Development of a modified paediatric coma scale in intensive care clinical practice

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Abstract
James' adaptation of the Glasgow coma scale (JGCS) was designed for young children. Intubated patients are not allocated a verbal score, however, so important changes in a patient's conscious level may be missed. A grimace score was therefore developed and assessed for use in intubated children.

Two observers made a JGCS observation within 15 minutes of each other. One observer was the patient's nurse and the other a trained investigator. Interobserver reliability was determined between the first and second observation for each component of the scale. Reliability was measured using κ and weighted κ statistics.

Seventy three children had 104 sets of observations. Interobserver reliability was moderate to good for all components, with the grimace score better than the verbal score.

It is concluded that the grimace score is more reliable than the verbal score and may be useful in intubated patients in whom the verbal score cannot be used.

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Keywords: coma scale; intensive care; conscious level

The Glasgow coma scale has been widely adopted in the management of adult and paediatric coma.^{1 2} It should not be used in small children as the verbal component is not

appropriate.³ Several coma scores have been developed specifically for children in an attempt to compensate for their differences in verbal and motor capabilities.⁴⁻¹¹ Three years ago, we introduced into our intensive care unit (ICU) a modified Glasgow coma scale, which is Sharples' adaptation (personal communication) of the James' adaptation of the Glasgow coma scale (JGCS) (table1).¹²

During this time, our nursing staff reported that many children who were intubated showed varying degrees of orofacial grimacing when stimulated. Therefore we developed a grimace score to replace the verbal component in intubated children. We report the results of a study to assess the reliability of our modified coma scale in this clinical setting.

Subjects and methods

STUDY DESIGN

After receiving local ethical committee approval, children on the ICU with coma from any cause were selected in a quasirandom manner: whenever one of the three trained investigators was available, the patient accessible, and the patient had not been studied within 24 hours nor with the same JGCS (on the routine nursing JGCS chart).

Verbal consent was obtained from parents when available. A set of observations consisted of two JGCS (table 1) scores, the second score being completed within 15 minutes of the first. These were performed sequentially by two observers, one being the child's bedside nurse

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Table 1 Modified Glasgow coma scale. Pain as nail bed pressure with pencil; score best response

Adult and child > 5 years	Child < 5 years
Eye opening	
E4 spontaneous	As older child
E3 to verbal stimulus	As older child
E2 to pain	As older child
E1 no response to pain	As older child
Verbal	
V5 orientated	Alert, babbles, coos, words or sentences to usual ability
V4 confused	Less than usual ability or spontaneous irritable cry
V3 inappropriate words	Cries to pain
V2 incomprehensible sounds	Moans to pain
V1 no response to pain	No response to pain
VT intubated	Intubated
Grimace	
G5 spontaneous normal facial/oromotor activity, for example sucks tube, coughs	
G4 less than usual spontaneous ability or only responds to touch	
G3 vigorous grimace to pain	
G2 mild grimace or some change in facial expression to pain	
G1 no response to pain	
Motor	
M6 obeys commands	Normal spontaneous movements or withdraws to touch
M5 localises to pain stimulus	As older child
M4 withdraws from pain	As older child
M3 abnormal flexion to pain	As older child
M2 abnormal extension to pain	As older child
M1 no response to pain	As older child

and the other being one of three trained observers. The observers were blinded to the preceding score. Children who were not intubated were given a verbal score. Children

Table 2 Diagnostic category on admission to ICU

Diagnosis	Number
Cardiac surgery	30
General surgery	12
Neurosurgery	5
Metabolic	7
General medical	3
Neurology	10
Head injury	6

Table 3 Each pair of observations for each component of the adapted JGCS

<i>Eye opening E1-E2</i>						
	<i>E2 score</i>					
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>		
E1 score						
1	35	6	1	1		
2	5	8	0	5		
3	0	2	0	3		
4	2	5	3	24		
<i>Verbal V1-V2</i>						
	<i>V2 score</i>					
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	
V1 score						
1	5	1	0	0	0	
2	0	1	1	1	0	
3	0	0	1	1	0	
4	2	1	1	3	1	
5	1	0	3	0	5	
<i>Motor M1-M2</i>						
	<i>M2 score</i>					
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>
M1 score						
1	5	0	0	3	0	0
2	0	0	1	2	1	0
3	0	1	2	4	0	0
4	3	1	2	24	10	2
5	1	0	0	6	12	4
6	0	0	0	2	8	10

<i>Grimace G1-G2</i>					
	<i>G2 score</i>				
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>
G1 score					
1	14	2	0	1	0
2	6	9	4	1	1
3	0	2	5	3	1
4	0	2	3	1	0
5	0	2	0	0	11

Table 4 Each pair of observations for the summated adapted JGCS, with grimace in place of verbal

<i>Summated EGM1-EGM2</i>															
<i>EGM1 score</i>															
	3	4	5	6	7	8	9	10	11	12	13	14	15		
<i>EGM2 score</i>															
3	3	0	0	1	0	0	0	0	0	0	0	0	0		
4	0	0	0	2	0	0	0	0	0	0	0	0	0		
5	0	0	1	1	0	0	0	0	0	0	0	0	0		
6	0	0	1	2	2	1	0	1	0	0	0	0	0		
7	0	1	0	3	2	0	0	0	0	0	0	0	0		
8	1	0	0	0	3	2	2	0	1	0	0	0	0		
9	0	0	0	1	0	2	3	2	0	0	0	0	0		
10	0	0	0	0	1	2	2	1	1	0	1	0	0		
11	0	0	0	0	0	0	1	0	1	0	0	0	0		
12	0	0	0	0	0	0	0	0	0	0	2	0	0		
13	0	0	0	0	0	0	0	0	0	2	0	0	2		
14	0	0	0	0	0	0	0	1	0	0	1	2	2		
15	0	0	0	0	0	0	0	0	1	0	0	2	3		

Table 5 Interobserver agreement

	No	κ (95% CI)	Weighted κ (95% CI)
E1-E2	100	0.50 (0.38 to 0.63)	0.64 (0.53 to 0.76)
V1-V2	28	0.41 (0.20 to 0.63)	0.49 (0.25 to 0.73)
G1-G2	68	0.50 (0.32 to 0.61)	0.63 (0.50 to 0.77)
M1-M2	104	0.33 (0.20 to 0.46)	0.49 (0.36 to 0.62)
EVM1-EVM2	28	0.29 (0.10 to 0.48)	0.57 (0.39 to 0.75)
EGM1-EGM2	68	0.25 (0.13 to 0.38)	0.69 (0.60 to 0.78)

CI=confidence interval.

who were intubated were given a grimace score. We excluded children with cervical spinal cord injury, peripheral nerve disease, or neuromuscular disorders, including residual paralysis from neuromuscular blockade. The painful stimulus was nail bed pressure on both upper limbs, using a pencil. The best response was taken for the observation.

STATISTICAL ANALYSIS

Interobserver reliability (E1-E2, V1-V2, G1-G2, M1-M2, and summated scores EVM1-EVM2 and EGM1-EGM2), that is, the level of agreement between the two observations, was measured by the κ and weighted κ statistics.¹³ While the κ statistic measures the level of agreement above that expected by chance, it does not take into account the degree of disagreement between observations. The weighted κ statistic measures agreement and takes into account the magnitude of the disagreement.

For both κ and weighted κ , strength of agreement is interpreted as < 0.2 = poor; $0.21-0.40$ = fair; $0.41-0.6$ = moderate; $0.61-0.80$ = good; > 0.8 = very good or near perfect.

Results

One hundred and four sets of observations were completed in 73 children of whom 42 were boys. Four children had severe orbital swelling and were not given an eye score. Forty one observers were involved (38 nurses and three trained observers). The children ranged in age from 1 day to 16 years (median age 73 days). Table 2 shows the diagnostic categories. Tables 3 and 4 show the raw data for each component and for summated scores using the grimace and verbal scores separately. Table 5 shows the interobserver reliability.

Discussion

We adopted the JGCS because it takes account of developmental immaturity in small children, uses the same number of points irrespective of the child's age, and is simple for the patient's nurse to use without additional staff or equipment.

Several studies have examined the reliability of paediatric coma scales using two or three trained observers.^{5 10 14} This is useful for determining a scale's experimental reliability, but may not necessarily translate into clinical practice.¹⁵ For example, in our ICU there are over 100 nurses with varying levels of experience. Therefore, any scale must be robust enough to produce reliable results given the observers who will be using it. Complicated scales, which are used relatively infrequently, are unlikely to be reliable.

Our results suggest that despite a large number of observers, there is moderate to good interobserver agreement for the components of this scale.

The grimace component appears to be more reliable than the verbal component. They may measure different aspects of brain function and cannot necessarily be equated clinically. Facial expression, however, is an important part of non-verbal communication, so facial grimace

and verbal language are not totally independent skills. Furthermore, we believe that in intubated patients the restoration of a third variable (eye opening, motor, and grimace) in assessing coma increases the likelihood of detecting an improvement or a deterioration in the patient's condition, particularly when the variables are measured independently.

We have included the summated values for interest. We do not summate the values clinically, as the variables have different weights and are not clinically comparable.^{16 17}

Although the grimace score has not been validated for outcome, it is more reliable than the verbal score in this study and may be useful in intubated patients when the verbal score cannot be used.

This study has also shown the reliability of the other components of our adaptation of the JGCS when used by nurses and doctors in an ICU.

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