseline Ax = 12 (34%)

Day cases = 27 (8 inpatients)

Referral Source



# Patient Outcomes: LP



## Post-tap interval:

Average = 68mins  
(range 30 – 120min)

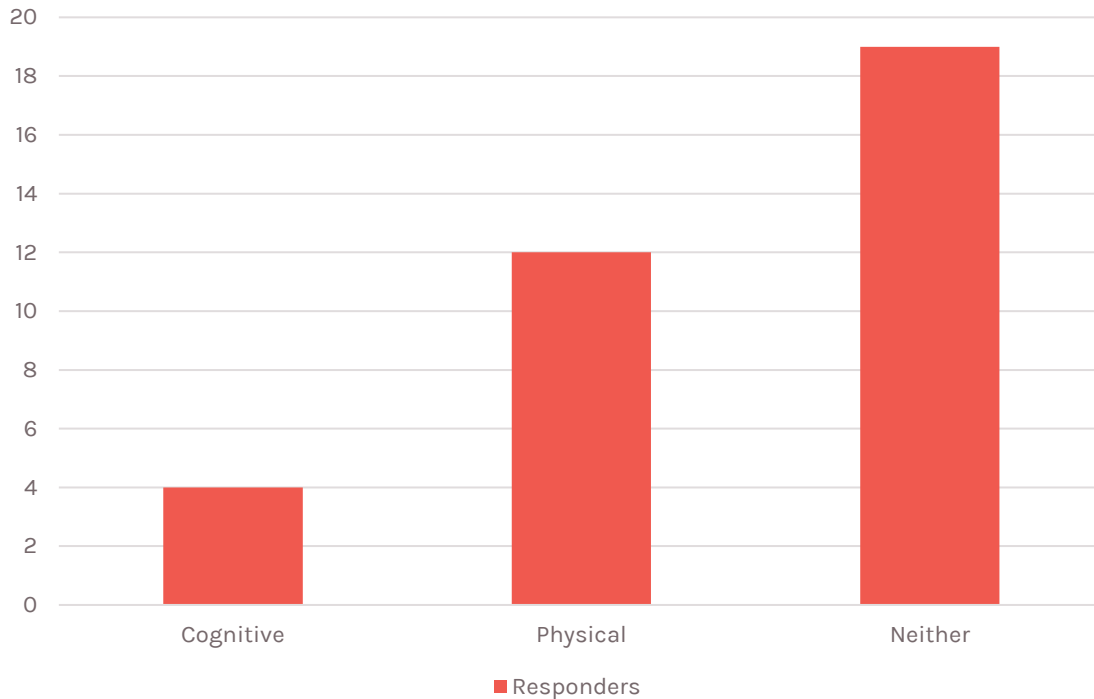
\*CSF produced 0.3ml/min; CSF withdrawn will have been replaced after 3 hours  
*Graff-Radford & Jones (2019)*





# Patient Outcomes: Post-tap Response

Improvement Post-Tap



## Positive responders: 34%

- Very few 'cognitive responders' (N = 4)
- Mostly 'physical responders' (N = 12)

## Level of agreement PT/NP: 73%

- Both negative (63%)
- Both positive (10%)

## Mixed outcome: 27%

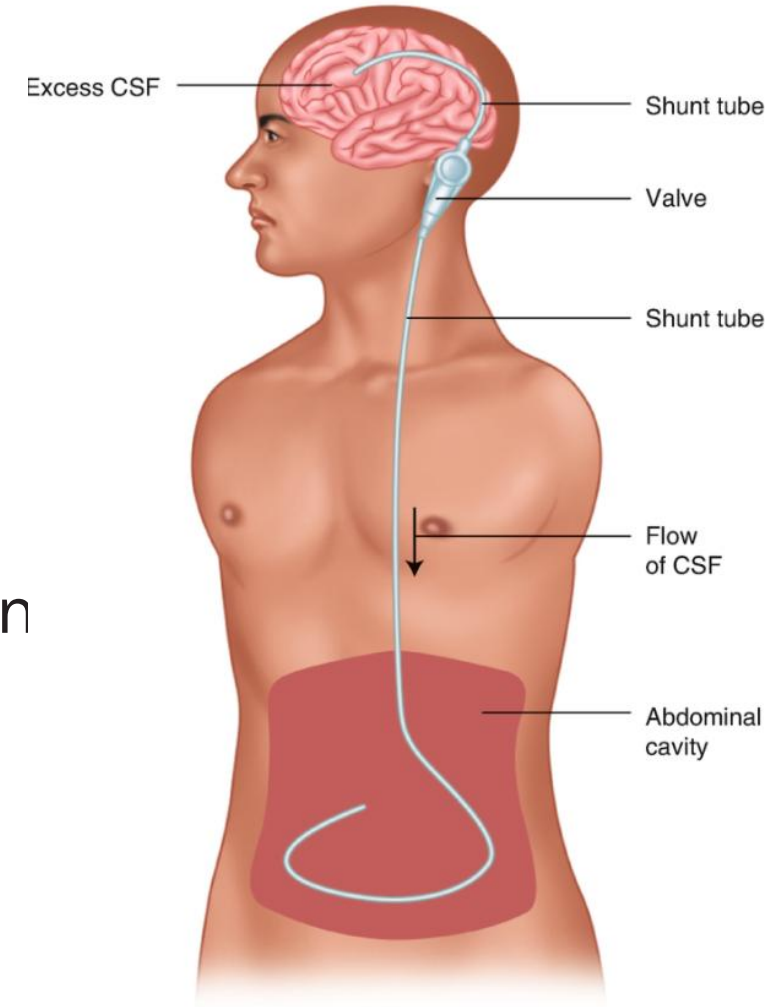
- Physical response only (24%)
- Cognitive response only (3%)



# Patient Outcomes: Who gets a shunt?

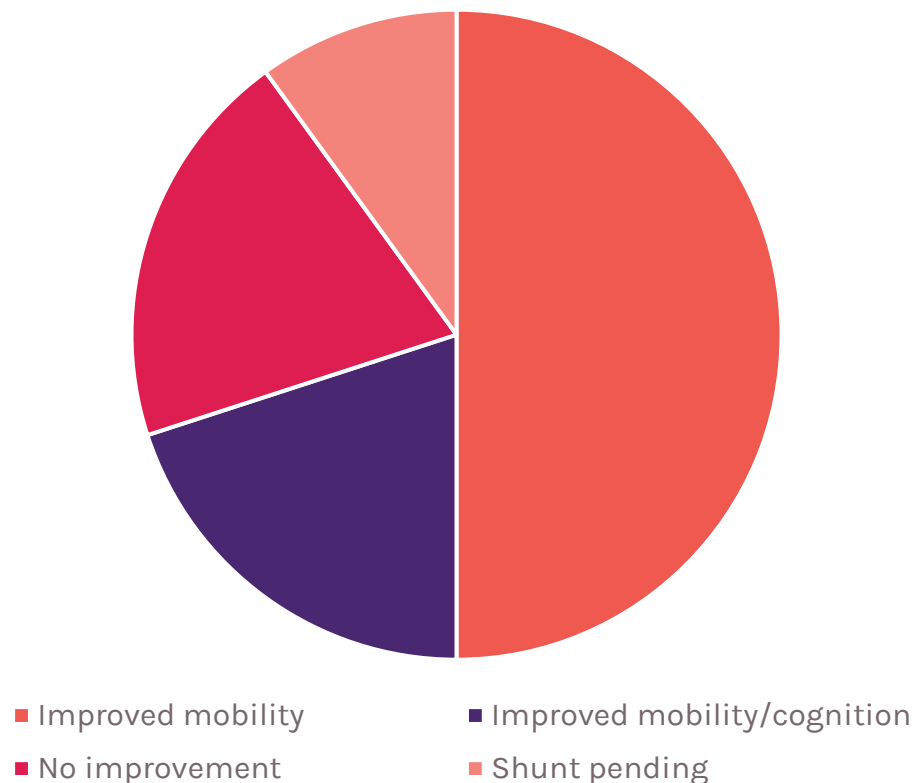
Number VP shunts: N = 10

- Physical responders (N = 8)
  - Non-responders (N = 2)
  - Cognitive responders only (N = 0)
- 
- 2/12 'physical responders' pending NSurg opinion
  - 2/12 'physical responders' progress unknown



# Patient Outcomes: Post shunt response?

Post-shunt response



|        | Complications                                                                                        |
|--------|------------------------------------------------------------------------------------------------------|
| Case 6 | Improved with "aggressive drainage", caused bilateral subdural hygromas (secondary to over-shunting) |
| Case 8 | Shunt infection, recurrent, shunt removed                                                            |

"Improved" - based on doctor/patient impression (i.e., no post VP re-testing)



# Take home messages

## Clinical Guideline

- Streamlined the tap-test process
- Reduced demand for inpatient beds

## Epworth Protocol

- Grounded in research
- Efficient to administer
- Cognitive response rate is low

## Outcomes

- Primarily physical response (post-tap & post-VP)
- Physical outcome predicts decision to shunt

## Future?

- Increase rate of baseline cognitive assessments
- More comprehensive ax of non-responders
- Objective PT/NP review of post VP shunt patients



# Thankyou – Questions/Comments?



Contact: [jennifer.bradshaw@austin.org.au](mailto:jennifer.bradshaw@austin.org.au)

