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Comparison of Avpu with Glasgow Coma Scale for Assessing Level of Consciousness in Infants and Children

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Abstract:
Background: *Coma is a common problem in pediatric patients with high morbidity and mortality. Early recognition is important and several coma scales like GCS have been developed for recording level of consciousness. The AVPU scale is simpler, easy to use and easy to remember. We conducted this study to know how the AVPU scale corresponds with GCS in children.*
Aims And Objectives*: To compare AVPU scale with GCS for assessing level of consciousness in infants and children admitted in emergency department with both infectious and noninfectious etiology.*
Study Design*: Observational study.*
Setting: *Emergency department of pediatrics, Niloufer hospital, Hyderabad.*
Materials And Methods*: Patients aged between 2months to 12years admitted in emergency department requiring assessment of level of consciousness were included. Each patient's level of consciousness is then assessed by using AVPU and GCS scale and compared. Attained data is analyzed statistically. The mean GCS score for each AVPU component was determined and a one way analysis of variance technique was employed.*
Results: *85 patients were included in the study to meet the required sample size with a minimum of 20 patients in each category of AVPU scale. One way analysis of variance indicated that all components of AVPU had significantly different average scores p<0.001.There is a good correlation with a constant relationship between the two scores in pediatric patients with causes of impaired consciousness.*
Conclusion: *AVPU response scale is comparable to GCS in assessing level of consciousness in infants and children and in both infectious and noninfectious etiology. P&U of AVPU indicates necessity for intubation.*
Keywords: *AVPU, Coma, GCS, Level of consciousness.*

I. Introduction

Traumatic and non-traumatic coma is a common problem in Paediatric practice with a potential for catastrophic high mortality and morbidity. Disturbances leading to altered level of consciousness may result from varying causes which can be broadly divided into traumatic and non-traumatic causes. Traumatic causes of altered level of consciousness in children include accidents, non-accidental injuries and birth injuries. Non traumatic causes are more varied and include infections of central nervous system, hypoxic ischemic encephalopathy, metabolic disorders, cerebrovascular disorders, endocrine abnormalities, exogenous poisons and structural and degenerative central nervous system disorders.[1]

Early recognition of coma is essential and several coma scales have been developed for recording depth of consciousness that are widely used in clinical practice in adults and children. The scales should be reliable, i.e. with little variation between observers and in test–retest by one observer, since this promotes confidence in the assessments at different time points and by different examiners. This is particularly important when the patient is being assessed by personnel dealing with adults as well as children, discussed on the telephone, handed over at shift change, or transferred or hospital between units. Studies are conflicting on the best quick assessment tool for neurologic status. Scales can be used to initially evaluate a patient for critical conditions such as impending airway compromise or brain herniation in a medically ill or trauma patient. Furthermore, these scales provide a baseline that is used for serial examinations and for communication with consultants.[2]

The Glasgow Coma Scale (GCS) is a 13-point scale described in 1974 by Teasdale & Jennet. The GCS evaluates consciousness by scoring a response in three areas: eye opening, motor response and verbal performance and was designed for assessment of consciousness in head injury patients and has become ubiquitous since, now being put to many uses for which it was not originally designed.There have been concerns expressed regarding complexity, spurious precision, lack of agreement between individuals and groups of clinicians, and therefore validity of the scale. Although the GCS has not been validated as a prognostic scoring

system for infants and young children as it has been in adults, modified GCS is commonly used in the assessment of pediatric patients with an altered level of consciousness. Patients with a GCS score ≤8 require aggressive management, including stabilization of the airway and breathing with endotracheal intubation and mechanical ventilation.

Assessment of the GCS in children adds another layer of complexity[3], as there is a need to relate normal responses to minimum normal developmental attainments.[4] A child under 6 months of age for instance may still demonstrate primitive reflex responses and simply 'withdraws' or 'flexes' after any form of painful stimulus.[5] It has also been shown that the 6-poin motor scale is inappropriate for use below the age of 6 months.[5]The main difference between paediatric and adult GCS has been in verbal scoring. The Advanced Paediatric Life Support course uses a detailed verbal subscore utilising descriptive terms which can be applied across spectrum of age, with a score of 5 for 'Alert' also being described as 'babbles, coos words to usual ability', and a score of 4 described as 'Less than usual words; spontaneous irritable cry'.[6] However a salient and important point is that paediatric GCS scoring may be particularly challenging, and often requires consistent practice to become familiar with its use.[3]

A number of criticisms have been leveled against the GCS since its inception, one being its complexity, leading to a lack of agreement among clinicians attempting to quantitate consciousness for the purposes of diagnosis, intervention or prognosis, and another being the lack of contribution of the eye opening and verbal scales to the overall discrimination of the scale.

The AVPU scoring system is used to determine both a child's level of consciousness and cerebral cortex function. Unlike the GCS the AVPU scale is not developmentally dependent—a child does not have to understand spoken language or follow commands, merely respond to a stimulus. The child is scored according to the amount of stimulus required to get a response, from alert to unresponsive. A very simple (AVPU) has been recommended for immediate emergency assessment of level of consciousness, e.g. by nursing, medical, or paramedical staff at the scene of an accident or collapse or in the resuscitation room. It has been said that to be accurately and consistently applied, a clinical scale must be easy to use and remember.[7]

The GCS was compared to the AVPU score with adult studies and median GCS scores of 15, 13, 8 and 3 corresponded to A V P and U respectively. Anecdotal evidence suggests that AVPU is simpler to use than the GCS. When an assessment of consciousness was made, clinicians were more comfortable using AVPU scale (41%) than the Glasgow coma scale (26%) for the assessment.[8]There is only one study in pediatric population comparing AVPU with GCS. We conducted this study to determine how the AVPU responsive scale corresponds with the GCS in children admitted to a pediatric intensive care unit.[9]

II. Aims And Objectives

To assess level of consciousness in infants and children with infectious and noninfectious etiology admitted in emergency department by using AVPU & Glasgow Coma Scale and compare AVPU with Glasgow Coma Scale with the goal to have a rapid and simpler method of assessment of level of consciousness.

III. Materials

Study Design: Observational Study

SETTING: Emergency Department, Department of Paediatrics, Niloufer Hospital, Osmania Medical College, Hyderabad, Andhra Pradesh.

STUDY PERIOD: May 2013 to August 2013

STUDY SUBJECTS: Children admitted to Emergency Department, NILOUFER HOSPITAL within the study period.

Inclusion Criteria:

Children of age 2 months to 12 years admitted with primary diagnosis requiring assessment of level of consciousness or the conditions mentioned below

i) Meningitis / encephalitis / encephalopathy
ii) Cerebral malaria
iii) Complex seizures
iv) Metabolic disorders that affect consciousness such as Diabetic KetoAcidosis, hypoglycemia, Inborn Errors of Metabolism
v) Head injury
vi) Poisoning with organophosphorous / antipsychotic drugs/ antiepileptic drugs / unknown substances

Exclusion Criteria:

i) Infants of age less than 2 months & children with age more than 12 years.
ii) Children already intubated and receiving Positive Pressure ventilaton.
iii) Children without Brain Stem Reflexes.

SAMPLE SIZE: Based on the previous studies, where mean GCS scores for A/ V/ P/ U were 14, 11, 6 & 3 respectively. Assuming the standard deviation of 4, it was determined that at least 20 readings in each AVPU score would be needed for a one way ANOVA with 90% power to detect significance at 5% level. Accordingly the study was continued till a minimum of 20 patients were enrolled in each of the 4 categories A/V/P/U.

IV. Methodology

All the patients of age 2 months to 12 years admitted to Emergency Department requiring assessment of level of consciousness are included in the study with consent being taken from the patients' parents. Identification data, presenting complaints are noted. Physical examination done and the diagnosis is noted.

The level of consciousness is then assessed for every patient by using AVPU and Glasgow Coma Scale using the following proforma:

Is the patient? (Tick one) Scale 1 (AVPU SCALE)

a) Alert and Orientated
b) Responds to Voice
c) Responds to Pain
d) Unresponsive

GLASGOW COMA SCALE AND MODIFICATION FOR CHILDREN			
GLASGOW COMA SCALE	SCORE	GLASGOW COMA SCALE (INFANT MODIFICATION)	SCORE
EYE OPENING		EYE OPENING (INFANT MODIFICATION)	
Spontaneous	4	Spontaneous	4
To speech (shout)	3	To speech (shout)	3
To pain	2	To pain	2
None	1	None	1
VERBAL RESPONSE		VERBAL RESPONSE (INFANT MODIFICATION)	
ORIENTED	5	Babbles, coos appropriately	5
Confused conversation	4	Irritable cry	4
Inappropriate words	3	Cries in response to pain	3
Incomprehensible sounds	2	Moans in response to pain	2
None	1	None	1
MOTOR RESPONSE		MOTOR RESPONSE (INFANT MODIFICATION)	
Obeys commands	6	Purposeful movements	6
Localizes pain	5	Withdraws to touch	5
Withdraws in response to pain	4	Withdraws in response to pain	4
Responds to pain with Abnormal flexion	3	Responds to pain with decorticate posturing (Abnormal flexion)	3
Responds to pain with Extensor response	2	Responds to pain with decerebrate posturing (Abnormal Extension)	2
None	1	None	1

STATISTICAL ANALYSIS : The Glasgow Coma Scale Score and AVPU readings of each patient were compared. Attained data is analysed statistically. The mean GCS score for each AVPU component was determined and a one way analysis of variance technique was employed.

Ethical Considerations

Written approval to carry out the study was obtained from ETHICS SCIENTIFIC COMMITTEE OF OSMANIA MEDICAL COLLEGE, HYDERABAD held on 21/ 05/ 2013. Individual informed written consent for assessment of level of consciousness was obtained from the guardian. No patient suffered delay of treatment as a result of the study.

V. Results

Eighty five patients were enrolled in the study to meet the required sample size with a minimum of 20 patients in each category of AVPU scale. Out of the total 85 cases, 20 (23.5%) were alert, 21 (24.7%) were responsive to voice, 23 (27.1%) were only responsive to painful stimuli and 21 (24.7%) were unresponsive. Youngest patient was 3 months old, oldest was 144 months old. Mean age is 60months. Minimum GCS score is 3, maximum is 15 with mean of 8.66.

TABLE 1 : Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
AGE	85	3	144	59.99	46.013
GCS SCORE	85	3	15	8.66	4.503
Valid N (listwise)	85				

TABLE 2: Case Processing Summary

	Cases					
	Valid		Missing		Total	
AVPU SCALE	N	Percent	N	Percent	N	Percent
A	20	100.0%	0	.0%	20	100.0%
V	21	100.0%	0	.0%	21	100.0%
P	23	100.0%	0	.0%	23	100.0%
U	21	100.0%	0	.0%	21	100.0%

TABLE 3: AGE DISTRIBUTION: Youngest patient was 3 months old, oldest was 144 months old.

AGE DISTRIBUTION (months)	NUMBER OF PATIENTS
3 – 23	27 (31.7%)
24 – 43	12 (14.2%)
44 – 63	8 (9.4%)
64 – 83	4 (4.7%)
84 – 103	12 (14.2%)
104 – 123	13 (15.3%)
124 – 144	(10.5%)

Sex Distribution: 34(40%) female & 51(60%) male. Mean age of male child was 57 months, female child was 64 months.

Etiological Distribution: 46 were of infectious etiology (male=27, female=19) with mean age being 56.8 months, 39 were non-infectious(male=24, female=15) with mean age of 63.7 months

Table 4: Etiological Distribution Of The Patients In Each Component Of Avpu Scale

AVPU scale	INFECTIOUS CASES	NON-INFECTIOUS CASES
A	9	11
V	11	10
P	15	8
U	11	10

TABLE 5: SEX DIsTRIBUTION OF PATIENTS IN EACH COMPONENT OF AVPU SCALE

AVPU scale	FEMALE BABIES	MALE BABIES
A	6	14
V	10	11
P	6	17
U	12	9

Table 6: Minimum And Maximum Glasgow Coma Scale Scores In Each Component Of Avpu Scale Of Total Cases, Cases Of Infectious And Non Infectious Etiology

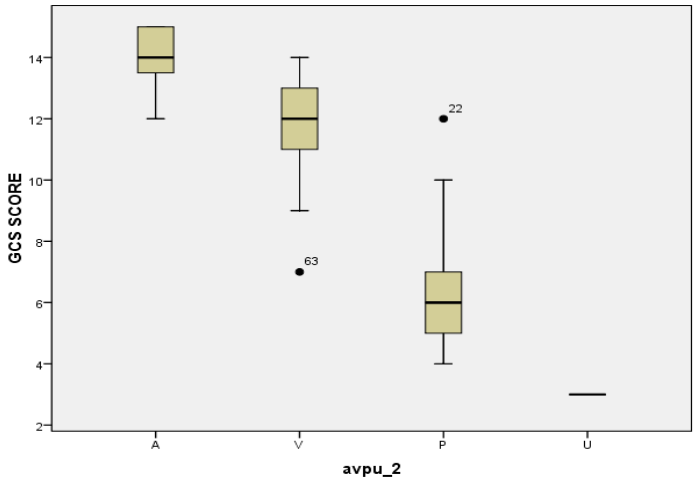
AVPU scale	GCS SCORES					
	TOTAL CASES		INFECTIOUS CASES		NON-INFECTIOUS CASES	
	MINI. (1)*	MAXI. (2)*	MINI. (3)*	MAXI. (4)*	MINI. (5)*	MAXI. (6)*
A	12	15	12	15	13	15
V	7	14	7	14	9	13
P	4	12	4	12	5	7
U	3	3	3	3	3	3

VI. Analysis Of Total Cases

Table 7: Mean Value Glasgow Coma Scale Scores & Standard Deviation For Each Component Of Avpu Scale

AVPU scale	NUMBER OF CASES	MEAN GCS scores	Standard Deviation
A	20	14	.858
V	21	11.7	1.853
P	23	6.4	1.830
U	21	3	.000

FIG 1: Box – and whisker plot showing mean GCS scores for the AVPU responsive scale total cases. The boxes represent the interquartile range (IQR); the whisker represents the range.



ANALYSIS OF PATIENTS WITH INFECTIOUS ETIOLOGY

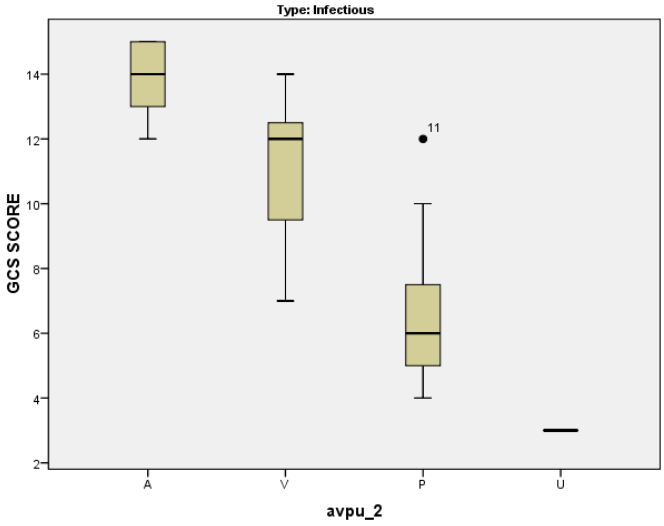
TABLE 8: Descriptives[a]

GCS SCORE

AVPU scale					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
A	9	13.89	1.054	.351	13.08	14.70
V	11	11.18	2.228	.672	9.69	12.68
P	15	6.67	2.193	.566	5.45	7.88
U	11	3.00	.000	.000	3.00	3.00
Total	46	8.28	4.339	.640	6.99	9.57

a. Type = Infectious

FIG 2: Box – and whisker plot showing mean GCS scores for the AVPU responsive scale of patients with infectious etiology. The boxes represent the interquartile range (IQR); the whisker represents the range.



Analysis Of Patients With Non Infectious Etiology

TABLE 9: Descriptives[a]

GCS SCORE

AVPU Scale					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
A	11	14.09	.701	.211	13.62	14.56
V	10	12.20	1.229	.389	11.32	13.08
P	8	6.00	.756	.267	5.37	6.63
U	10	3.00	.000	.000	3.00	3.00
Total	39	9.10	4.706	.754	7.58	10.63

a. Type = Non Infectious

FIG 3: Box – and whisker plot showing mean GCS scores for the AVPU responsive scale of patients with Non-infectious etiology. The boxes represent the interquartile range (IQR); the whisker represents the range.

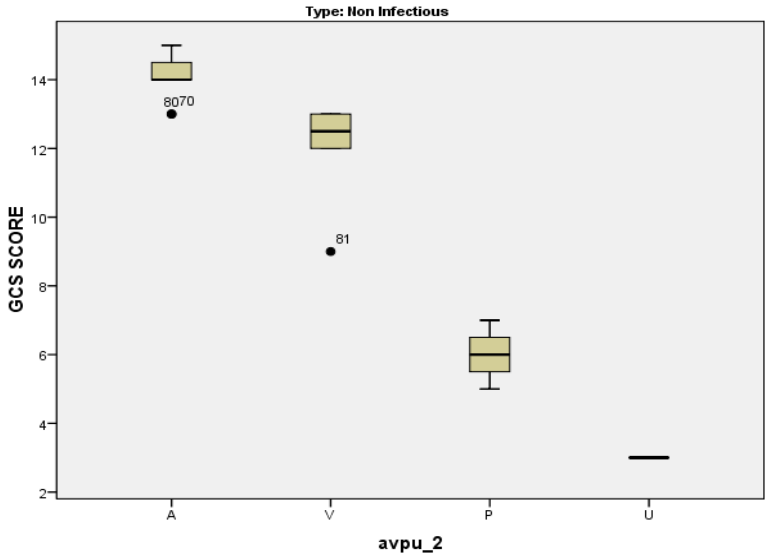


Table 10: Mean Gcs Scores For The Avpu Responsive Scale Of Total Patients, Patients With Infectious And Noninfectious Etiology.

Components of AVPU scale	GLASGOW COMA SCALE SCORE								
	Total cases			Cases with infectious etiology			Cases with non-infectious etiology		
	mean	IQR	Range	mean	IQR	Range	mean	IQR	Range
A	14	13-15	12-15	13.89	13-15	12-15	14.09	13.5-14.5	13-15
V	11.7	9.5-12.5	7-14	11.18	9-12	7-14	12.20	11-13	9-13
P	6.4	5-7.5	4-10	6.67	5-8	4-12	6	5-6.5	5-7
U	3	3-4	3-4	3	3-4	3-4	3	3-4	3-4

Comparison Of Various Components Of Gcs With Avpu Scale

TABLE 11: A/V/P/U Compared with Eye Response of GCS

AVPU scale	NUMBER & GRADE OF EYE RESPONSE TO STIMULI			
	E 1	E 2	E 3	E 4
A	0	0	0	20
V	0	0	16	5
P	9	13	0	1
U	21	0	0	0

Maximum cases with A had E4 20 (100%), V had E3 16 (76.2%), P had E2 13(56.5%) and U had E1 21(100%).

TABLE 12: A/V/P/U Compared with Verbal Response of GCS

AVPU scale	NUMBER & GRADE OF VERBAL RESPONSE TO STIMULI				
	V 1	V 2	V 3	V 4	V 5
A	0	0	0	14	6
V	2	2	2	14	1
P	10	11	2	0	0
U	21	0	0	0	0

Maximum cases with A had V4 14 (70%), V had V4 14(66.66%), P had V1 10, V2 11 [V1 + V2 = 21 (91.3%)] and U had V1 21 (100%).

TABLE 13: A/V/P/U Compared with Motor Response of GCS

AVPU scale	NUMBER & GRADE OF MOTOR RESPONSE TO STIMULI					
	M 1	M 2	M 3	M 4	M 5	M 6
A	0	0	0	1	4	15
V	0	0	1	3	13	4
P	0	6	12	2	3	0
U	21	0	0	0	0	0

Maximum cases with A had M6 15 (75%), V had M5 13 (61.9%),P had M 3 12 (52.2%) and U M1 21 (100%).

VII. Discussion

The child presenting with altered consciousness is a common presentation to our wards with various diagnoses requiring rapid assessment and quick intervention. Every second is countable in providing better outcome. After stabilizing the child for airway, breathing and circulation, it is of prime importance to assess the child's neurological status and intervene appropriately at the earliest. The Glasgow Coma Scale (GCS) score is one of the most commonly used methods [10, 11, 12, 13, 14,] The Alert Verbal Painful Unresponsiveness (AVPU) scale is a simpler method of assessment of consciousness [6]. The two scales have been compared with adult studies. They have not been compared in pediatric intensive care patients. We conducted this study to determine how the AVPU responsive scale corresponds with the GCS in children admitted to a pediatric intensive care unit.

In a study done on children aged 2months to 12 years at admitted in PICU, st joseph hospital, delhi by Shomi Raman et al with the aim to determine how AVPU scale corresponds to GCS showed that A/V/P/U corresponds with median GCS score of 14 (12-15), 11 (10-12), 6 (5.5-8) and 3 (3-4), respectively[9]. There is some overlap between the range of GCS scores corresponding to each AVPU scale category. It is the first study done on pediatric age group. In my study mean GCS scores of total cases are obtained, which are equivalent to median GCS scores of previous studies. Similar types of results are obtained when cases with infectious and non-infectious etiology were analysed. There is some overlap between the range of GCS score corresponding to each AVPU responsive scale category for total cases & cases with infectious etiology but such overlap is not seen in cases with non infectious etiology. Inter Quartile Ranges are distinct from each category in total cases, cases with infectious and non infectious etiology. In a study done by Mackey et al in 2000 on patients aged 5years or older which included traumatic patients transferred to emergency ward suggested a GCS of 13 was the division between Alert and responds to voice, while a GCS of 9 was the division between responds to voice and responds to pain and AVPU is simpler than GCS[15].It has shown similar results, and the corresponding scores in adults were 15, 12, 8 and 3.

In my study, One way analysis of variance indicated that all the components of AVPU had significantly different average GCS scores ($P < 0.001$). Bonferroni corrected multiple comparisons indicated no two components are similar with respect to the GCS score.Significant difference between the two scales was found (Wilcoxon matched pairs, $p < 0.0001$). Each component of AVPU described a statistically distinct range of GCS values (Kruskal–Wallis $p < 0.0001$, with Dunn's Multiple Comparisons post test $p < 0.001$ all comparisons).

Each component of Glasgow Coma Scale is separately analysed with each category of AVPU responsive scale. In maximum number of cases, eye response of GCS corresponds to E4 for A, E3 for V, E2 for P and E1 for U, verbal response of GCS corresponds to V4 for A, V4 for V, V1 & V2 for P and V1 for U and motor response for GCS corresponds to M6 for A, M5 for V, M3 for P and M1 for U. 91.3% of cases with P of AVPU scale have GCS score =< 8 which is an indication for intubation.The good correlation seen in our study suggests that there is a constant relationship between these two scores in pediatric patients with various causes of impaired consciousness for both infectious and non infectious etiology.

OUTCOME: The changes in the AVPU scale when compared to the GCS scale are significant & denote a major change in the sensorium of the patient.

VIII. Conclusions

1. Most of the children admitted in Emergency Department with impaired consciousness are of infectious etiology and most common diagnosis being viral meningoencephalitis.

2. AVPU responsive scale is comparable to Glasgow Coma Scale in assessing level of consciousness in infants and children and in both infectious and non infectious etiology.
3. A of AVPU have Eye response of E4, verbal response of V4 to V5and motor response of M4 to M6.
4. P & U of AVPU indicates necessity for intubation.
5. U of AVPU means GCS score 3 with E1, V1, M1.

IX. Recommendations

1. AVPU responsive scale can be used to determine level of consciousness in infants and children.
2. In Emergency situations, a rapid AVPU scale is more advantageous to use than a time taking Glasgow Coma Scale.
3. AVPU scale being a simple scale can easily be used by paramedical staff, untrained personnel and patient attendants. By this, level of consciousness can be assessed at the earliest, even before getting to the hospital, serial assessments made by these people can identify deterioration early, if occurs.
4. AVPU scale P & U are indication for prompt intubation and ventilation.

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