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Title

Nurses' understanding and experience of applying painful stimuli when assessing components of the Glasgow Coma Scale

Abstract

Aims and Objectives

This study aimed to evaluate nurses' application, understanding and experience of applying painful stimuli when assessing components of the Glasgow Coma Scale.

Background

The Glasgow Coma Scale has been subjected to much scrutiny and debate since its publication in 1974. However, criticism, confusion and misunderstandings in relation to the use of painful stimuli and its application remain. An absence of evidence informed guidance on the use and duration of application of painful stimuli remains, with the potential to negatively impact on decision-making, delay responsiveness to neurological deterioration and result in adverse incidents.

Design

This international study used an online self-reported survey design to ascertain neuroscience nurses' perceptions and experiences around the application of painful stimuli as part of a GCS assessment (n=273). STROBE checklist was used.

Results

Data revealed varied practices and a sense of confusion from participants. Anatomical sites for the assessment of pain varied, but most respondents identified the trapezius grip/pinch in assessing eye opening and motor response. Most respondents identified they assess eye opening and motor responses together and apply pain for less than 6 seconds to elicit a response. Witnessed complications secondary to applying a painful stimulus were varied and of concern.

Conclusion

Neuroscience nurses in this study clearly required evidence informed guidelines to underpin practice in both applying painful stimuli and in managing the experience of the person in their care and the family response. A standardised approach to education is necessary to ensure greater interrater reliability of assessment not only within nursing but across professions.

Relevance to Practice

Results of this study illustrate inconsistency and confusion when using the Glasgow Coma Scale in practice; this has the potential to compromise care. Clarity around the issues highlighted is necessary. Moreover, these results can inform future guidelines and education required for supporting nurses in practice.

Keywords

- Glasgow Coma Scale (GCS)
- Noxious painful stimuli
- Eye opening response
- Motor response
- Neurological assessment

Introduction

Nurses frequently encounter people who have a neurological disorder which requires careful monitoring and assessment of their neurological status. Monitoring neurological dysfunction is a fundamental nursing skill that demands appropriate education to ensure accuracy and understanding to underpin clinical decision-making. The Glasgow Coma Scale (GCS) is a universal standardised neuromonitoring tool to assess *'the depth and duration of impaired consciousness and coma'* (Jennett and Teasdale, 1977 p.81). Since then, the GCS has become the preferred assessment tool, in a variety of clinical settings, for evaluating levels of consciousness and as a guide to prognosis.

Performing GCS observations requires a nurse to use skills and proficiencies to assess a person's level of consciousness, interpret the clinical signs and compare with previous recordings. Failure to assess the level of consciousness accurately and take appropriate action in a timely manner may lead to irreversible and serious clinical implications with devastating consequences, especially if acutely/critically ill people are involved. The literature indicates that inadequate education and training of the assessor can negatively impact on the degree of accuracy, confidence and understanding of the GCS (Rowley and Fielding 1991; Ellis and Cavanagh 1992; Shoqirat 2006). Therefore, an accurate assessment of a person's level of consciousness is critical to ensure safe, appropriate and effective practice.

Whilst it may be argued that significant publications and guidelines exist to support practice, a review by Braine and Cook (2016) identified the deficit in evidence and consistency necessary to ensure standardisation of practice. There remains considerable controversy with regards to the optimal site and approach to elicit eye opening and best motor responses. Moreover, clarity is required as to how long the noxious stimulus should be applied. Specifically, published literature is not explicit with regards to whether peripheral/central refers to the anatomical position of the stimuli application or whether the peripheral/central nervous system is the target for stimulation. Braine and Cook (2016) identified the need to establish current practices regarding the application of noxious /painful stimuli to assess both the eye opening and motor response components of the GCS which is the focus of

this study. In 2014, the GCS celebrated its 40th anniversary with a relaunch which saw the reference to painful stimuli change to pressure (Teasdale *et al.* 2014). This change of wording, however, does not alter the fact that the stimulus remains noxious and the observed response relates to pain. This research occurred after this revision of the GCS in 2014, capturing contemporary issues.

Literature review / Background

According to the International Association for the Study of Pain (IASP) pain is defined as “*An unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage*” (Merskey and Bogduk 1994, p210). This implies that pain has both physical and emotional properties, requires consciousness and is mediated by complex neuronal pain pathways. A noxious stimulus, on the other hand, can be defined as “*a stimulus that is damaging or threatens damage to normal tissues*” (IASP 2019). Nociception, the sensory perception of pain of harmful stimuli, may elicit unconscious postural responses as well as other motor reflexes, autonomic and endocrinological responses, without necessarily evoking the experience of suffering.

The stimulation of nociceptors results in the transmission of information via multiple ascending pathways, including the spinothalamic and spinothalamic tracts to higher centres in the brain i.e. thalamus, periaqueductal grey (PAG) and cortical regions (primary and secondary somatosensory cortex, insular, anterior cingulate and prefrontal cortices) (Boore *et al.*, 2017). This information may be modulated by the midbrain and thalamus in the persons response to a stimulus. Moreover, pain processing involves a more complex well-characterised anatomical network known as the descending pain modulatory system, an integrated network of widely distributed regions of the brain that modulates sensory perception and the overall response to pain (Goksan *et al.* 2018). While this complex system is not fully understood, what is known is that the pain experience needs cortico-subcortical interaction (Garcia-Larrea and Bastuji 2018). In people with altered levels of consciousness, localisation of pain is the only motor response considered indicative of conscious perception according to international guidelines (Multi-Society Task Force on PVS 1994; Giacino *et al.* 2002).

As a person's condition deteriorates and they lose the ability to communicate verbally, a noxious stimulus is required to assess the responsiveness to that stimuli. During assessment, perception of pain is determined by evaluating behavioural responses to noxious stimuli and recording the best motor response observed in the upper limbs. In descending order of worsening function, one of five responses is recorded on the GCS:

- Localising, whereby the person touches the part of the body stimulated and may attempt to remove it,
- Flexion characterised by rapid withdrawal and abduction of the shoulder
- Abnormal flexion whereby the limb moves away from the point of stimulation
- Extension with adduction and hyper-pronation of the upper extremities and extension of the legs, or
- No movement at all.

Heron *et al.* (2001), Barlow (2012), and Braine and Cook (2016) argue that the application of a noxious stimulus is the most controversial issue in using the GCS. The most appropriate method to apply a noxious or painful stimulus is not only controversial but is often the cause of much confusion for clinicians in terms of interpreting the response. Several studies argue that the motor sub score, which evaluates cerebral cortex function, is the most important and clinically significant response of the three components of the GCS assessment and therefore the best choice for a level of consciousness indicator (Healey *et al.* 2003; Juarez *et al.* 2005). However, it is contended that the motor sub score is the most difficult and problematic of the GCS sub scores (Guin 1997; Heron *et al.* 2001; Barlow *et al.* 2012). While there remains ambiguity around the application of painful stimuli, evidence exists that can be applied in practice.

Location of noxious stimuli

There is much debate about the application of noxious stimuli to elicit a response when assessing the eye opening (E) or motor (M) component of the GCS, with up to 8 locations identified (Braine and

Cook 2016) with varying efficacy. Six common techniques permeate the literature; earlobe pinch, sternal rub, supraorbital pressure, nail bed pressure, mandibular pressure/ retromandibular or styloid process pressure and trapezius or pectoralis grip. However, few studies have explored the issue of locality and efficacy of stimuli and evidence suggests that there is an inconsistent approach in practice. Waterhouse's (2008) audit of nurses use of the GCS found 89% (n=53) of the nurses working in a neurosurgical unit applied pressure to the side of the finger, other nurses used a combination of methods. Reith *et al.* (2016), used a web-based survey to assess the use of painful stimuli, recruiting UK Nurses and European neurosurgeons and neuro anaesthetists (n=616). They also found a variety of methods used in practice. In an earlier study Starmark and Heath (1988) compared the efficacy of the six common techniques and reported sternum rubbing and retromandibular pressure as the most potent stimuli, and least potent was earlobe and supraorbital pressure. However, Guin (1997), whilst assessing the merit of nail bed pressure, sternal rub & trapezial grip/pinch, found no significant difference in any of the indices among painful stimulus under test conditions. In 2014 the GCS was revised to reflect these variations in practice and advocated the application of painful stimuli to the fingertips, but this has yet to be universally and systematically adopted nationally and internationally.

Combined with the ambiguity of where to apply a noxious stimulus, there is also a lack of clarity about whether a central or peripheral stimulus is the most effective at detecting signs of altered consciousness. Some sources report that the spine responds to peripheral stimuli whereas the brain responds to central stimulus (Edwards 2001; McLeod 2004). Teasdale and Jennett (1974) advises peripheral stimulation such as nail bed pressure for motor and eye opening components of the GCS, later revised to fingertip pressure. More recently, others have supported the use of central stimulus such as trapezius pinch and supraorbital pressure when assessing the motor component and peripheral stimulus for the eye-opening component (Waterhouse 2009; Okamura 2014). However, these two nociceptive pathways ultimately end in the primary somatosensory cortex (Boore *et al.*, 2017). Thus, the location of application may be peripheral or central and distinguishing between peripheral and central stimuli is therefore somewhat irrelevant and unnecessary in practice.

How long to apply noxious stimuli?

The literature is scant in providing evidence or guidance regarding how long a painful stimulus should be applied to elicit a response when using the GCS. Teasdale and Jennett (1974) state that this '*...should be maintained until a maximum response is obtained*' (p. 82). When applying pain to assess components of the GCS, nurses are applying nociceptive pain i.e. peripheral stimulus to nociceptor nerve fibres and observing the processing of the noxious stimulus resulting in the perception of pain by the brain. The patient's response is then recorded accordingly. The nociception process involves four main components; transduction, transmission, modulation and perception. Transduction involves the conversion of the noxious stimulus into electrical energy by a peripheral nociceptor (free afferent nerve ending). Nociceptors are only excited when the stimulus intensity reaches the noxious range. Transmission describes the propagation through the peripheral nervous system via first-order neurons these include small diameter unmyelinated and C fibres (slow conduction velocities of 0.4–1.4 m/s), small thinly myelinated α fibres (fast conduction velocities of 5–30 m/s) terminating in the dorsal horn of the spinal cord. Thus, the speed of transmission is directly correlated to the diameter of axons of sensory neurons and whether they are myelinated. Following the application of a noxious stimuli with a transmission rate of between 2-40 metre/second (7-144 Km/hr) then a pain response is almost instantaneous. Despite this physiological evidence the limited literature on the subject proposes up to, but no longer than, 30 seconds (Lower 1992; Woodward 1997), but most papers do not discuss this critical issue or provide any justification for applying a stimulus for such a duration. While it may take some time for a response to be observed, due to slower processing speeds, this does not impact on the duration of stimulus application.

Knowledge of nurses

Nurses caring for people with an altered level of consciousness requires efficient assessment and evaluation skills and need to be competent in using the GCS. Over the years a small number of studies have examined nurses' knowledge of the GCS and several themes permeate the literature.

Nurses working in intensive/critical care units and emergency departments have reported poor levels of knowledge about the scale (Singh *et al.* 2016). Although with time and experience the nurse knowledge improves (Mater *et al.* 2013; Santos *et al.* 2016; Reith *et al.* 2016). Knowledge and skills obtained from education and experience in the GCS is reported to enhance accuracy and ability to use the GCS tool (Ellis and Cavanagh 1992; Hansen *et al.* 1992; Heron *et al.* 2001; Mattar *et al.* 2013). Additionally, with time, nurses attained more self-confidence in using the GCS (Chan and Mattar *et al.* 2013; Mattar *et al.* 2015) and a more positive attitude was associated with increased self-confidence (Shoqirat 2006). For nurses working in the field of neurosciences evidence suggests that their knowledge of the GCS is inadequate (Jaddoua *et al.* 2013) and that nurses lack confidence in its use (Ehwarieme 2017). More specifically when investigating aspects of the GCS such as assessing eye opening, the evidence suggests that nurses have poor knowledge (Holgate *et al.* 2006; Reith *et al.* 2016; Santos *et al.* 2016).

Despite the physiological evidence, literature indicates variations in location, duration and intensity of stimulus of painful stimuli and no clear guidance on the subject. Yet, it is crucial that the method and location of noxious stimulation used to elicit responses is maintained and recorded, as an inappropriate and insufficient painful stimulus can result in failure to determine the level of consciousness. Crucially, failure to stimulate the central nervous system will not enable arousability and awareness to be assessed, potentially delaying early detection of developing brain complications. Undoubtedly, this has the potential to compromise a person's nursing care and adversely affect their management. This sparked our interest and provided the impetus to explore the application of noxious stimuli when using the GCS and to provide data, and analysis, relating to anecdotal information around this contentious issue.

Methods

Design

A descriptive design was used to determine neuroscience nurse's experiences and perceptions. This enabled the researchers to access neuroscience nurses on an international level. The survey

contained both qualitative and quantitative methods to enable the researchers to tease out and illuminate different dimensions of this subject area. STROBE checklist was used for reporting (See Supplementary File 1).

Sample

Participants were recruited from January to July 2017 using a non-probability, purposive sampling technique. The sample group was recruited into the study based upon specific criteria, convenience sampling (see Table 1). The target population was neuroscience nurses who were:

- Members of the British Association of Neuroscience Nurses (BANN) and European Association of Neuroscience Nurses (EANN) (survey link distributed through the organisations' secretary and via their social media sites)
- Neuroscience nurses in six neuroscience units across the UK (Northern Ireland, Scotland and England). Posters with a QR code to the survey link was used in these units. The researchers were not staff within these units.

Using a sample size calculator that assumed a sample population of 7,125 nurses with a confidence interval of 95%, a sample size of 365 was targeted. This is within a context of no available data on the exact numbers of neuroscience nurses within Europe and the absence of an internationally accepted classification/definition of a neuroscience nurse.

Data collection

The method of data collection was a self-report online questionnaire survey. No suitable pre-existing instrument questionnaire was identified to meet the aim and objectives of this study therefore an assessment tool in the form of a questionnaire was developed drawing on variables from the literature and guidance from an expert panel of senior nurses with experience in working with people with neurological conditions. This enabled content validity to be established. Content validity was established by distributing the questionnaire to a consensus panel consisting of 10 expert neuroscience nurses each with at least 15 years' experience in the area. Amendments to the instruments were made based on their suggestions. The final version had 23-items, comprising of 19

closed statements and four open-ended questions enabling the entry of free text in acknowledgment of the restrictive nature of closed questions. The questionnaire was comprised of three sections. The first section included eight closed-ended questions which collected nurses' demographic information followed by two questions related to the nurses' experience of working in the neuroscience setting (neuroscience specialism they currently work in and years of neuroscience nursing experience). The second section related to the application of noxious stimuli when assessing two components of the GCS: eye opening and motor response, including choice of technique, duration of stimulus and rationale for their method of practice (open response question). The final section asked for the nurses' experience of applying noxious stimuli in terms of complications observed with different techniques and whether they had any concerns about the application of a painful stimulus. The latter provided an open response question to capture those concerns. The questionnaire concluded with an open response question where any further comments regarding the application of painful stimuli in using the GCS could be provided. This ensured any pertinent issues not contained in the previous questions could be captured. Participants were provided with options to select for closed questions and, where relevant, the option of "other" was present for unanticipated responses to be captured.

The questionnaire was administered using a secure web-based survey tool. Responses were anonymously recorded, with respondents asked for personal details of age, gender and geographical location only. Data were collected and stored in accordance with the Data Protection Act (1998), being stored on a computer protected by a password and accessible only by the researchers.

Ethical considerations

Ethical approval was gained from the Research and Governance Ethics Committee in all three Higher Education Institutes at which the researchers are employed. Additionally, each of the six hospitals approved the study through their governance processes following submission for national approval (Health Research Authority (HRA) – reference: IRAS 208540). Finally, BANN and EANN consented to participate based on HEI and hospital approval. Following ethical approval, participant information and web access details of the online questionnaire were forwarded to the secretary for BANN and

other associations for dissemination to members to ensure no breach of data protection and avoid researcher coercion. All participants were provided with on-line participant information to support informed decision making on whether to give or withhold valid consent. Respondents were free to withdraw from the study at any stage without consequence. Each respondent gave consent prior to completing the on-line questionnaire.

Data analysis

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

A total of 273 participants completed the online survey, 48.9% response rate, with 793 accessing the study and 558 consenting to participate. Drop out from the study appeared to occur largely after the demographic questions. As Table 2, illustrates, most respondents 83.9% (n= 229) were female and were aged between 30-49 years 59% (n= 161) with fewer nurses 15.4% (n=46) aged over 50 years. Most nurses were working within the adult neuroscience care setting making up 97.8% (n= 267) of the respondents with the remaining identifying as working in children's and mental health neurosciences settings. Most respondents were from the United Kingdom (UK) (63.7%, n=174) with Australian, Danish and Finnish respondents being the next best represented (12.5% [n=34], 7% [n=19] and 6.2% [n=17] respectively).

The respondents identified that they had undertaken a variety of different types of neuroscience education (Table 2). In-service education was the most prominent form of neuroscience education. However, 31.1% (n=85) of respondents identified they had no neuroscience education, including no in-service induction, study day or other neuroscience programmes. Most of the respondents 65.2% (n=178) had over 6-year experience in neuroscience and 23.8% (n=65) reported having 2-5 years' experience and only 11% (n=30) had less than two years' experience.

Duration of Painful Stimuli

The first clinically focussed question was related to the duration that a painful stimulus was applied. Of those who responded, 50.2% (n=137) of nurses applied the stimulus for less than six seconds, for both eye opening and motor responses. Approximately 40-42% (n=116, n=111 (eye and motor response respectively)) applied the stimulus for 6-15 seconds and 7.3-9.2% (n=20, n=25 (eye and motor response respectively)) reported applying pain for 16-30 seconds. No participant reported applying pain for more than 30 seconds.

Determining Eye Opening Response

In identifying how an eye-opening response is elicited, 71.8% (n=196) of participants use trapezius pinch-grip, with supraorbital pressure being the next most common method (21.6%) (n=59). Pressure to the side of the finger (19%) (n=52), nail bed pressure (16.5%) (n=45) and sternal rub (15.8%) (n=43) featured as the next most prevalent techniques (Table 3). When asked if no response is observed, what action do you take? 46.2% (n=126) of respondents indicated they would record the result. The remainder of respondents applied a further painful stimulus with supraorbital pressure being the most common choice (12.5%) (n=34) (Table 4). When asking for the rationale for the choice of technique, almost half of the respondents indicated that their choice was secondary to how they have been taught or directed by policy/guidelines (25.6%, n=70) and 19% (n=52) respectively (44.6% commutatively) (Table 5). Twenty two percent (21.6%, n=59) responded that it was the most reliable and effective method and 16.8% (n=46) referred to it as being the appropriate technique to elicit a central response. The technique choice was considered least harmful by 12.5% (n=34) and the easiest method by 4.4% (n=12).

Determining Motor Response

Most respondents indicated they would use trapezius pinch/grip 62.3% (n=170) to elicit a response to pain in determining motor response (Table 3), followed by supraorbital pressure (21.2%, n=58), nail bed pressure (18.7%, n=51), pressure to the side of the finger (14.7%, n=40) and sternal rub

(10.3%, n=28). Other methods of eliciting a response were also reported these included; pinching the person's thigh (n=1) and applying pain to the toes (n=1). If no response to the stimulus was observed, 54.6% of the respondents either applied another painful stimulus or sought a second opinion; 45.4% recorded what they observed (Table 4). Several respondents (28.9%, n=79) identified effectiveness as the rationale for their chosen method and 12.8% (n=35) stated 'less harmful' as a rationale (Table 5). Similar to the rationale for choice for eye opening response, a number of respondents cited direction from guidelines/policy and being taught to do it that way as being their rationale (15% [n=41] and 16.1% [n=44] respectively). Ease of application was cited as the rationale for 5.1% (n=14) of respondents.

What to Assess First

When asked whether they assessed eye opening or motor response first, more than half (57.9%, n=158) assessed both components simultaneously, whereas 36.3% (n=99) started with eye opening and 5.9% (n=16) with the motor response. When asked for the rationale for this approach most respondents (24.2%, n=66) cited that it reduced the frequency of painful stimuli and that one form of stimulus can assess both elements effectively (20.9%, n=57). Whilst some made the choice to do both together as it is pragmatic and time saving (7%, n=19), others commenced with eye opening first as this is the way the GCS chart is laid out (13.6%, n=37). Policy/guidelines informed this decision in a minority of respondents (1.5%, n=4) and 8.4% (n=23) indicated their approach was what they were taught to do. Similarly, 6.2% (n=17) took this approach based on their personal preference. Interestingly, 1.8% (n=5) indicated they did not know why they took the approach they did.

Central Versus Peripheral Stimulus

When asking respondents when they would use a central stimulus 67% (n=183) reportedly used this approach to assess eye opening response and 79.1% (n=216) for motor response. However, 40.7% (n=111) and 66.3% (n=181) used a peripheral response for eye opening and motor response assessment respectively. Of note is that 28.9% (n=79) and 21.2% (n=58) of respondents

used a central and peripheral stimulus respectively to assess verbal response; using painful stimuli for the verbal response is not a component of the GCS.

Complications Reported from Applying Painful stimuli

Several complications were reported by participants for each of the techniques for applying a painful stimulus (Table 6). Sternal rub was the most frequently reported technique to result in complications, followed by nail bed pressure and trapezius pinch/grip. The most frequently observed complication was bruising. In some cases, some potentially life-threatening complications were observed such as fracture displacement and rib fractures with the use of the sternal rub and, when applying supraorbital pressure, raised intracranial pressure was reported. Nail bed pressure also resulted in several reported complications ranging from loss of finger nails to damaged nails and sensory loss. However, when applying the stimulus to the side of the finger the complications lessened and similarly when fingertip pressure was applied this resulted in the least number of reported complications. When asked if respondents had concerns related to the application of painful stimuli, 54.6% (n=149) responded that they had concerns. Analysis of these responses resulted in six key themes which are identified in Figure 1.

Discussion

This study provides primary evidence of nurses' experience of the application of painful stimuli when assessing components of the GCS. Indeed, the survey is the largest of any that has explored nurses' experience of the use of the GCS. Whilst Reith et al.'s (2016) survey of nurses and physicians (n=616) from 48 countries found major differences regarding the type of stimulus applied when patients do not obey commands, only 77 nurses took part in the survey. Similarly, Waterhouse (2008) audit of nurses' conduct and recording of observations using the Glasgow Coma Scale involved only 60 nurses from within the UK. No survey has yet quantified the complications observed in applying stimuli. Additionally, while most respondents are from the UK, the study has had an international response that gives a broader representation, albeit from a small percentage of the global neuroscience nursing population.

This study illustrates the use of a variety of forms of applying painful stimuli with trapezius grip being the most prevalent method used. However, results also indicate the existence of ambiguity in neuroscience nurses with regards to the application of painful stimuli in assessing level of consciousness using the GCS, supporting the findings of Singh *et al.*'s (2016) research. This is evident from the self-reported concerns that 55% of participants raised and the variation in where and how long to apply a painful stimulus. Rationale for practice cited indicates this is multifactorial, stemming from perception, education and peer observation. Moreover, this study's findings illustrate that some nurses hold the perception that their approach was best practice, based upon what they had been taught or in accordance with the hospital/ unit policy. This would suggest that an agreed, clear approach to education and policy has great potential to shape practice going forward. Interestingly, a small number of respondents identified ease of application as a rationale. This is congruent with the published literature where Waterhouse (2008) found that 11% (n=7) of neurosurgical nurses used a combination of nail bed, sternal rubbing, and pressure to the trigeminal nerve at the jaw margin whereas nurses working in general clinical areas 48% (n= 29) routinely employed nail bed pressure. Jennett and Teasdale's (1974) original paper advocates initially applying pressure to the fingernail bed and applying noxious stimuli in several ways during a single assessment, and recording the best response observed. This variance is not solely seen in nursing; Reith *et al.*'s (2016) on-line survey of UK Nurses and European neurosurgeons and neuro anaesthetists (n=616) reported substantial variation in approaches to assessing the GCS. These researchers found the frequency of stimuli differed significantly across the two disciplines, with nurses reported to use nail bed pressure most often and supraorbital pressure and retromandibular stimulation pressure least; whilst medical staff reported using sternum rub most frequently. These studies are in contrast to the preference to use trapezius grip found in this study.

There are other clear factors that stand out as contributing to this variance. Firstly, 31.1% of respondents indicated having no neuroscience nursing education; this included no form of induction, study day or in-service education. This is despite 89% of respondents having worked with people

with neurological disorders for more than two years. It is therefore not surprising that ambiguity exists with regards to this component of the GCS. Previous research indicates that knowledge and experience are the most significant factors in determining accuracy of nurses' use of the GCS (Mattar *et al.* 2013; Chan *et al.* 2013). Several respondents cited the rationale for their practice as stemming from being taught to practice in this way or because of local policy/guidelines. Given that Braine and Cook (2016) highlighted the ambiguity in guidelines and education, the disparity of practices found in this study are unsurprising. Combined, the lack of education, or indeed evidence-informed education, alongside the absence of clear, unambiguous, evidence informed guidelines for use of the GCS have contributed to the current situation. There is therefore a distinct need to formalise explicit guidelines for practice that provide the necessary clarity and synergise with nursing education. This must occur within a culture that recognises that if nurses are not provided with specialist knowledge, education and expertise, we cannot expect the desired level of practice. This need is clearly confirmed in the themes arising from the concerns that 55% of respondents had about applying painful stimuli in practice.

A second key finding from this study is that the anecdotally reported complications of application of painful stimuli in using the GCS are now more formalised. There is evidence of complications that are of serious concern such as fractures, fracture displacement, eye injury, sensory loss and loss/damage to finger nails. Iankova (2006) highlights how such actions by practitioners are considered assault or battery, and therefore unlawful. With a wide range of available painful stimuli options available, this could suggest practitioner desensitisation to applying pain, and a lack of risk assessment and/or critical thinking by those who applied the painful stimuli that resulted in these occurrences. For example, the risk of fracture displacement likely could have been anticipated before application of the sternal rub or supraorbital pressure. It is evident that supraorbital pressure and sternal rub should not occur without clear insight into the potential harm that can occur. Guidelines need to incorporate risk assessment to maximise patient safety and to make explicit the potential harm that can occur to people and how this may be interpreted within the law.

We have identified a need for disseminating clarity with regards to the duration of application of painful stimuli, another concern that arose from the findings; approximately half of respondents applied pain for greater than six seconds. This would suggest a lack of dissemination and understanding of the physiological parameters regarding the length of time for noxious stimuli to be relayed to the brain. However, considering several authors have stated that duration of stimuli should not exceed 30 seconds (Lower 1992; Woodward 1997; Edwards 2001) or should be increased for a maximum duration of 10-20 seconds (Waterhouse 2009), this practice, although not evidence-informed, is unsurprising. In addressing this matter, the ambiguity around central and peripheral noxious stimuli can also be addressed; understanding the physiology of pain reception, transmission and processing through effective education and explicit clinical guidelines is the foundation for ensuring that practitioners are not just guided with regards to how to practice but understand the rationale.

The results of the study clearly identify that nurses have concerns with regards to the application of painful stimuli to people in their care. The authors are not aware of any guidelines or education programme that addresses the counterintuitive application of pain to people who are likely to already be suffering in some way. Inflicting pain conflicts with the primary aim of healthcare professionals, to alleviate suffering (Woodrow, 2000), and with nurses' obligation to promote and safeguard the wellbeing of patients by not causing harm (Nursing and Midwifery Council, 2018). No previous study has raised this issue to this extent or led to it being formally addressed, and yet the responses to the survey indicate this to be a global issue for nurses. The challenge this presents to nursing education and practice is how to prepare nurses to reconcile the application of pain in this context. A connecting theme that emerged was with regards to the duration of application of painful stimuli, a factor we have addressed earlier in this discussion; this clarification may go some way towards lessening the anxiety that applying painful stimuli has for nurses.

Nurses also had concerns about the distress family members may experience when observing the application of painful stimuli; the authors are not aware of any guidelines or programme of education

that openly addresses this issue in order that this form of potential harm is minimised. Arguably this may result in an under stimulation for fear of causing harm to the person and distress to the family. Indeed, 12.5%-12.8% of respondents identified this as their rationale for choice of noxious stimuli as it was the one that was least harmful for the person. Given the preponderance of literature that has established the negative impact of neurological conditions such as traumatic brain injury (TBI) and haemorrhage on family caregivers, nurses need to address family caregiver concerns and provide reassurance, emotional support and suitable information to help mitigate against this impact. Indeed, family caregivers have been found to have significant information needs (Coco *et al.* 2011; Hafsteinsdóttir *et al.* 2011; Manskow *et al.* 2018), and failure to meet this need places them at increased risk of anxiety, distress and depression (Brooks *et al.* 1991; Degeneffe *et al.* 2011). Providing information as to the frequency and rationale for the application of appropriate painful stimuli may help to relieve some of their anxieties. Rueckriegel *et al.*, (2015) found that higher levels of interaction by staff with close relatives, e.g. explaining and providing rationales for interventions, improved mental health outcomes in close relatives and this should be emphasised in future guidelines. However, there is an absence of literature that guides educators and clinicians in how to support nurses in developing their coping skills for applying a painful stimulus when it goes against their ethos of practice. Further research and guidance are needed to help practitioners balance rational, clinical decisions with professional values and feelings in order that practitioners are not desensitised to their actions, but also not conflicted and traumatised by actions deemed necessary for a highly important component of assessment in this group of patients.

This research has also highlighted some practices that are unnecessary and, in some cases, may be harmful. The results show that 28.9% (n=79) and 21.2% (n=58) of respondents used a central and peripheral stimulus respectively to assess verbal response. No component of verbal response assessment requires that a painful stimulus is applied, and this may reflect that some nurses were using a painful stimulus to trigger the person to verbalise. Regardless, the results indicate this is relatively common in practice and the ethics and understanding of this aspect of this practice needs to be questioned and explored in more detail. Equally, pinching a thigh to obtain a response is a

cause for concern. With respondents clearly identifying that clinical guidelines are lacking in clarity with regards to how to appropriately assess for responses to painful stimuli, there is clearly a need to identify what is inappropriate and unjustifiable.

Finally, there appears to be a lack of clarity or confidence in how to respond when a patient does not respond to a painful stimulus. In this study, 45.4%-46.2% of respondents recorded what they observed after applying a painful stimulus. Therefore, over 50% went on to apply a second, usually different, stimulus or to seek a second opinion. Guidelines are needed to clarify whether to accept the initial observation or whether there is any clinical significance in whether someone responds to a second stimulus but not a first. The actions in this regard by nurses in this study may also indicate a lack of confidence in their practice which is unsurprising given the issues raised by participants in relation to ambiguity in practices and guidelines.

Limitations

This study was limited in several ways. When conducting online research, there are inherent problems with sampling. Despite attempts to boost the response rate through frequent reminders and advertising through social media and extending the duration of the survey availability, overall, given the potential target audience, the response rate was low, creating coverage nonresponse issues. Moreover, the accuracy of the sampling frame was difficult due to many members of the European neuroscience nursing community not being accessible by email, along with the potential for others, not included in the inclusion criteria, to miss the opportunity to complete the survey. Non-responders may have caused estimators of population characteristics to be biased as those who did not respond may have different views and characteristics to those who responded. Undoubtedly, there are individuals who are more likely than others to complete an online survey whilst others may choose to ignore it, leading to a self-selection bias. Moreover, respondents may have underreported or given favourable responses to avoid criticism (van de Mortel, 2008). The result obtained from this survey

may not be representative of the neuroscience nursing fraternity, however, those who have participated were willing to provide insight to this under researched area.

Recommendations

There are clear recommendations that arise from this study:

1. Clear, evidence informed guidelines for the application of painful stimuli are necessary to inform practice. These should include risk assessment, appropriate practices (including sites of application, duration of application and pressure necessary) while also highlighting what is inappropriate. They should also include content that develops the awareness of practitioners to how observers of practice may be distressed and how to manage this. Finally, these guidelines should also address the complex issue of an intervention that is at odds with the principles and values of professional practice in order that practitioners can reconcile their actions in the best interests of those in their care.
2. We advocate that these guidelines are multi-professional in order that the variance in practices found in this study are addresses. An interprofessional approach would maximise consistency and therefore accuracy.
3. Nurses who care for people with neurological disorders should be prepared to do so through effective education. In respect of the GCS, no nurses should undertake its application without enough knowledge and simulated practice, which address the issues presented in this study.
4. Materials for family and caregivers should be developed to enhance coping skills when observing painful stimuli being applied.

Conclusion

The GCS is a universal ordinal score designed to evaluate changes in level of consciousness and depth and duration of coma. It is used by nurses and other healthcare practitioners for assessing patients, identifying the development of complications and predicting potential degrees of recovery in people with neurological problems. If the GCS is to be used effectively, it is vital that nurses use a consistent approach if interpretation and repeated assessment is to be reliable, and ethical. This

study has revealed great variation in the use of a noxious stimuli when assessing components of the GCS, and, in some cases, identified inappropriate and ineffective methods in contemporary practice. To our knowledge, this study is the first to provide evidence of complications associated with applying a noxious stimulus and highlights the need for clear guidelines. The GCS is often cited as being a simple and easy to use tool; the results of this study indicate this is not the case and that robust education and clinical guidelines are essential to ensure its usefulness through safe, consistent practice.

Relevance to clinical practice

In spite of the longevity of the GCS as a universal accepted clinical assessment tool, there remains areas of confusion and concern, most notably with regards to the safe, evidence-informed application of noxious stimuli to provoke a response. Whatever the clinical setting, nurses need to be educated and alerted to the variability of applying a noxious stimulus and the subsequent consequences. Inadequate and inappropriate use of a noxious stimulus may lead to serious consequences not only for clinical decision-making but also for professional practice.

'What does this paper contribute to the wider global clinical community?'

- This study provides crucial evidence of inconsistencies in the application of painful stimuli when assessing the GCS secondary to the perceived lack of education and robust clinical guidelines.
- Application of a noxious stimulus has the potential to cause harm to people should it be performed inappropriately and without risk assessment and the use of critical thinking skills
- Nurses have several concerns with regards to applying a noxious stimulus which primarily related to concerns of causing harm to people in their care and distress to their family members. This aspect of practice is neglected in current guidelines and educational approaches.

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Conflict of interest

No conflict of interest has been declared by the authors

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