



**iNPH QUEST Study: Quantifying a battery
of Gait, Cognitive and Radiological
Examinations to improve identification of
Shunt candidates from the cerebrospinal
fluid Tap test**

A thesis by publication for the degree of
Doctor of Philosophy (Physiotherapy)

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Statement of ethical conduct

In addition, ethical approval from the Hunter New England Human Research Ethics Committee, and co registration from the University of Newcastle Human Ethics Committee was granted for the clinical studies presented in this thesis. In each instance, participants were required to read an information statement and provide informed written consent prior to the collection of any data.

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Signature

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2. **Gallagher R**, Marquez J, Osmotherly P. Can gait and balance measures identify individuals who respond to a lumbar puncture tap test in patients with idiopathic normal pressure hydrocephalus (INPH)? *Fluids and Barriers of the CNS*. 2018;15 Suppl1(4):A47
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Glossary of abbreviations

Abbreviation	Definition
AD	Alzheimer's disease
AMO	Admitting Medical Officer
AUC	Area under curve
BBS	Berg balance scale
CT	Computer tomography
CSF	Cerebrospinal fluid
ELD	External lumbar drainage
GRC	Global rating of change
ICP	Intracranial pressure
iNPH	Idiopathic normal pressure hydrocephalus
MRI	Magnetic resonance imaging
MDC	Minimal detectable change
MCID	Minimally clinically important difference
MoCA	Montreal cognitive assessment
PD	Parkinson's disease
SEM	Standard error of measurement
SSS	Superior Sagittal sinus
TE	Echo time
TR	Repetition time
TUG	Timed up and go

TUG-C	Timed up and go cognition
TT	Tap test
VP	Ventricular peritoneal
9HPT	9 hole peg test
10MWT	10 metre walk test

Thesis abstract

Idiopathic normal Pressure hydrocephalus (iNPH), a condition resulting in abnormalities of gait, cognition and continence, is treated by the placement of a ventricular peritoneal (VP) shunt to drain cerebrospinal fluid (CSF). To identify surgical candidates the CSF tap test (TT) was devised to mimic VP shunt insertion. The CSF TT involves drainage of a small volume of CSF to assess for symptom improvement. Additionally, measurements of CSF flow on MRI imaging have been devised to identify VP shunt candidates. Limited research has investigated assessing what outcome measures can identify change from a CSF TT. Neither the tests capable of definitively identifying change from a CSF TT nor the degree of change required on any test constituting a clinically important difference have been extensively investigated. Additionally, whether any measure on MRI CSF flow studies can identify change using outcome measures has not been explored.

This thesis aims to: 1. Identify a battery of standardised gait and balance outcome measures which can identify change from a CSF TT. 2. Identify a battery of standardised upper limb and cognitive outcome measures which can identify change from a CSF TT. 3. Develop minimally clinically important differences (MCIDs) for a battery of outcome measures. 4. Identify radiological markers on MRI CSF flow studies that are prognostic of response to CSF drainage. The ability of the Timed up and go (TUG), Timed up and go cognition (TUG-C), performance oriented mobility assessment (Tinetti), Berg balance scale (BBS), 10 metre walk test (10MWT), Montreal cognitive assessment (MoCA) and 9 hole peg test (9HPT) to identify change from a CSF TT was assessed.

These studies demonstrated that the TUG, TUG-C, Tinetti and BBS could identify change from a CSF TT. Calculated MCIDs were 3.63sec for the TUG, 2.60sec for the TUG-C, 4 points for the Tinetti and 4 points for the BBS represent MCIDs for improvement from a CSF TT. Additionally, we have shown that the measurements of the sagittal sinus circumference and area can differentiate improvement in gait as a result of CSF drainage. Further research is required to evaluate the utility of these MCID values in identifying improvement following VP shunt insertion.