

Assessment of motor limb strength by neuroscience nurses: variations in practice and associated challenges from a UK and Irish survey

Background

Neurological assessment is the cornerstone of practice in neuroscience nursing, being the core method of evaluating the function of the nervous system for people with neurological disorders (Agrawal, 2019). However, the evidence base around neurological assessment is an emerging one, and aspects of practice could be considered legacy-based, rather than evidence-informed. A common error seen across the literature is that of confusion between the Glasgow Coma Scale (GCS) and neurological assessment (Jain & Iverson, 2021). The GCS is just one component of the overall assessment utilised to assess the level of consciousness (arousability and awareness). However, there remain four other components, pupillary response, sensory assessment (not normally included on a standard neurological observation chart), vital signs, and motor limb assessment. The latter, for most nurses working in neuroscience, traditionally focuses on limb strength or motor limb strength.

Muscle/limb weakness may result from injury or disorders of the central nervous system or the peripheral nerves or muscle. Furthermore, a person's active muscles determine an individual's ability to carry out daily activities and any change in strength measurements is a critical indicator of improvement or deterioration in the underlying disease. Thus, an evaluation of muscles strength is an important component of a neurological assessment. Currently the evidence informing practice is limited, despite such assessment being central to monitoring neurological status, determining the presence of deficits, and informing decisions around interventions, treatment and care. Moreover, the need for nurses to be able to undertake a full neurological assessment that is accurate and cohesive within an interprofessional arena is paramount for patient care to be effective and safe.

Muscle function is underlined by three concepts: strength, power, and endurance. The literature often uses the terms strength and power interchangeably. Muscle strength can be described as the amount of force a muscle with a single maximal effort (peak force) and should

be differentiated from power, which is defined as the ability to exert maximal effort in as short a time as possible (Beaudart *et al.* 2019). Thus, power is the product of force and velocity of muscle contractions.

Manual motor limb strength assessment can be historically linked back to Mitchell and Lewis who in 1886 initiated the practice of the tabulation of neurological signs for peripheral nerve injuries. This practice was further enhanced by Lovett in 1917, who introduced an original scoring system for muscle weakness, which formed the cornerstone for the development of the Medical Research Councils 'Manual Muscle Testing Grading System' (MRC Grading System) (Table 1) (Medical Research Council, 1943; Dyck *et al.* 2005). The Medical Research Council (MRC) grading system is widely recognised as a principal feature of daily neurological, rehabilitation, and general medical examination of patients. This method involves testing key muscles from the upper and lower extremities against the examiner's resistance and grading the patient's strength on a 0 to 5 ordinal scale.

Following the development of GCS by Teasdale & Jennett (1974), a limb strength assessment tool the Normal Power, Mild Weakness, Severe Weakness, and No Movement (No response) (NP-NM scale) was added. This inclusion of limb strength in the **neurological observation** chart was reflected at the time the need by colleagues, at the time of the development of the GCS (Table 2) for a comparison of the two sides rather than an absolute measure (G. Teasdale, personal communication, August 2021). However, this addition was never formally evaluated. Presently the NP-NM tool is regularly included alongside the GCS when performing neurological observations in practice and, like the MRC, requires a subjective evaluation of muscle strength. What's more, the interpretation of the terminology used in the NP-NM scale is not generally available on the **neurological observation** chart. For example, mild weakness is a subjective term that can be interpreted differently, whereas the MRC scale provides a descriptor. **Another important factor to consider is that whichever tool is used, it needs to be efficient and accurate to use given the frequency at which neurological observations can be required to be undertaken.** It is within this context that we sought to understand the practices of neurosciences nurses and their understanding of limb strength assessment **as part of**

neurological observations (but not within the context of a full neurological examination in which several separate muscle groups are examined).

Aims

The aims of this study were to:

- Identify tools that were used in clinical practice to assess motor limb strength
- Understand the nurse's experiences of using these tools within an interprofessional context
- Identify further areas of inquiry related to neuroscience nursing practice

Methods

Design

This study used a descriptive design to determine which tools are used by neuroscience nurses and their experiences of these tools in practice when assessing muscle strength. No suitable pre-existing instrument questionnaire was identified to meet the aim and objectives of this study. Thus, a questionnaire was developed drawing on variables from the literature and guidance from an expert panel from the executive board of the British Association of Neuroscience Nurse (BANN), establishing content validity. Following the distribution of the questionnaire online to a consensus panel from the BANN board, each with at least 15 years of experience in the area to establish face validity, a 16-item questionnaire was established. Of the 16 items, 12 were closed statements and four open-ended questions. Four of the questions were demographic (region of work, speciality, years in neuroscience practice), with the remainder being in relation to:

- Tool used to assess motor limb strength for differing condition groups
- Challenges experienced with the tool used, if any.
- Education/training in the use of tools used to assess limb strength
- Whether sensory assessment was conducted at the same time as motor limb strength assessment and rationale
- When motor limb strength assessment takes place and rationale

Ethical approval was sought, and obtained, from the BANN executive committee and a letter of supporting opinion sought from the Institute of Nursing and Health Research Ethics Filter Committee at Ulster University in tandem. Therefore, all procedures were performed in compliance with relevant laws and institutional guidelines (BANN) and that the appropriate institutional committee (BANN) approved them.

Data collection

Participants were recruited from March to May 2021 using a non-probability, purposive sampling technique. The target population was neuroscience nurses who were members of BANN, including those in the Republic of Ireland. Using a sample size calculator for a population of 225 nurses with a confidence interval of 95%, a sample size of 142 was needed (n=160 achieved after data cleansing, 71% response rate).

The survey was advertised via social media and the BANN website (email) and administered using Qualtrics®, a secure, General Data Protection Regulation (GDPR, 2018) compliant, web-based survey tool with a unique web link (URL) for respondents to access. Consent was obtained within the same survey at the beginning of the process, assurances were made that they had the right to withdraw at any time and that their responses were anonymous. The survey was open for three months and data were collected and stored in accordance with General Data Protection Regulation regulations (2018). No participant requested the removal of their data.

Data analysis

Data were exported from Qualtrics® into IBM Statistical Package for the Social Sciences (SPSS) v26.0 for analysis. Descriptive statistics and cross-tabulations (non-parametric analysis) were collated for the closed questions. Descriptive statistics such as mean and standard deviation were used to analyse background variables. Qualitative data were analysed using content analysis using Newell and Burnard's (2006) six-stage approach.

Results and Discussion

Most participants worked in the neurosurgical setting (61.9%, n=99) with intensive/critical care (23.1%, n=37) and neurology being the next most prevalent clinical areas (18.8%, n=30) (Table 3). The most common form of education/training to undertake motor limb strength assessment was ward/unit/team training (86.9%, n=139), followed by post-registration (40.1%, n=67) and pre-registration education (31.3%, n=50) (Table 4). Most of the participants (91.2%, n=146) had over two years of experience in neuroscience (Table 5).

The tool used to assess limb motor strength

Two tools were dominant in practice: the NP-NM scale (Normal Power, Mild Weakness, Severe Weakness, No Movement (No response)) and the MRC Scale (Table 6). The NP-NM scale was most dominant across all categories (53.1%, n=85 - 76.9%, n=123) and the hand dynamometry/grip test was used by only one respondent. Assessment not using any tool was rarely reported (n=1 to n=4) however, respondents who indicated that limb strength assessment was not applicable were unexpectedly high, ranging from 5% (n=8) to 20.6% (n=33). Most respondents reported undertaking limb strength assessment as part of baseline assessment and ongoing observation (73.1%, n=117 to 93.1%, n=149). Similarly, most respondents 73.8% (n=118) chose the same tool for all neurological conditions, however, 26.3% (n=42) selected their tool based on condition.

The validity and reliability of these assessment scales are essential to monitoring a person's recovery and are critical for determining appropriate therapies. Muscle strength can be assessed by various techniques including Manual Muscle Testing (MMT). Given that motor limb strength assessment using the NP-NM tool was introduced alongside the GCS in 1974 without establishing the tool as reliable and valid, and without a comprehensive approach to education and support practice standards, it is not surprising that the issues uncovered in this study exist. In contrast, the MRC Scale is noted for its simplicity of use and is supported by clear illustrations of how limb muscles should be tested (Vanhoutte *et al.*, 2012). Additionally, the MRC scale's inter-rater and intra-rater reliability has been determined as reliable and valid through a variety of studies (Florence *et al.*, 1992; Brandsma *et al.*, 1995; James, 2007; Paternostro-Sluga *et al.*, 2008), and would appear to have a stronger evidence base.

Few respondents identified evaluating muscle strength assessment via other methods such as hand-held isometric dynamometry (HHD). This may be because the context of the questionnaire was in relation to limb strength (i.e., the whole limb, usually as part of neurological observations) whereas HHD is often used for **distal muscle groups** as opposed to the whole limb. **Also, the focus of the study was on neurological observations as opposed to a full neurological examination.** This approach may be dependent on the clinical situation i.e., depending on the patient's specific condition, but provides a superior quantitative measure to the subjective manual muscle testing such as the MRC, albeit assessing different things. The more subjective NP-NM scale or the MRC scale results may vary according to the examiner's skills and ability to resist the force produced by the patient, although the MRC scale has established good interrater reliability as identified earlier.

This variability in the selection of assessment tools raises the question as to whether a sound evidence base is the driving factor or legacy practices as the choice between these tools provides no distinction in terms of what is being measured. Additionally, some respondents cited the following guidelines in this respect e.g., NICE guidelines, GCS guidelines, and NEWS2/INEWS guidelines, none of which guide limb motor strength assessment. This highlights that some respondents did not make practice decisions based on the best evidence, underpinned by critical thinking. Additionally, the results suggest that some respondents lack clarity on what they are assessing. Of more concern is the rationale for omitting limb strength assessment in their patient groups (5%, n=8 – 20.6%, n=33) (Tables 6 and 7), and this requires further investigation. Ultimately, due consideration is required in choosing the right assessment tool for the right purpose.

Frequency of the tool used

We asked respondents how they decide the frequency of assessment, and this was dominated by protocol/policy (63.1%, n=101), and autonomous decision-making based on the assessment of the person (62.5%, n=100) (Table 7). Several respondents identified that frequency was prescribed by medical staff (n=29, 18.1%) or set by national or professional guidelines e.g., NICE, Glasgow Coma Scale, and NEWS2/INEWS) (8.1%, n=13).

Challenges with tools used

When asked about challenges with the tool used, 34.4% (n=55) reported the tool they used as being clear and transparent. However, 58.8% (n=94) of respondents reported perceived poor interrater reliability in terms of inconsistent use of the tool within the team. Additionally, 18.8% (n=30) reported that the tool they use to assess limb strength was different from that used by other healthcare professionals within the team and 1.3% (n=2) reported the tool they use was different from that in other departments. When separating these issues by tool, the MRC scale has less challenges reported against it than the NP-NM tool (table 8).

However, respondents reported more issues around training with regards to the MRC tool with 10.1% (n= 15) respondents reporting inadequate training/education in its use compared to just 1.4% of respondents using the NP-NM tool. This is within the context of only 31.3% of respondents being educated in limb strength assessment as part of their pre-registration education. This suggests that enhancing education and training in the use of the MRC Scale could result in more consistency in practice and fewer practice issues given that respondents reported fewer issues overall with the use of the MRC scale in comparison to the NP-NM tool (43.17% and 33.7% respectively).

It is evident that there are similar trends in terms of challenges with practice to that found with the use of the Glasgow Coma Scale (Cook *et al.*, 2019); issues exist with regards to interrater reliability of the NP-NM tool and MRC scale. If the approach to education was enhanced nationally, this could result in an increase in the accuracy of limb strength assessment in practice, and could further be enhanced through clear, unambiguous practice guidelines and benchmark standards.

Simultaneous assessment of Sensory Function and Limb Strength

Whilst sensory assessment was not the primary focus of the study, it is an important aspect of neurological observations and thus the researchers sought to establish whether sensory assessment was undertaken alongside limb motor strength assessment; 31.3% (n=50) responded that they did the two assessments together in contrast to 46.3% (n=74) indicating they did this sometimes. Of interest, over a fifth of respondents 22.5% (n=36), indicated they

do not perform a sensory assessment alongside a limb strength assessment, citing the primary reason for this as not seeing this as part of their role. Seven respondents indicated that they did not know why they did not undertake it, indicating a need to enhance awareness around the various components of neurological assessment and to promote critical thinking in decision making. Although this was not the primary aim of this study, the inconsistency in the approach to sensory assessment alongside limb strength assessment raises several issues. In assessing nervous function, it is unclear why there is greater importance placed on motor assessment over sensory assessment, other than a loss of motor function is functionally more obvious. A clear factor was the absence of education/training to undertake a sensory assessment and a lack of protocol to inform practice. Despite this several respondents indicated that clinical decision-making and professional judgment informed their decisions regarding undertaking a sensory assessment alongside a limb strength assessment. **What is clear is that there needs to be greater consideration of the inclusion of sensory assessment in neurological observations, including the boundaries of such assessment. It can be argued that it is logical to assess both motor and sensory function in neurological observations (and not just one), but this may be more relevant for particular conditions (e.g., spinal injury). Thus, the extent and focus of the neurological observations are key considerations. Moreover, the utilisation of sensory assessment highlights the complexity of an accurate appropriate neurological observation.**

Other Factors

Finally, other factors merit consideration when assessing limb strength that limits the use of any tool. These were not reported by respondents, which could be a limitation of our survey or could suggest that these were not considered by the respondents in their practice. For example, neither the NP-NM tool nor the MRC scale consider factors that may make testing painful or difficult to tolerate, such as pain or the person's position when being assessed. Muscle strength could be normal, but pain or their position (e.g., prone), prevents the person from demonstrating that strength (Ciesla *et al.*, 2011). The ability of the person to participate in the assessment also merits consideration as both tools measure manual volitional strength; those with impaired consciousness and cognition may not be able to have the capacity to engage in the assessment fully (Hough *et al.*, 2011; Hermans & Gosselink, 2011). Additionally,

Tzanis *et al.*, (2011) assert that the effort of the person being assessed can impact results. Ultimately limb strength assessment relies on motivation, cooperation and functional ability.

Limitations and strengths

Several limitations exist with this study. The survey targeted members of the BANN, this may have limited a wider sampling of neuroscience nurses, and experiences of those working in other disciplines were excluded. The use of an online survey tool may have represented participants who were more likely to engage and complete a survey in an online format and to whom the subject is salient. Additionally, there is the potential for respondents to provide responses they think are more favourable to avoid criticism (Van de Mortel, 2008). The survey also took place during the Covid-19 pandemic, a time when the nursing profession was under considerable pressure, and this may have impacted practices reported in the survey. The use of survey design did prevent the researchers from exploring some aspects in more depth, particularly concerning decisions around sensory assessment and why nurses chose a different tool when assessing different neurological conditions. However, to the author's knowledge, this is the first study of its kind. Despite these limitations, results from this study provide useful insight into the motor assessment practices of neuroscience nurses and important baseline evidence for further research.

Recommendations

The authors make the following recommendation:

- c. This may still require additional assessment to determine the presence of flexor or extensor posturing.
- Other assessment tools may be required, as appropriate, depending on the patient group being assessed, as part of a neurological assessment.
- Further research across different clinical settings and in the wider international community to understand limb strength assessment practices
- There is a need to implement a clear comprehensive educational strategy on motor limb strength assessment, with supporting guidelines, from pre-registration education onwards. As part of this process, a review of how muscle strength assessment is

taught in nursing programmes could identify an existing clear education strategy that could be adopted or enhanced.

- Further research is warranted on sensory assessment to establish current practice and enhance and develop practice in this area

Conclusion

This is the first known study to examine practices around limb/motor strength assessment in neuroscience nurses. This research provides important baseline evidence around the practices of limb strength assessment by registered nurses in the UK and Ireland working in neurosciences. Of note is that the predominant tool is the NP-NM tool, which is a tool that is traditionally handed down alongside the introduction of the GCS, one which has not been evaluated or has any established evidence base, that is until now. The other dominant tool is the MRC Scale which has an established evidence-base and would appear to be the tool of choice at this time for limb strength assessment. This study further illustrates the need for greater consistency in practice, particularly in relation to the choice of an assessment tool and resolving issues around interrater reliability. Muscle strength can be evaluated by different methods, such as a manual muscle test for example the MRC Scale, NP-NM tool, and hand-held dynamometer. Given the heterogeneity of people with neurological disorders, it is important to choose the right tool that is highly practicable in various patient groups and one that maximises consistency in practice and lends itself to a common professional language. Interprofessional collaboration is necessary to advance this issue, particularly when considering any changes in assessment tools to maximise interprofessional practice and in the development of practice standards and guidelines to support practice and development. As highlighted by Cook (2021), nurses cannot expect to work in specialised areas of practice without the provision of appropriate knowledge and skills through supportive education and development approaches that develop their skills and ability to think critically in the application of their knowledge. This is also necessary for nurses to be able to traverse the chasm that can appear between autonomous practice and practice guidelines. Finally, this research has identified the need for further research on neuroscience nurses' practices regarding sensory assessment.

Key Words

- Limb assessment (motor strength assessment)
- Limb strength assessment
- Muscle strength grading
- Neurological assessment

Key points

- When undertaking assessment of motor limb strength, due consideration is required in choosing the right assessment tool for the right purpose.
- Assessment of muscle strength in differing clinical populations requires sound decision-making based on an evidence base.
- This survey highlights inconsistencies in assessment practices, and a lack of practice guidelines, sufficient education, and clarity around role responsibilities in relation to motor limb strength assessment.
- The MRC Scale and the NP-NM tool are the two most prevalent tools used to assess motor limb strength in practice in the UK and Ireland.
- The MRC scale is advocated as the tool of choice for motor limb strength assessment as part of neurological observations; other assessment tools may be required, as appropriate, depending on the patient group being assessed, as part of a neurological assessment.

CPD reflective questions (3-5)

- Is the assessment tool you use in clinical practice for motor limb strength assessment evidence-informed? If not, how could you address this in your practice setting?
- What are some of the challenges that you have encountered with motor limb strength assessment in your practice setting and how could you overcome these?

- Are you aware of the different tools used to assess motor limb strength and when each is appropriate to use?
- What have you learned from reading this article and how will this impact on your professional practice?

Declaration of interest: None

References

Agrawal S. Glasgow coma scale: what is new? **International Journal of Medical Reviews and Case Reports**. 2019; 3(6): 327-330.

Brandsma JW, Schreuders T A, Birke JA, Piefer A and Oostendorp R. Manual muscle strength testing: intraobserver and interobserver reliabilities for the intrinsic muscles of the hand. **Journal of Hand Therapy**. 1995; 8(3): 185-190.

Beudart C, Rolland Y, Cruz-Jentoft AJ, Bauer JM, Sieber C, Cooper C, Al-Daghry N, Araujo De Carvalho I, Bautmans I, Bernabei R, Bruyère O, Cesari M, Cherubini A, Dawson-Hughes B, Kanis JA, Kaufman JM, Landi F, Maggi S, McCloskey E, Petermans J, Rodriguez Manas L, Reginster JY, Rollen-Wirnsberger R, Schaap LA, Uebellhart D, Rizzoli R, Fielding RA. Assessment of Muscle Function and Physical Performance in Daily Clinical Practice. **Calcified Tissue International**. 2019; 105(1): 1-14.

Cook N. Education and neuroscience nursing: the challenge. **British Journal of Neuroscience Nursing**. 2021; 17(3): 77-78.

Cook NF, Braine ME and Trout R. Nurses' understanding and experience of applying painful stimuli when assessing components of the Glasgow Coma Scale. **Journal of Clinical Nursing**. 2019; 28(21-22): 3827-3839.

Ciesla N, Dinglas V, Fan E, Kho M, Kuramoto J and Needham D. Manual Muscle Testing: A method of measuring extremity muscle strength applied to critically ill patients. **Journal of Visualized Experiments**. 2011; 50: 2632.

Dyck PJ, Boes CJ, Mulder D, Millikan C, Winderbank AJ, Dyck PJ and Espinosa R. History of standard scoring, notation and summation of neuromuscular signs, A current survey and recommendation. **Journal of the peripheral nervous system**. 2005; 10(2): 158-173.

General Data Protection Regulation (GDPR). **General Data Protection Regulation (GDPR)**. 2018; Available from: <<https://www.gov.uk/government/publications/guide-to-the-general-data-protection-regulation>> [Accessed Dec 2021].

Hough C, Lieu BK and Caldwell ES. Manual muscle strength testing of critically ill patients: feasibility and interobserver agreement. **Critical Care**. 2011; 15(1): 1-7.

Hermans G and Gosselink R. Should we abandon manual muscle strength testing in the ICU? **Critical Care**. 2011; 15(2): 1-2.

Florence JM, Pandya S, Kine WM, Robinson JD, Baty J, Miller JP, Schierbecker J and Signore LC. Interrater reliability if manual muscle test (Medical Research Council scale) grades in Duchenne's muscular dystrophy. **Physical Therapy**. 1992; 72(2): 115-122.

James MA. Use of the Medical Research Councils muscle strength grading system in the upper extremity. **Journal of Hand Surgery**. 2007; 32(2): 154-165.

Jain S and Iverson LM. Glasgow Coma Scale. **Stat Pearls**. 2021; (Online). Available from: <https://pubmed.ncbi.nlm.nih.gov/30020670/> . (Accessed on 13th August 2021).

Newell R and Burnard P. **Vital Notes for Nurses: Research for Evidence-Based Practice**. 2006; Oxford: Blackwell Publishing.

Paternostro-Sluga T, Grim-Steiger M, Posch M, Schuhfried O, Vacariu G, Mittermaier C, Bittner C, Fialka-Moser V. Reliability and validity of the Medical Research Council (MRC) scale and a modified scale for testing muscle strength in patients with radial palsy. **Journal of Rehabilitation Medicine**. 2008; 40(8): 665-671.

Teasdale G and Jennett B. Assessment of com and impaired consciousness; A practical scale. **Lancet**. 1974; 302(7872): 81-4.

Tzani G, Vasileiadis I, Zervakis D, Kaeatzanos E, Dimopoulos S, Pitsolis T, Tripodaki E, Gerovasili V, Routsis C and Nanas S. Maximum inspiratory pressure, a surrogate parameter for the assessment of ICU-acquired weakness. **BMC Anaesthesiology**. 2011; 11(1): 1-7.

Van De Mortel TF. Faking it: Social desirability response bias in self-report research. **Australian Journal of Advanced Nursing**. 2008; 25(4): 40-48.

Vanhoutte EK, Faber CG, Van Nes SI, Jacobs BC, Van Doorn PA, Van Koningsveld R, Cornblath DR, Van Der Kooij AJ, Cats EA, Van Der Berg LH and Notermans NC. Modifying the Medical Research Council grading system through Rasch analyses. **Brain**. 2012; 135(5): 1639-1649.