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The Reaction Level Scale - Useful tool or just another scale?

Malcolm Elliott Dip.Health Sci (Nurs), BN, MN, IC Cert
Clinical Nurse Specialist, Intensive Care Unit, Westmead Hospital

Abstract

The Glasgow Coma Scale is the tool currently used in Westmead Hospital to assess patients' neurological status. Whilst this tool has received international acceptance and is generally considered to be the "gold standard" of neurological assessment tools, it does have its limitations. One of the major ones is its limited ability to assess patients who have an artificial airway insitu, which comprises the assessments of the majority of patients admitted to intensive care units.

It therefore seems appropriate to investigate an alternative neurological assessment tool. The Reaction Level Scale is an eight step ordinal scale designed to assess patients' level of responsiveness. It was designed in Sweden in 1985 and is reported[18] to be just as reliable as the Glasgow Coma Scale.

Whilst overseas studies have been performed on the Reaction Level Scale, no Australian trial has yet been reported in the literature. The Swedish creators of the Reaction Level Scale suggest[17] that studies on reliability be performed by clinical departments before they adopt the Scale as an assessment tool. 'When speaking of the reliability of a coma scale, one expects that assessments on the same patient by different observers...must, at least on a large number of cases, coincide'. The investigator has therefore explored the interrater reliability of the Reaction Level Scale, using Kappa analysis. This study has found the Reaction Level Scale to have high interrater reliability.

Key Words: Reaction Level Scale, interrater reliability, kappa analysis

Introduction

The Glasgow Coma Scale (GCS) is the tool currently used in Westmead Hospital to assess patients' neurological status. It is most frequently used in the Intensive Care Unit, the Emergency department and the neurosurgical wards. Whilst this tool has received international acceptance as a neurological assessment tool, it does have its limitations. One if the main ones is its limited ability to assess patients who have an artificial airway (endotracheal tube, tracheostomy) insitu.

The Reaction Level Scale (RLS 85; see figure 1) is a tool which can be used to assess patients' neurological status, including those who are intubated. Its assessment criteria is similar to that found in the GCS, but it is combined into one single line scale, rather than three separate scales (eye/motor/verbal). Although the scales contain many similarities, there are some differences:

- delay of response is an added item in the RLS 85 in order to differentiate between Levels 1 and 2[18].
- the intensity of stimulation differentiates Levels 2 and 3 in the RLS 85 (compare the eye scale in the GCS)[18].
- supraorbital pain stimulation in the original GCS is replaced by retromandibular pain stimulation in the RLS 85[18].
- the eye-opening measure in response to pain in the GCS is replaced by visual contact or orientating eye movements in the RLS 85[18].
- 'purposeful warding off of pain stimuli' is an added motor response in the RLS 85[18].
- the levels of 'incomprehensible sound' and 'inappropriate words' in the GCS verbal scale are discounted in the RLS 85; however, the ability or inability to express single words is incorporated in the coma definition of the RLS 85[18].
- two internationally recognised coma limits are accounted for in the RLS 85: Levels 3 to 4 and 4 to 5, respectively[18].

The major advantages of the RLS 85 include:

- it has good inter-observer agreement when tested in different neurosurgical departments and for all kinds of personnel in a neurosurgical ward responsible for direct care of the patient[15].
- it can be used accurately in neurosurgical disorders involving disturbed consciousness; tumour cases being more variable.
- it has good reliability over all reaction levels[18].
- it can be used for accurate delineation of coma[15].

The advantages of the RLS 85 when compared with the GCS include the following:

- patients who have an artificial airway insitu can be assessed in a reliable and valid way.
- "improved discriminatory ability across all levels of consciousness. By weighting separate responses on the eye, motor and verbal categories and combining the information into a single eight-step scale, the RLS 85 removes the

Figure 1 - THE REACTION LEVEL SCALE[17]
(reproduced with permission, Starmark and *Acta Neurochirurgica*)

1.	Alert No delay in response	**Alert**: Not drowsy, orientated (intubated patient: no signs of delay in reaction)
2.	Drowsy or confused. Responsive to strong stimulation. *Light stimulation:* approaching the patient verbally or by touch.	**Drowsy**: the patient is drowsy if he feels or seems drowsy and shows delay in action. **Confused**: if the patient gives the wrong answer to at least 1 or the 3 questions: a) what is your name? b) where are you? c) what year and month is it?
3.	Very drowsy or confused Responsive to strong stimulation *Strong stimulation:* repeated loud verbal approach, shaking or pain stimulation.	**Mental responsiveness**: Arousable - performs at least 1 of the following: oral response with words, orientating eye movements, obeying commands, warding of pain **Orientating eye movements**: eye opening with eye contact and some attempt at orientating eye movements **Obeying commands**: at request the patient performs a specific movement, eg. 'Lift up your arms', 'put out your tongue', 'open/close your eyes'. **Warding off pain**: the patient localises pain and makes an active attempt to remove the painful stimulus.
4.	Unconscious Localises but does not ward off pain	**Unconscious**: no mental response. Cannot perform any activity under mental responsiveness. **Localises pain**: the patient is examined lying on his back with arms resting along the sides of his body. a) on retromandibular stimulation, the patient moves one hand above chin level. b) on pain stimulation of the nailbed of one hand, the patient moves the other hand across the midline.
5.	Unconscious Withdrawing movements on pain stimulation	**Withdrawing movements**: a) on retromandibular pain stimulation, the patient turns away his face, or b) on pain stimulation of the nailbed, the patient does not localise the pain stimulus but makes clear withdrawing movements.
6.	Unconscious Stereotype flexion movements on pain stimulation	**Stereotype flexion movements**: a) on retromandibular pain stimulation, or b) pain stimulation of the nailbed the patient makes slow and mechanical flexion movements of elbows and wrists, but not localising or withdrawing movements.
7.	Unconscious Stereotype extension movements on pain stimulation	**Stereotype extension movements**: a) on retromandibular pain stimulation, the patient turns away his face, or b) on pain stimulation of the nailbed, the patient makes extension movements, straightening his arms and legs NB: no flexion movements must be observed. If both flexion and extension movements occur, the best response will be recorded.
8.	Unconscious No response on pain stimulation	**No response to painful stimulation**: on repeated strong pain stimulation, retromandibular or fingertip, the patient does not respond with any movement of either arms, legs or face.

problems with the reliability and validity of the GCS sum scores, especially for middle range scores" [14].

- "because it captures the theoretic framework of levels of consciousness more comprehensively, the RLS 85 creates a clearer picture of neurological behaviour across the responsiveness continuum and minimises the ambiguity of the middle-range scores"[14].
- significantly better interobserver agreement than the GCS sum score and the eye/motor/verbal profile[18].
- increased interrater reliability of neurological assessments.
- an improved means of assessing patients with artificial airways insitu.

Literature Review

Since its introduction in 1974, the Glasgow Coma Scale has received international acceptance as a neurological assessment tool[5]. This status is not easily achieved, and research[5,24] has been done to establish the reliability and validity of the GCS.

Despite its widespread acceptance and established reliability and validity, the GCS has received many criticisms. Patients who are unable to verbalise due to: an artificial airway, dysphasia, deafness, or who do not speak English, lose four points on the scale[2,7,17,22]. This is one of the major limitations of the GCS. Although the Scale allows for these patients to be "acknowledged", it does not suggest a way to assess them, such as the Innsbruck Coma Scale[14], Clinical Neurological Assessment tool[3] and Reaction Level Scale[17] do.

The psychometric properties of the Glasgow Coma scale are weak because it fails to provide clear definitions of levels of consciousness and behavioural indicators for consciousness[14]. This makes the GCS very inadequate for monitoring head injured patients at risk of deterioration as it is insufficiently sensitive[2,3,12]. Omitting definitions of the assessment criteria is a significant flaw amongst coma scales, as it encourages subjective assessment of the patient. This limitation is also apparent in other scales, such as the Innsbruck Coma Scale and the Clinical Neurological Assessment tool, and may be the reason for the suspect accuracy of the ratings obtained by practitioners with limited training and experience with the GCS[13].

The GCS is weakest where clinical prognostication is most difficult and monitoring most important for influencing quality of survival[14]. The prognosis of patients with low (3-5) or high (9-15) GCS sum scores is much more apparent than those with middle range scores (6-8). As is the case with some other scales (Innsbruck Coma Scale, Clinical Neurological Assessment tool, Comprehensive Level Of Consciousness Scale, Glasgow-Liege Scale), the inclusion of brain stem indicators greatly enhances a scale's ability to predict outcome.

The GCS was originally intended to be used as three separate scores (eye/motor/verbal). Many clinical settings have adopted the use of a total or sum score, which has been shown to have low reliability[16]. Two patients can have the same GCS sum score yet neurologically be quite different. For example, a sum score of 9 in the GCS may be made up of eighteen different combinations[21]. Although all of these combinations may not be seen in the clinical area, it emphasises the point that when describing the state of an individual patient...it is important to convey the maximum information by considering each response separately[23]. The original purpose of the sum score was in fact as a statistical and research tool[1].

The GCS is obviously of limited value in paediatric patients[10]. In children, the pain and terror of injury often results in the youngster holding his [sic] eyes tightly closed, refusing to follow any commands, and at best only localising a painful stimulus[2]. It would also be unreasonable to expect a child to know certain relevant information required to assess their orientation. Other scales, such as the Children's Orthopedic Hospital and Medical Center coma scale[10], which assesses brain stem function but not eye opening or verbalisation, may be more appropriate for assessing children.

With senility, a low GCS score only indicates the significance of age rather than the true severity of the injury[2]. A patient who has a permanent neurological deficit due to their age or the presence of a chronic neurological disease (such as Alzheimer's disease) may "normally" have a low GCS score.

The GCS has limited applicability for assessing level of consciousness in patients who are hemiplegic, aphasic, or who have sustained a concurrent spinal-cord injury[6]. A patient with any one or more of these three deficits, cannot be assessed validly with at least one third of the eye/motor/verbal profile. Furthermore, the motor response score accounts for almost all the predictive power of the GCS[7]. Thus, the predictive power of the GCS is lost if the patient has a limb weakness that is not caused by an intracranial lesion.

As the GCS has many limitations, it seems appropriate to investigate an alternative neurological assessment tool. The Reaction Level Scale is an eight step ordinal scale of common domain designed to assess patients' level of consciousness. The RLS 85 was designed in Sweden in 1985, and is reported to be just as reliable as the GCS[17,18].

The Swedish societies of Neurosurgery, Anaesthesiology and Intensive Care have recommended replacement of the GCS with the RLS 85 in Swedish hospitals[20]. Although studies have

reported the RLS 85 to be a useful tool, the research papers are few in number, and the majority of them are European. As yet, no Australian trials of the RLS 85 have been reported in the literature. The Swedish authors suggest that studies on reliability be performed by clinical departments before they adopt the RLS 85 as an assessment tool[17]. Segatore and Way[14] "strongly support extensive clinical testing of alternate instruments that contain brainstem indicators". An Australian trial of the RLS 85 has therefore been performed.

Methodology

Purpose

The purpose of this study was to determine the interrater reliability of the Reaction Level Scale.

Hypothesis

The Reaction Level Scale will display the same or greater interrater reliability (K = 0.65), as that determined in previous studies[15].

Sample

A convenience sample of patients who had had any form of head injury and/or cerebral event (such as neurosurgery) and who were intubated (endotracheal tube or tracheostomy tube) was used. These were patients who were admitted to the intensive care unit, neural science high dependency unit and the neurosurgical ward of Westmead Hospital, over an eight month period. The exclusion criteria were: patients with any form of spinal cord injury, chemical paralysis/barbiturate coma and patients who do not comprehend the English language. Consideration was given to stratifying the sample to enable assessment across the RLS 85's scale range. However, given time constraints and limited patient availability, this was not done.

Sample Size

In a previous study[15] of the Reaction Level Scale, the four contributing clinical departments included a total of eighty-eight patients in the trial. Each department, therefore, included an average of twenty two patients in the study. As this study is a semi-replication study, the total number of patients (22) included, is the average of the number of patients assessed by the four clinical departments in Stalhammar's study[15]. Each patient was assessed twice, with a minimum of twenty four hours between assessments.

The age range of the sample was nineteen to seventy years of age, with a mean of forty one years. Ten females and twelve males were included in the study. Nine of these patients had spontaneous intracranial haemorrhages (subarachnoid, intracerebral, extradural, subdural, intraventricular) secondary to cerebral aneurysms or arteriovenous malformations. Eight patients suffered traumatic head injuries (haemorrhage and/or contusions/oedema) secondary to motor vehicle accidents or physical assault. Two patients had meningitis, one had intractable seizures, one had an hypoxic brain injury secondary to drug overdose and one patient had neuroleptic malignant syndrome.

Data Collection

Three senior nurses who are experienced in neurosurgical nursing and are thus familiar with the Glasgow Coma Scale acted as data collectors. These were the Intensive Care Unit nurse educator, the Clinical Nurse Consultant for neural sciences and a Clinical Nurse Specialist from the Neural Science High Dependency ward. As this study examined the nurses' responses to the Reaction Level Scale assessments, their consent to participate in the study was obtained.

One of the potential limitations of the methodology was that none of the nurses were familiar with the RLS 85. Differences in their scores may therefore have arisen from their differing understandings of the RLS 85. To overcome this limitation, a semi-formal teaching program was implemented to ensure that all the nurses had the same understanding of the RLS 85. Each nurse also had a copy of the RLS 85 and the RLS 85 decision tree (see appendix one) present during data collection to prevent them from developing their own standards (this was recommended in a previous study by Starmark et al[17]).

The teaching program for the data collectors was based on that recommended by Starmark[19]. The data collectors were given copies of the RLS 85, the RLS 85 decision tree as well as articles[15,17,18] relevant to the RLS 85. Data collectors were given approximately six weeks to assess and critique this literature. After this time, pilot assessments were performed at the bedside, with both the data collectors and the chief investigator present. The results of these assessments were discussed to ensure that the data collectors had the same understanding of the RLS 85. These pilot assessments were performed on a number of patients.

Data collection was performed with any two of the three assessors present at the bedside. The investigator or the Registered Nurse caring for the patient at the time would perform a neurological assessment of the patient, with the assessors observing. Without conferring, each assessor then independently and individually recorded an RLS 85 score for the patient, based on the assessment they observed. This data collection technique was used for every patient.

This methodology was chosen based on the methodology used in other studies [8,15,18,25]. The technique used in these studies was for each assessor to independently assess each subject. This technique presumably prevents the assessors contaminating

each others scores. The mean time periods between each observers' assessments, for these studies, were seventeen and twenty minutes. This methodology was not adopted for this study as a patient's neurological status can change within a twenty minute period. Although the change may be only minor, it would allow for a difference in each assessor's scores, thus contaminating the results.

Ethical Considerations

All of the patients included in this study were having regular neurological observations performed as part of their routine medical/nursing management. These observations involved the application of noxious stimuli. For patients to be included in this study, they had to be neurologically examined, which may have involved the application of further noxious stimuli. To prevent further unnecessary stimulation, data collection was co-ordinated to coincide with times set for routine neurological observations. This methodology was also used by Ingersoll and Leyden[6] in their study.

There were no detrimental consequences for the nurses who agreed to act as assessors in this study. Their employment was not affected in any way by agreeing to participate in this study, or by choosing to withdraw their consent, which they were free to do at any time.

Consent

Patient consent was not obtained, as all the patients in this study were having regular neurological observations performed as part of their routine management. The patients were therefore not exposed to any additional stimulation, other than that which they were already receiving.

This study investigated the nurses' response to patient assessments, rather than the patients' response to being assessed with the RLS 85. As it was the nurses who were being "investigated", their consent was obtained.

The nurse caring for each patient at the time data collection was performed, as well as any relatives in attendance, were given a verbal explanation of the assessors' activities, and had their questions answered.

Approval was obtained from the Western Sydney Area Health Service Scientific and Ethics committees. Approval was also obtained from the Director of Nursing, the director of Intensive Care, the Head of the Neurosurgical department, and the Nursing Unit Managers of the intensive care unit, the neural science high dependency unit and the neurosurgical ward.

Analysis

Analysis of the data has been performed to determine the interrater reliability of the RLS 85. Interrater reliability is the degree to which two raters or observers, operating independently, assign the same ratings or values for an attribute being measured[11]. This has been determined by the kappa method, which is defined as the inter-observer agreement corrected for agreement by chance[15]. The formula for calculating kappa is:

$$K = \frac{Po - Pe}{1 - Pe}$$

"Po" is the observed proportion of agreement and "Pe" is the expected agreement by chance[15]. Kappa values range from -1 to +1. A value of -1 indicates complete disagreement; 0 indicates agreement only by chance; and +1 indicates complete agreement between observers[15]. A kappa value of 0.6 is considered good in neurosurgery[15,17].

Kappa analysis of the data indicated the RLS 85 had an interrater reliability of 0.88. This kappa value was determined using the data when there was only absolute agreement between the scorers. For example, if the scorers both gave a patient scores of 7 and 7, this would be absolute agreement, but scores of 7 and 6 would not. However, a change in a patient's RLS 85 score from 7 to 6, would probably not be considered clinically significant. If consecutive scores (for example 3 and 4 or 7 and 8) were therefore considered to be agreement between scorers, the RLS 85 would have had an even higher kappa value.

Discussion

Differences between the assessors' scores may have occurred because of a number of reasons. Ellis and Cavanagh[4] suggest several reasons why mistakes occur:

1. There is lack of knowledge of how to elicit the best response from a patient and how to interpret the result.
2. There is no clearly agreed standard criteria for each level on the scale which can be universally known and understood.
3. There is a difference in the quality of stimulus applied by different observers.

Most of these sources of error were avoided in this study in the following ways:

- none of the scorers actually assessed the patients, they only did the scoring
- all scorers were given a copy of the RLS 85 and the RLS 85 decision tree to assist them with scoring the patients
- the RLS 85 gives reasonably specific descriptions of the criteria required to grade a patient on each level of the scale.

Limitations

There are some limitations in this study which may have influenced data. Although all of the assessors are clinically very experienced, none of them have used the RLS 85 before. Education sessions were held prior to data collection, but a lack of experience with the tool may have meant the assessors used their "own personal criteria" to score patients. All of the assessors had copies of the RLS 85 decision tree which they used when scoring patients.

Secondly, not all nurses have years of experience with comatose patients; therefore a coma scale has to be simple enough for inexperienced users[9]. Although this study determined the RLS 85 to have high interrater reliability, the results may have been quite different if the data collectors had had no experience with comatose patients. Rowley and Fielding[14] certainly found this to be the case with the GCS.

Starmark et al[17] state that when using the RLS 85, the patient should be placed supine so that all limbs can move freely. If the patient was assessed whilst lying on their side, one of their limbs may not be able to move freely, thus suppressing or disguising the best motor response. Not all of the patients in this study were assessed whilst lying supine. There are a number of reasons for this: (1) if the RLS 85 is adopted as an assessment tool, it would be impractical to reposition the patient every hour for neurological assessment; (2) it may be inappropriate to reposition a patient every hour if they have high intractable intracranial pressure, as physical movement may worsen their intracranial pressure.

The patients were therefore not repositioned when the assessments were performed, regardless of whether they were side-lying or supine. If they were side-lying, it was ensured that their limbs were not being restricted under their body and could therefore move freely. Did this affect the results of the study? Strictly speaking, the patients were not assessed in the way that Starmark[17] recommend. However, even if the position of the patients did affect the motor response they exhibited, it would not have affected the interrater reliability, since the assessors were scoring the patients based on the assessment they observed. As stated previously, even if the investigator had performed an assessment that was not very thorough, it would not have affected the results, since interrater reliability was the focus of this study.

The advantage of the RLS 85 is that it is exactly that - a reaction level scale. In other words, it assesses patients' level of reaction to a stimulus, which still allows their neurological status to be assessed. The question, "Is it possible to define a conscious level?" has been addressed by Starmark and Lindgren[16]. Their conclusion was that perhaps one should abandon the whole concept of conscious levels and just talk about reaction levels[16].

In conclusion, what do the results of this study mean? Strictly speaking, this study has only indicated that the RLS 85 has high interrater reliability. That is, clinicians experienced with the GCS should be able to adopt the RLS 85 as an assessment tool, and agree on the scores given to a patient on the majority of occasions. This study has not indicated any more than this. However, this study constitutes the author's first experience with the Reaction Level Scale. Although interrater reliability has been the focus, it has given the author the opportunity to use the Scale in the clinical setting.

Based on this limited experience, the author believes that although the RLS 85 is a very good assessment tool, it is not better than the GCS, for the following reasons:

1. retromandibular stimulation failed to produce any response in the majority of the patients assessed, whilst sternal rubbing and/or nailbed pressure did (this may, of course, have been due to a lack of strong stimulus)
2. the scorers occasionally found it difficult to score a patient using the RLS 85 due to the specificity of the Scale's decision tree
3. patients must be placed onto their back to be assessed, which may be inappropriate if the patient has high intracranial pressure (as regular repositioning may act as a noxious stimuli potentially worsening the already high intracranial pressure).

Although some of these reasons are unique to this study, they possibly indicate why the RLS 85, despite having high reliability and validity, has failed to gain international popularity as a neurological assessment tool.

Further Research

This study has highlighted some areas for further research projects. They include the following:

- a comparison of RLS 85 scores between experienced and inexperienced users
- the effect that the initial position of a patient's limbs has on the motor response they display
- a study to determine which patients (if any) are more appropriate to assess with the RLS 85 and which are more appropriate to assess with the GCS.

Conclusions / Recommendations

The hypothesis that the RLS 85 will display the same or greater interrater reliability (K = 0.65) as that determined in previous studies, has been proven. There are many factors which can affect interrater reliability and this study has attempted to minimise them. It is the author's recommendation therefore, that if clinicians currently use the GCS or any other neurological assessment tool with which they are discontent, that they trial the RLS 85 in their department.

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APPENDIX 1 - THE RLS 85 DECISION TREE[17]
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First arouse the patient to a stable level by increasing order of stimulation intensity:

1. Talk / touch
2. Shaking / shouts
3. Pain

Any sign of mental responsiveness? At least one of:

1. oral response or words
2. visual contact or orientating eye movements
3. obeying commands
4. warding off pain

YES:
Mentally responsive

Delay of response.....No.....Intubated or dysphasic.....Yes.....RLS 1
.....No
orientated.....yes.....RLS 1
.....No
Assess for psychiatric conditions

Mentally responsive to - *light* stimulation.....Yes.....RLS 2
- *strong* stimulation.....Yes.....RLS 3

NO:

Unconscious

Exclude neurological or psychiatric conditions like vegetative state, akinetic mutism, depressive stupor, postictal states or epilepsy, trancelike states, hysterical mutism, katatonia, locked-in syndrome.

Place patient on his back. First use retromandibular then nailbed stimulation. Record response from both sides. Level determined from best response.

Localising response.....RLS 4

Withdrawal.....RLS 5

Stereotyped flexion? or flexion and extension.....RLS 6

Stereotyped extension? or at least movements in the face?.....RLS 7

No response at all.....RLS 8