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# Interrater Reliability and Predictive Validity of the FOUR Score Coma Scale in a Pediatric Population

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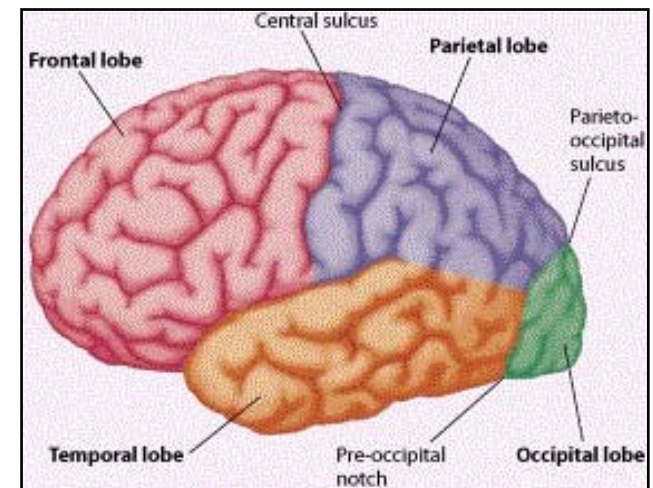


## Disclosures:

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## Background

- Adult human brain 2% total body weight
- Consumes more than 20% of oxygen used at rest
- Metabolically active
- No oxygen or glucose storage
- Even a brief interruption can result in acute changes in level of consciousness
- Increased morbidity and mortality



## Background

- Clinical assessment is key to identifying subtle changes and is fundamental to management of neuroscience patients
- Quality care depends on the nurses' ability to accurately and consistently assess and communicate these changes



## Background

- Glasgow Coma Scale (GCS) 1974 to objectively describe neuro status and predict outcome
- GCS has become the gold standard for coma assessment and measuring LOC
- Incorporated into Intensive Care and Trauma scores (internationally) to assess risk of in-hospital mortality and predict future disability
- Accuracy of the GCS is therefore crucial
- Despite its widespread use it has several well documented limitations...

## Limitations

- Heavily weighted motor assessment
  - Paralytics
  - Sedatives
  - Spinal Cord Injury
  
- Verbal
  - Intubated
    - Inconsistent scoring
  
- Eye
  - Injury
  - Edema

Glasgow Coma Score			
*	Child	Infant	Score
Motor	obeys comm.	spont. movements	6
	localizes	withdraws to touch	5
	withdraws	withdraws to pain	4
	flexion	flexion	3
	extension	extension	2
	nil	nil	1
	Verbal	oriented	coos & babbles
confused		irritable cry	4
inappropriate		cries to pain	3
incomprehensible		moans to pain	2
nil		nil	1
Eye	opens spont.		4
	opens to speech		3
	opens to pain		2
	nil		1

## Limitations

- Wide variation in GCS scoring *within* organizations among nurses with varying levels of expertise, and *between* healthcare organizations (Ingram, 1994)
- Only moderate degree of interrater agreement (Gills, Reiley, & Green, 2004)
- Many attempts over the years to modify or simplify GCS
- Dissatisfaction and need for better tool





## Background

- Full Outline of UnResponsiveness (FOUR) score
- Proposed replacement for GCS
- Developed and validated by Mayo Clinic in adults 2005
- No studies to validate its use in pediatrics
  
- The purpose of this study was to compare the interrater reliability and predictive validity of the FOUR score and the GCS in pediatric patients

# FOUR Score

- Value of 0-4 in each of 4 functional categories:
- In each of these categories, a score of zero indicates nonfunctioning while a score of four represents normal functioning

GCS varies E-4, V-5, M-6

(Wijdicks, et al., 2005)

MAYO CLINIC

### FOUR Score

**Eye Response**

4 Eyelids open or opened, tracking or blinking to command

3 Eyelids open but not tracking

2 Eyelids closed but opens to loud voice

1 Eyelids closed but opens to pain

0 Eyelids remain closed with pain

**Motor Response**

4 Thumbs up, fist, or peace sign to command

3 Localizing to pain

2 Flexion response to pain

1 Extensor posturing

0 No response to pain or generalized myoclonus status epilepticus

**Brainstem Reflexes**

4 Pupil and corneal reflexes present

3 One pupil wide and fixed

2 Pupil or corneal reflexes absent

1 Pupil and corneal reflexes absent

0 Absent pupil, corneal, and cough reflex

**Respiration**

4 Not intubated, regular breathing pattern

3 Not intubated, Cheyne-Stokes breathing pattern

2 Not intubated, irregular breathing pattern

1 Breathes above ventilator rate

0 Breathes at ventilator rate or apnea

Wijdicks EFM, Bamlet WR, Marambaen BV, Marino EM, McClelland RL. Validation of a new Coma Scale: the FOUR score. *Annals of Neurology*. 2005; 58:585-593

## PICO Question

- Among neurosurgical PICU patients,
- Does nursing assessment using the FOUR score
- Compared to the traditional assessment using the GCS
- Result in a more reliable and comprehensive assessment and/or predictor of patient morbidity and mortality?

## Purpose of Study

- Evaluate and compare the interrater reliability of nurse rater scores on the GCS and FOUR score in pediatric patients
- Evaluate and compare the predictive validity of the two scoring systems
- Determine nurse rater comfort with the use of the FOUR Score assessment tool

# Protocol

- PICU Nurses were asked to voluntarily participate in study
- Nurses who agreed were educated on:
  - Study protocol
  - GCS and FOUR Score Assessments
- Patient inclusion criteria
  - In-patient status
  - Neuroscience patients
  - Ages 2 years-18 years of age
- Patient exclusion criteria
  - Sedatives or Neuromuscular Blockades
  - Patients less than 2 years or greater than 18 years of age

## Protocol

- 2 nurse raters assessed the patient at the time of admission to the PICU using both GCS and FOUR Score
- Assessments were performed at the same point in time (within 10 minutes) and documented on separate score cards without knowledge of each other's scores
- Raters immediately sealed score cards in separate envelopes and placed them into a secure box
- Each rater agreed not to discuss their scoring

## Subjects

- Convenience sample of 60 neuro patients admitted to CHOC PICU
  - 4 categories:
    - Alert
    - Drowsy
    - Stuporous
    - Comatose
- Hydrocephalus  
TBI  
Seizure  
Brain tumor, various  
Near drowner  
AVM  
Moya-moya  
Craniosynostosis  
Leukemia  
Spina Bifida  
Encephalitis  
Chiari Malformations

## Rater Demographics

35 Nurse Raters, with wide variety of experience

- Ages 23-60
- 12 ADN, 20 BSN, 3 MSN
- <1-40 years of experience in nursing
- Certifications 10 CCRNs





# Interrater Reliability Weighted Kappa Statistics

Value of $K$	Strength of Agreement
<0.40	Poor
0.41-0.60	Fair
0.61-0.80	Good
0.81-1.00	Excellent

(Landis & Koch, 1977)

Weighted kappa ( $\kappa$ ) values, standard error (SE) and 95% confidence intervals (CI) for interrater agreement on the FOUR Score and GCS (N=60 patients)

	FOUR Score					Glasgow Coma Scale			
	Eye	Motor	BS	Resp	Total	Eye	Motor	Verbal	Total
Weight K	0.975	0.860	1.000	1.000	0.951	0.619	0.711	0.595	0.738
SE	0.025	0.081	0.000	0.000	0.022	0.133	0.092	0.104	0.076
95% CI	0.93-1.00	0.70-1.00	1.00-1.00	1.00-1.00	0.91-0.99	0.36-0.88	0.53-0.89	0.40-0.80	0.59-0.87

## Outcome Upon Discharge

### Modified Rankin Score Upon Patient Discharge (Select One):

- 0= No symptoms
- 1= No significant disability despite symptoms  
(able to carry out all usual duties and activities)
- 2= Slight disability  
(unable to carry out all previous activities)
- 3= Moderate disability  
(requiring some help, but able to walk without assist)
- 4= Moderately severe disability  
(unable to walk without assist)
- 5= Severe disability  
(bedridden, incontinent, constant care)
- 6= Dead

## Conclusions

- Weighted Kappa for FOUR score total **0.951**
  - **Very Good**
- Weighted Kappa for GCS total **0.738**
  - **Good**
- FOUR score better predictor of outcome (71% of patients correctly classified vs. 63% with GCS)
- Nurses found the FOUR score clinically relevant and easy to use

## Nursing Implications

- Nursing assessment using FOUR score was more reliable between raters than GCS
- Nurses were comfortable with FOUR and described the tool as easy to use

## Limitations and Areas for Future Research

- Small  $n$  in stuporous and comatose categories
- Need for future studies on interrater reliability and outcome prediction of FOUR score compared to GCS in a wide variety of settings and subjects
- Need for more studies on sicker patients
- More pediatric studies on implications of FOUR Score for this population

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## References

- Altman DG (1991). Practical statistics for medical research. London: Chapman and Hall
- Buechler, CM, Blostein, PA, Koestner, A, Hurt, K, Schaars, M, McKernan, J (1998). Variation among trauma centers' calculation of Glasgow Coma Scale score: Results of a national survey. The Journal of Trauma: Injury, Infection, and Critical Care 45:3, 429-432.
- Gill, M, Reiley, D, Green, S (2004). Interrater reliability of Glasgow Coma Scale scores in the Emergency Department. Annals of Emergency Medicine 43:2, 215-223.
- Ingram, N. (1994) Knowledge and level of consciousness: application to nursing practice. Journal of Advanced Nursing; 20:5, 881-884.
- Jennett, B (2005). Development of the Glasgow coma and outcome scales. Nepal Journal of Neuroscience 2:24-28.

- Rutledge, R, Lentz, CW, Fakhry, S, Hunt, J (1996). Appropriate use of the Glasgow Coma Scale in intubated patients: A linear regression prediction of the Glasgow verbal score from the Glasgow eye and motor scores. *The Journal of Trauma: Injury, Infection, and Critical Care* 41:3, 514-522.
- Sims, J, Wright, C (2005). The Kappa statistics in reliability studies: Use, interpretation, and sample size requirements. *Physical Therapy* 85:3, 257-268.
- Sullivan, MG (2005). FOUR Score takes on Glasgow Scale. *Clinical Neurology News* 1:11, 11-13.
- Tatman, A, Warren, A, Williams, A, Powell, JE, Whitehouse, W (1997). Development of a modified paediatric coma scale in intensive care clinical practice. *Archives of Disease in Childhood*. 77, 519-521.