What factors influence nurses' to undertake accurate assessment of performance of the Glasgow Coma Scale?

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Abstract

Aim- To identify influencing factors that have an impact on nurses' performance of the Glasgow Coma Scale (GCS)
Objectives- To appraise contemporary primary research investigating nurses' performance of the GCS, to identify concerning factors that have an impact on nurses' performance of the GCS, to facilitate a more accurate and consistent use of the tool, and to formulate recommendations for optimising its reliability.
Background- The GCS has been routinely used for over 40 years as an objective neurological tool to assess patient's level of consciousness following head injury, however, users have found certain aspects of the GCS confusing despite the accuracy of performance being of utmost importance for patient's safety.
Method- Six databases were searched (2006-2016) to review studies that addressed factors influencing nurses' performance of the GCS.
Findings- Seven studies were identified and critically reviewed. Knowledge and experience were found to be the main factors, issues with accuracy and application of painful stimuli have been highlighted. Scores between healthcare providers were inaccurate.
Recommendations- Educational interventions should be implemented and the Neuroscience Nurse Benchmarking Group (NNBG) guidelines more widely available. To ensure consistency, nurses' taking handover should observe how the GCS was obtained and documented.
Conclusion- This review has found that knowledge and experience are the most significant factors influencing nurses' performance of the GCS. Inconsistencies were found regarding the application of painful stimuli and accuracy of documentation.

Keywords:

Glasgow coma scale; assessment of consciousness; nursing knowledge; competence

Key Points:

1) **There is inconsistency with how painful stimuli is undertaken which could lead to inaccurate assessment of GCS**
2) **Less experienced nurses become uncertain if they obtain a different GCS to what has been previously recorded which could lead to patient deterioration not being identified**
3) **There is a requirement for better education and training as to how to undertake GCS assessment**

What factors influence nurses' to undertake accurate assessment of performance of the Glasgow Coma Scale?

Background

The Glasgow Coma Scale (GCS) was devised by Teasdale and Jennett (1974) as a tool for assessing level of consciousness and to allow staff to communicate this in a clear and objective way. The tool was designed to be simple to use in a variety of healthcare settings by 'all grades of staff', without special training (Teasdale & Jennett, 1974) and to ensure a high inter-rater (IR) reliability of scores between observers (Teasdale *et al*, 1979; Rowley & Fielding, 1991). The GCS is the international standard and is the most widely used form of neurological assessment taught to nurses (Frawley, 1990), however, its apparent simplicity leaves it open to misunderstanding and misuse (Addison & Crawford, 1999).

Published guidelines for the management of head injuries stipulate the use of the GCS for assessment and classification of all head injured patients (NICE, 2014). The national Neuroscience Nursing Benchmarking Group (NNBG) has developed evidence based guidelines for GCS observations. While the benchmarking standards are applied in neuroscience wards, the guidelines are not widely used in non- neuroscience settings.

Various studies have criticised the GCS and questioned its general applicability (Lowry, 1998; Wijdicks, 2006; Zuercher *et al*, 2009; Green, 2011). Sedative drugs interfere with the GCS assessment reducing its reliability for intensive care patients (Brunker, 2006). Barlow (2012) argues that the GCS contains subjective elements, particularly motor and painful stimuli. Gill et al (2004, 2005) have identified that the motor response rating to painful stimuli was problematic to IR reliability and accuracy. Nursing staff use variations of painful stimuli, e.g. ear lobe and jaw margin pressure (Barlow, 2012); such non-standardised practice and inaccurate recordings have potentially serious clinical implications for patient's safety (Edwards, 2001; Fischer & Mathieson, 2001). Coroners are increasingly identifying incidents where the GCS has been used inaccurately and ineffectively in some clinical areas, further underlying the importance of this issue (Baker, 2008).

Question

What factors influence nurses' to undertake accurate assessment of performance of the GCS?

Aim

To identify influencing factors that have an impact on nurses' performance of the GCS

Objectives

- To appraise contemporary primary research investigating nurses' performance of the GCS
- To identify concerning factors that have an impact on nurses' performance of the GCS to facilitate a more accurate and consistent use of the tool
- To develop recommendations for optimising the reliability in the use of the GCS

Methodology

To identify relevant primary research, a systematic search was conducted using the databases Academic Search Complete, CINAHL Plus full text, E Journals, MEDLINE Complete, PsycARTICLES and

PsycINFO. Keywords and Boolean Operators with truncation were used to widen the search and ensure all possible endings for keywords were picked up. The search terms used were 'glasgow coma scale' OR 'conscious* assessment' AND 'nurs*'. After removing duplicates, this initial search strategy generated a total of 22,177 articles. To further refine the search, inclusion/exclusion criteria were added, this generated 2,630 articles.

The Inclusion criteria included:

- Primary research studies
- Published 2006 onwards
- Studies that focus on nurses undertaking the GCS and factors which may influence it
- Peer reviewed
- Written in English
- Adult patients

Exclusion criteria were:

- Non primary studies e.g. reviews, case studies, editorials.
- Studies involving paediatrics

This search, with inclusion and exclusion criteria applied, identified 238 articles. Titles and abstracts were screened for relevance to this review. Of these, 183 were excluded (primary reasons were irrelevance to the topic, and participants were not nurses). 55 studies were considered potentially eligible for this review: their full texts were read and the studies which did not address the research question were excluded. This left a total of six studies from the main search. Due to the limited studies available the electronic search was supplemented with a hand search using the reference lists of the six eligible studies (Holdgate *et al,* 2006; Shoqirat, 2006; Waterhouse, 2008; Chan & Mattar, 2013; Bledsoe *et al,* 2014; Mattar *et al,* 2014), and two relevant systematic reviews (Chan *et al,* 2013; Reith *et al,* 2016). This yielded one further study (Matter *et al, 2013)* which met the inclusion and exclusion criteria. A total of seven studies were identified to review (figure 1).

Critical appraisal tool

To evaluate the quality of the studies, a critical appraisal tool was identified for use. The quantitative critical appraisal tool by Coughlan *et al* (2007) can be applied to both quantitative and qualitative research, so was deemed as appropriate.

Findings

Description of studies

The identified seven studies had different research designs: six had quantitative study designs and one used both mixed methods. Six of the identified studies used convenience sampling with one not stating the sampling method (Waterhouse, 2008). The sample sizes were generally small ranging from 39 to 217 participants. Four studies used questionnaires, one used mixed methods: questionnaire, direct observation and interview, two used prospective observational methods (one using videotaped simulated scenarios and the other using patients in the emergency department (ED)).

The studies were diverse in the factors examined, location and method. Of the seven studies, one examined interrater reliability between ED professionals, one examined the accuracy of the GCS performed by ED professionals, one examined nurses' baseline knowledge, one examined nursing students understanding, and three examined other factors such as the effect of nurses' knowledge, demographic factors, attitudes, and self-confidence on the performance of the GCS. Three of the studies took place in Singapore, two in the UK, one in Australia and one in the USA. The variation in research methods enables an in-depth insight into the factors affecting nurses' performance of the GCS, thus reflecting a range of study methods from interviews, questionnaires, observation and video vignettes (Parahoo, 2014) (table 1)

Themes

Following critical appraisal, four common themes were identified within the findings of the studies. These themes were:

- Application of painful stimuli and interpretation of responses
- Experience and Knowledge
- Self-confidence and attitude
- Comparison with other healthcare professionals

Application of painful stimuli and interpretation of responses

Uncertainty and confusion with regards to the application of painful stimuli is evident in the findings of several of the studies. Waterhouse's (2008) study found that the study participants (n=60) were all able to list the non-recommended methods of stimulation (including sternal rub and nipple tweaking). However, only 47% (n=29) could identify approved methods such as trapezius muscle pinch. Waterhouse (2008) found that 11% (n=7) of nurses on neuro speciality wards used a combination of nail bed, sternal rubbing, and pressure to the trigeminal nerve at the jaw margin. In general clinical areas, 48% (n=29) routinely employed nail bed pressure, while the remaining nurses used sternal rubbing, trapezius pinch, and supra-orbital ridge pressure as both peripheral and central stimulus. Four of the ten nurses who had worked on the neurosurgical unit for >5years regularly used jaw margin compression, compared to more junior nurses, who applied supra-orbital ridge pressure. Twenty percent (n=12) of nurses' applied pain to the centre of the body rather than to the central nervous system. These findings demonstrate inconsistencies and wide variations in the way that painful stimuli are applied in both neuro speciality and general wards. Despite recognition of the non-recommended methods, they were still used. This could be due to a lack of rationale, or not knowing the approved methods to apply. Shoqirat (2006) also identified uncertainty with painful stimuli with 72% (n=28) of 3rd year nursing students within their study unable to answer a question regarding the localisation of pain correctly

Waterhouse (2008) also found that the participants were unsure about understanding and recognising the difference between localisation, abnormal flexion and extension. While nurses working in neurosurgery and neuro intensive care were able to identify the differences, 14 were unclear that they needed to record the highest level of movement from the responses. Neuro intensive care unit nurses are required to perform GCS assessments on a more regular basis compared to nurses on general medical ward and this could explain why there were fewer errors in the neuro speciality wards. Also, 37% (n=22) of the nurses had received additional GCS instruction by attending university modules in neuroscience, critical care or emergency care nursing practice and 35% (n=22) have received education in their clinical area. With regards to documentation and handover, few nurses documented the sum of the components of the GCS, and only 28% (n=17) nurses stated that they performed a set of GCS observations during shift handover.

Experience/ knowledge

Shoqirat (2006) assessed level of knowledge and found that 14 of the 39 (36%) third year nursing students answered the majority of the questions correctly and, of these, 10 had undertaken placements in neurological wards. When asked how confident they felt about their theoretical knowledge of the GCS, 49% (n=19) felt 'a little confident' and 23% (n=9) felt 'not confident'. When asked about their confidence of practical skills in the GCS, 62% (n=24) responded 'not confident' and 18% (n=7) responded 'a little confident'. This suggests that inexperienced users have difficulties using the tool, however, neuroscience placements appear to have a positive influence on knowledge of how to carry out the GCS accurately.

Holdgate *et al* (2006) study also suggested experience was a factor. They found that the level of agreement between doctors and nurses for eye response scores was lower for nurses with less than 2 years' experience (k=0.32; 95% CI 0.36-0.61) compared with more experienced nurses (k=0.75; 95% CI 0.63-0.87). However, the larger sample size of nurses compared to doctors does not allow for accurate comparison. The 18 doctors involved in the study were made up of emergency physicians and trainee doctors in emergency medicine, with at least 3 years' postgraduate experience. Seventy-nine of the 108 patients were assessed by trainee doctors compared to only 32 patients who were assessed by nurses with <24 months ED experience. Seventy-six of patients were assessed by nurses with >24 months' experience compared to 29 patients assessed by emergency physicians. The study does not include information of the nurses past work experience therefore it is difficult to assess their true level of experience of using the GCS. Therefore, it is difficult to ascertain which of the assessors performed the GCS with accuracy. Even so, Bledsoe *et al* (2014) looked at the degree of accuracy between different emergency care professions and found that resident physicians were the most accurate while nurses were the least, despite 60.2% of the nurses having >10 years' experience and 35.4% with 1-10 years of experience.

Matter *et al* (2013) found that nurses' working in a neuroscience setting for 6 years or more scored higher on their knowledge, than nurses' working on general medical wards, whereas nurses' working in neuro-intensive care unit had the highest score of knowledge. The results showed that the type of clinical discipline (P<0.001) and the length of experience in a neuroscience setting (P=0.005) were significant in determining nurses' knowledge of the GCS. This correlates with Chan & Matter (2013), and Matter *et al* (2014), whose data suggested that length of time spent in a neuroscience setting had an impact on nurses' self confidence in using the GCS. Interestingly, Waterhouse (2008) identified that 75% (n=45) of experienced nurses (qualified >2 years) repeatedly made reference to the importance of their intuitive skills giving them a sense of impending neurological change or deterioration that heightened their level of observation and vigilance, irrespective of obvious clinical signs.

Waterhouse (2008) distributed 8 questionnaires to universities across the country and found the GCS is taught during the first year of nurse training, this concurs with 70% (n=42) of the nurses in the study who had received instruction during their first year of training. Students may not relate theory with practical skills until the second or third year of training or they may forget how to perform the GCS unless they experience a neuro speciality placement. Waterhouse (2008) also found that only 16% (n=7) of the nurses, who had received additional GCS training, could recall relevant anatomy.

Self Confidence and attitude

Waterhouse (2008) found less experienced nurses became uncertain when their GCS score did not tally with previous recordings, attributing it to their inexperience rather than changes in patient condition. This suggests a lack of confidence in their ability to perform the GCS accurately. Mattar *et al* (2014) investigated nurses' self-confidence and found the most significant factors influencing self-confidence were clinical discipline ($P<0.001$), length of time in neuroscience setting ($P<0.001$), advanced diploma or post-basic education ($P<0.027$) and length of time working in current discipline. Similar results were found as factors influencing nurses' attitude towards the GCS, these were clinical discipline ($P<0.003$), length of time in neuroscience setting ($P<0.001$) and length of time in nursing ($P=0.0028$). Overall, positive correlations were found between self-confidence and attitudes towards the GCS ($P<0.001$). This data indicates that the length of time spent in nursing, working in a neuroscience setting and a more positive attitude towards the GCS are factors contributing to a nurse's self confidence in using the GCS.

Chan & Matter (2013) compared two groups of nurses with different demographics ($P=0.531$), age, years of experience, education, and clinical discipline, and compared this to their knowledge, attitude and self-confidence. "Cluster A" consisted of 55 nurses, a majority were aged 21-25 (74.5%, n=41) with 74.5% (n=41) educated to diploma level, 87.3% (n=48) were junior nurses, 47.3% (n=24) worked in neuroscience setting, 43.6% (n=24) worked in general medicine and 89.1% (n=49) have worked in their current discipline for <2 years. Nurses in "Cluster B" (n=59) a majority had more work experience (>6 years, n=43, 72.9%), educated to degree level and above (n=31, 52.5%), worked in current discipline for over 3 years (n=41, 69.5%) and aged 26-36+ (n=59, 100%). Nurses in "Cluster B" showed higher average scores than "Cluster A" for knowledge ($P=0.002$), attitudes ($P<0.001$), and self-confidence ($P<0.001$), again reinforcing the importance of clinical exposure and experience.

Comparison with other health care professionals

Holdgate *et al* (2006) found that the level of IR agreement in GCS scores between emergency department (ED) doctors and nurses was generally high, although a significant number of total GCS scores differed by two or more points. IR reliability was excellent for verbal ($k= 0.79$; 95% CI, 0.71-0.86) and total scores ($k=0.76$; 95% CI, 0.69-0.83), intermediate for motor ($k= 0.75$; 95% CI, 0.64-0.86) and poor for eye scores ($k= 0.64$; 95%CI, 0.52-0.77). Compared with nurses, doctors trended towards lower scoring for eye response, and higher scores for motor and total scores. In subgroup analysis, agreement between doctors and nurses for eye scores was lower for nurses' with < 24 months' experience ($k=0.32$; 95% CI, 0.36-0.61) compared with more experienced nurses' ($k=0.75$; 95% CI, 0.63-0.87). The level of experience of the doctors included trainee doctors with 3 years post graduate experience to senior doctors. In many ED's junior medical staff may be involved in GCS scoring and management when senior medical staff are unavailable, and nurses are responsible for the ongoing measurement of GCS scores; this may influence the outcome of the GCS assessments

and IR reliability. Emergency departments can be busy, and unpredictable workload pressures may also influence assessments. Additionally, the participants were instructed to score within 15 minutes of each other: any interventions within this time period, for example, applying oxygen to the patient, could have potentially altered the patients GCS.

Bledsoe *et al* (2014) with the use of 10 video vignettes, found resident physicians (n= 22) were the most accurate in using the GCS and nurses (n=82) were the least. The overall total GCS scoring accuracy for all of the professionals was 33.1% (95% CI, 30.2-36.0). The highest accuracy was observed on the verbal component (69.2%; 95% CI, 67.8-70.4), eye opening was the second most accurate (61.2%; 95% CI, 59.5-62.9), and the least was the motor component (59.8%; 95% CI, 58.1-61.5). A majority of the nurses (60.2%, n=50), had >10 years of experience compared to the resident physicians who had < 10 years' experience. The use of video vignettes where the participants score the GCS, increases the level of control and reduces variability of assessments, however, the hypothetical scenarios and the use of young actors may not accurately represent the patient population.

Discussion

This review has found two key factors that may affect nurses' performance of the GCS; experience and knowledge and has also highlighted that there are issues with accuracy and the application of painful stimuli. There is a large evidence base investigating the GCS, however, it is limited surrounding nurses' performance. Although the number of studies included in this review are small, they share common themes. All seven studies suggest that nurses' clinical experience has an influence on performance of the GCS, and five studies suggest that theoretical and practical knowledge also does.

Shoqirat (2006) provides strong evidence that inexperienced users have difficulties using the tool. This is supported by other studies which found that the majority of students or new practitioners have some misunderstanding of the GCS and are unable to use it accurately (Fielding & Rowley, 1990; Elliott, 1996; Addison & Crawford, 1999; Lowry, 1998) and does not support the premise that the GCS should be easy to use by all grades of staff (Teasdale & Jennett, 1974). On the contrary, Janosik & Fought (1992); Prasad (1996); and Crossman *et al* (1998) found experience not to be a factor with experienced users making errors (Bassi *et al* 1999). These studies support that reliability should be independent of experience, however, Bazarian *et al* (2003) and Kelly *et al* (2004) suggest inexperience may affect reliability and consistency. Fairley & Cosgrove (1999) found inconsistencies of GCS scoring in their neuroscience unit despite the findings of Waterhouse (2008) who found neuroscience units had the least errors in knowledge and scoring. This could be because the GCS is used on a more regular basis and gain an insight into its application in different types of patients which may not occur for nurses on general wards (Gocan & Fisher, 2005). Holdgate *et al* (2006) and Bledsoe *et al* (2014) highlighted the issues with IR agreement and accuracy of recording between healthcare professionals. Studies have shown high rates of IR reliability and accuracy when the GCS is conducted by experienced nurses compared to lesser experienced nurses (Fielding & Rowley, 1990; Rowley & Fielding, 1991; Ellis & Cavanagh, 1992). Contrary to this, Heron *et al* (2001) reported significant differences in age and education. Younger nurses were found to be more accurate in their use of the GCS. A younger nurse may have more experience compared to an older nurse if they entered the profession later in life. Nurses with critical care qualifications were found to be less accurate compared to nurses holding undergraduate degrees and diploma qualifications. These findings are surprising as it would be expected a nurse specialised in critical care knowledge and practice would perform better in GCS.

Bledsoe *et al* (2014) found nurses were less accurate when compared with other health care professionals despite having more years of experience, however, overall accuracy between providers of various levels was poor. Holdgate *et al* (2006) identified that when compared with other health care professionals, nurses have a moderate to high agreement rating, however, there were still instances of disagreement between nurses and doctors. This is similar to studies by Gill *et al* (2004), and Juarez and Lyons, (1995) who tested IR reliability and found agreement was generally lower. Menegazzi *et al* (1993) found excellent reliability for GCS scores of 14-15, but poor agreement for mid-range and low GCS scores. This differs from Holdgate *et al's* (2006) study where there was no significant difference in agreement across the range of GCS scores. Differences with other studies could be accounted for by fluctuations in responsiveness following acute injury (Mclernon, 2014). However, there does seem to be discrepancies in ability to interpret patient responses which will lead to inaccurate patient assessment.

Self- confidence has been shown to be a predictor of skill performance (Moores & Chang, 2009), Chan & Matter (2013) and Matter *et al* (2014) found experience positively improves self-confidence in using the GCS. This is supported by Shoqirat (2006), who showed that nursing students with positive attitudes were more self-confident in using the GCS. There is however, a lack of research on nurses' self-confidence and the GCS to support the studies by Chan & Matter (2013) and Matter *et al* (2014). Benner & Tanner (1987) found experienced nurses use intuition with their practice; this concurs with Waterhouse's (2008) findings that experienced nurses used their intuitive skills. However, assessment of level of consciousness should be based on objective data not subjective. Another reported source of error in using the GCS is one observer following the results of another (Frawley, 1990), this could occur when the nurse is unable to interpret the results or unwilling to accept a change in the patient's condition. Waterhouse (2008) also found that less experienced nurses became unsure when their recordings did not match and attributed this to lack of experience.

This review has demonstrated that knowledge plays an important role in GCS performance. Ellis & Cavanagh (1992) reported few nurses understood the mechanism underpinning the GCS assessment which would enable them to act appropriately when the patient's condition changes. This results in patients changing neurological state not being identified early enough to be either life-saving or prevents further brain insults. The use of non-recommended methods of applying stimuli are still being used in practice (Waterhouse, 2008), and should be avoided as this can result in unnecessary bruising and prolonged residual discomfort (Teasdale & Jennett, 1974; Fairley & Cosgrove, 1999; Waterhouse, 2005). NICE (2014) suggests that deterioration of motor response by 1 point, a drop of 3 points in the eye opening or verbal response, or an overall deterioration of 2 points in the GCS is of clinical significance. The differences in first assessment GCS scores of 1 or 2 points between assessors in Holdgate *et al's* (2006) study, indicates the importance of accurately scoring a baseline to enable recognition of deterioration.

Limitations

There is limited research focusing on nurses' performance of the GCS. The studies in this review had small sample sizes, used convenience sampling and were not multi-centred. Many of the studies were self-report questionnaires which can introduce response bias and limit generalisability of results.

Recommendations

This review has provided useful information that could contribute to the enhancement of nurses' GCS in practice. To improve accuracy, new nurses should perform the GCS under observation by an

experienced mentor, having the opportunity to practice and gain feedback so that they can develop confidence in using the tool (O'Farrell & Zou, 2008). To ensure consistency with documentation, the nurse taking handover should observe how the GCS score was obtained and documented; this is considered good practice in the NNBG benchmark (Waterhouse, 2008). When recording and reporting the score, each component should be recorded, not just the total. There is a need for more explicit guidelines so access to NNBG guidelines should be more widely available.

Further research focusing on trends of nurses' GCS scoring and whether nurses who receive additional training perform more accurately using larger sample sizes, multiple hospitals and clinical areas throughout the UK would be useful. Qualitative research would be beneficial investigating why nurses experience difficulty in using the GCS.

This review has highlighted the importance of training and education required to maintain knowledge and skills in performing the GCS. The implementation of a standardised method of training to perform GCS scoring could improve reliability of measurements. Evidence suggests formal training taught by expert neuroscience nurses are effective in improving assessment skills (Hansen *et al,* 1992), confidence (Chan & Matter, 2013; Matter *et al,* 2014) and understanding the significance of their findings. The GCS should be taught through pre-registration programmes, in conjunction with simulating practice, so that pre-registration nursing students are able to link theory to practice prior to qualifying and practice this skill in a safe environment.

This review has highlighted the confusion surrounding the application of painful stimuli, which affect care given to patients. Clarification on the type, degree and indications for applying stimuli is required. Standardisation of applying stimuli is essential to reduce variation and discrepancies in the way that painful stimulus is applied. Painful stimulus should only be applied when the patient shows no response to voice or commands, and the non-recommended methods must be avoided (Teasdale & Jennett, 1974; Fairley & Cosgrove, 1999). Ideally the same nurse should perform the GCS assessment throughout the shift to ensure continuity and consistency.

Conclusion

In conclusion, this review has found that knowledge and experience are the most significant factors influencing nurses' performance of the GCS. Inexperienced users have found certain aspects of the GCS confusing and can doubt their findings if the findings differ from previous assessments. Inconsistencies have been found regarding application of painful stimuli and documentation. The studies showed that the GCS scores can be inaccurate and vary between healthcare providers therefore the GCS should not be used alone as a basis for clinical decisions as the varying levels of disagreement between scores may create inaccuracies. Patients requiring frequent neurological assessment must be looked after by nurses who have the appropriate knowledge and experience of the GCS; this review has shown that there is a clear need for ongoing education and exposure to neurological assessment to ensure accuracy of assessment and confidence in nurses undertaking this skill.

Reference List

Addison,C., Crawford,B. (1999) Not bad, just misunderstood. *Nursing Times*. 95 (43): 52- 53

Baker,M. (2008) Reviewing the application of the Glasgow Coma Scale: Does it have interrater reliability? *British journal of neuroscience nursing*, 4 (7): 342-347

Barlow,P. (2012) A practical review of the Glasgow coma scale and score. *The Surgeon* 10 (2): 114-119

Bassi,S., Buxton,N., Punt,J,A., O'Reilly,G. (1999) Glasgow Coma Scale: a help or a hindrance. British *Journal of Neurosurgery*. 13(5):526-539

Bazarian,J,J., Eirich,M,A., Salhanick,S,D. (2003) The relationship between pre-hospital and emergency department Glasgow Coma Scale scores. *Brain Injury*. 17 (7):553-560

Benner,P., Tanner,C. (1987) How expert nurses use intuition, *American Journal of Nursing* 87 (1):23-31

Bledsoe,E,B., Casey,J,M., Feldman,J., Johnson,L., Diel,S., Forred,W., Gorman,C. (2014) Glasgow coma scale scoring is often inaccurate. *Prehospital and Disaster Medicine* 30(1):46-53

Brunker,C. (2006) Assessment of sedated head-injured patients using the Glasgow Coma Scale: An Audit. *British journal of neuroscience nursing.* 2 (6): 276-280

Chan, F,M., Matter,I. (2013) Investigating nurses' knowledge, attitudes and self-confidence patterns to perform the conscious level assessment: A cluster analysis. *International journal of nursing practice.* 19 (4):351-359

Chan,F,M., Mattar,I., Taylor,J,B. (2013) Investigating factors that have an impact on nurses' performance of patients' conscious level assessment: a systematic review. *Journal of nursing management*. 21(1) 31-46

Coughlan,M., Cronin,P., Ryan,F. (2007) 'Step-by-step guide to critiquing research'. Part 1: Quantitative research. *British journal of nursing*. 16(11): 658-63

Crossman,J., Bankes,M., Bhan,A., Crockard,H,A. (1998) The Glasgow Coma Scale: reliable evidence? *Injury.* 29(6): 435-437

Edwards,S,J. (2001) Using the Glasgow Coma Scale: analysis and limitations. *British Journal of Nursing.* 10 (2): 92-101

Ellis, A., Cavanagh,S,J. (1992) Aspects of neurological assessment using the Glasgow Coma Scale. *Intensive and Critical Care Nursing*. 8 (2):94-99

Fairley,D,F., Cosgrove,J,A., (1999) Glasgow Coma Scale: improving nursing practice through clinical effectiveness. *Nursing in Critical Care*, 4 (6): 276-279

Fielding,K., Rowley,G. (1990) Reliability of assessments by skilled observers using the Glasgow Coma Scale. *Australian Journal of Advanced Nursing*. 7(4):13-17

Fischer, J., Mathieson, C. (2001) The history of the Glasgow coma scale: implications for practice. *Critical care nursing quarterly.* 23(4): 52-58

Frawley,P. (1990) Neurological observations, *Nursing Times* 86(35):29-34

Gill,M,R., Reily,D,G., Green,S,M. (2004) Interrater reliability of Glasgow Coma Scale scores in the emergency department. *Annals of emergency medicine*. 43(2):215-223

Gill,M., Windemuth,R., Steele,R., Green,S,M. (2005) A comparison of the Glasgow Coma Scale score to simplified alternative scores for the prediction of traumatic brain injury outcomes. *Annals of Emergency Medicine*. 45(1):37-42

Gocan,S., Fisher,A. (2005) Ontario regional stroke centres: Survey of neurological nursing assessment practices with acute stroke patients. *Axone,* 26 (4): 8-13

Green,S,M. (2011) Cheerio, laddie! Bidding farewell to the Glasgow Coma scale. *Annals of Emergency Medicine*. 58(5) :427-430

Hansen,R., Norris,H., Sceriha,N. (1992) The effectiveness of education on the performance of neurological observations: a collaborative study. *Australasian Journal of Neuroscience,* 5: 1-9

Heard,K., Berbata,V,S. (2004) Reliability of the Glasgow Coma Scale for the emergency department evaluation of poisoned patients. *Human and Experimental Toxicology*, 23(4): 197–200

Heron,R., Davie,A., Gillies,R., Courtney,M. (2001) Interrater reliability of the Glasgow coma scale scoring among nurses in sub-specialities of critical care. *Australian Critical Care* 14(3): 100-105

Holdgate,A., Ching,N., Angonese,L., (2006) Variability in agreement between physicians and nurses when measuring the Glasgow coma scale in emergency department limit its clinical usefulness. *Emergency medicine Australasia* 18 (4): 379-384

Janosik, M., Fought,S. (1992) The Glasgow coma scale: observer variability and correctness of scores. *Heart Lung.* 21(3): 291-292

Kelly, C,A., Upex,A., Bateman,D,N. (2004) Comparison of consciousness level assessment in the poisoned patient using the alert/verbal/painful/unresponsive scale and the Glasgow Coma Scale. *Annals of emergency medicine.* 44(2): 108-113

Lowry,M. (1998) Emergency nursing and the Glasgow Coma Scale. *Accident and Emergency Nursing*. 6(3): 143-148

Matter,I., Liaw,Y,S., Chan,F,M. (2013) A study to explore nurses' knowledge in using the Glasgow coma scale in an acute care hospital. *American association of neuroscience nurses* 45(5):272-280

Matter,I.,Liaw,Y,S.,Chan,F,M. (2014) Nurses' self-confidence and attitudes in using the Glasgow Coma Scale: a primary study. *British association of critical care nurses* 20(2):98-107

Mclernon,S. (2014) The Glasgow Coma Scale 40 years on: a review of its practical use. *British journal of neuroscience nursing* 10(4):179-184

Menegazzi, J,J., Davis,E,A., Sucov,A,N., Paris,P,M. (1993) Reliability of the Glasgow Coma Scale when used by emergency physicians and paramedics. *Journal of trauma and acute care surgery.*34:46-48

Moores,T,T., Chang,J,C. (2009) Self-efficacy, overconfidence and the negative effect on subsequent performance: a field study. *Information Management. 46: 69-76*

NICE (2014) Head Injury: Assessment and Early Management of Head Injury Clinical Guideline 176. NICE, London.

O'Farrell,B., Zou,G,Y. (2008) Implementation of the Canadian Neurological Scale on an Acute Care Neuroscience Unit: A Program Evaluation. *Journal of Neuroscience Nursing,* 40(4): 201–211

Parahoo,K. (2014) *Nursing research, principles, process and issues.* 3rd ed. Palgrave Macmillan: Basingstoke

Prasad,K. (1996) The Glasgow Coma scale: a critical appraisal of its clinimetric properties. *Journal of clinical epidemiology*. 49(7):755-763

Reith,M,C,F., Brande,D,V,R., Synnot,A., Gruen,R., Maas,R,I,A. (2016) The reliability of the Glasgow coma scale: a systematic review. *Intensive care med* 42(1):3-15

Rowley,G., Fielding, K. (1991) Reliability and accuracy of the Glasgow coma scale with experienced and inexperienced users. *Lancet* 337: 535-538

Shoqirat,N (2006) Nursing students' understanding of the Glasgow Coma scale. *Nursing Standard* 20 (30): 41-47

Teasdale,G., Jennett,B. (1974) Assessment of coma and impaired consciousness. *Lancet* 2 :81-4

Teasdale,G., Murray,G., Parker,L., Jennet,B. (1979) Adding up the Glasgow Coma Scale. *Acta neurochir suppl (Wein).*28(1): 13-6

Waterhouse,C. (2005) The Glasgow coma scale and other neurological observations. *Nursing standard* 19(33): 56-64

Waterhouse,C. (2008) An audit of nurses' conduct and recording of observations using the Glasgow coma scale. *British journal of neuroscience nursing* 4(10): 492-499

Wijdicks,E,F,M. (2006) Clinical scales for comatose patients: the Glasgow Coma Scale in historical context and the new FOUR Score. *Reviews in Neurological Diseases*. 3(3): 109-117

Zuercher,M., Ummenhofer,W., Baltussen,A., Walder,B. (2009) The use of Glasgow Coma Scale in injury assessment: a critical review. *Brain Injury*. 23(5): 371-384