ORIGINAL ARTICLE

Comparison of Three Consciousness Assessment Scales in Poisoned Patients and Recommendation of a New Scale: AVPU Plus

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Abstract

Background: Few methods have been introduced to assess the level of consciousness in critically-ill patients. This study was designed to evaluate how the Alert\Verbal\Painful\Unresponsive (AVPU) responsive scale corresponds with the Glasgow Coma Scale (GCS) and Richmond Agitation-Sedation Scale (RASS) scores in drug-poisoned patients and to devise an augmented AVPU scale.
Methods: In this prospective study, patients with diagnosis of acute drug poisoning were included and their level of consciousness was assessed using GCS, RASS and AVPU scales.
Results: Overall, 165 poisoned patients (59% female) were studied. According to AVPU scale, 123 patients (74.5%) were graded as "alert", 26 patients (15.8%) as "responsive to verbal stimulation", 10 patients (6.1%) as "responsive to painful stimulation", and 6 patients as "unresponsive" (3.6%). AVPU grades of "alert", "responsive to verbal stimulation", "responsive to painful stimulation" and "unresponsive" corresponded with median [IQR] GCS scores of 15 [15–15], 13 [12–13], 8 [7–10] and 6 [5–6], and median [IQR] RASS scores of -1 [-1 – +1], -2 [-3 – -1], -3 [-4 – -1], -5 [-5 – -5], respectively. By taking the median of RASS scores corresponding with each AVPU grade, an augmented AVPU scale for the assessment of consciousness was devised. The first proposed version of AVPU plus includes 14 qualitative grades of consciousness. By application of this scale, clinicians can evaluate both the alertness/attentiveness and arousal/excitability of poisoned and critical patients.
Conclusion: The AVPU plus is a new scale designed for more detailed assessment of neurologic status of poisoned and critical patients. The prognostic-ability, reliability and validity of the scale should be investigated in future studies.

Keywords: Glasgow Coma Scale; Psychomotor Agitation; Sedation; Unconsciousness; Weights and Measures

How to cite this article: Rajabi Kheirabadi A, Tabeshpour J, Afshari R. Comparison of Three Consciousness Assessment Scales in Poisoned Patients and Recommendation of a New Scale: AVPU Plus. Asia Pac J Med Toxicol 2015;4:58-63.

INTRODUCTION

Few methods have been introduced to assess the level of consciousness in critical patients, namely poisoned patients, in emergency departments and intensive care unit (ICU). Among them Glasgow Coma Scale (GCS) and Alert\Verbal\Painful\Unresponsive (AVPU) responsiveness scale are the most widely used (1). The GCS was developed by Teasdale and Jennet in 1974 (2), aimed at standardizing assessment of level of consciousness in head trauma victims (3). The maximum score a patient can get in GCS is 15. Based on this scale, reduced consciousness has been classified into mild (GCS: 13-15), moderate (GCS: 9-12) and severe (GCS: 3-8) levels (4). Later on, the AVPU scale has been developed for rapid neurologic assessment of traumatic patients and advanced life support. It has also been used by paramedics and physicians in out-of-hospital as well as medical settings for critically ill patients and poisoned patients (1,5). It is a simple method of assessing level of consciousness according to response to verbal or painful stimuli (1).

In order to assess agitation-sedation status of critical patients in ICU, Richmond Agitation-Sedation Scale (RASS) has been developed (6,7). In this scale, four levels of agitation [+1 (restless) to +4 (combative)] and 5 levels of sedation [-1 (drowsy) to -5 (unarousable)] has been defined (7). Accordingly, "0" denotes an alert person (7). A unique feature of the RASS is that the duration of eye contact following verbal stimulation is the principal indicator for titrating the sedation. The RASS has been demonstrated to have excellent reliability in a broad range of ICU patients and excellent validity when compared with other sedation scales (7,8).

In poisoning treatment centers, agitated or combative subjects are frequently observed (9,10). In these situations, precise assessment of the consciousness level by GCS or AVPU is relatively complicated. Hence, it might be helpful to use RASS as well as GCS and AVPU to assess agitation-sedation status in poisoned patients. None of these methods are indicative of prognosis in poisoned patients, but by using them more detailed evaluation of patients' consciousness can be obtained. This is particularly important when interventions such as intubation are required to be performed.

Rapid and accurate triage and monitoring of poisoned

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Received 5 April 2015; Accepted 1 June 2015

patients is vital and life-saving (1). For this purpose, AVPU scale, comprised of 4 grades of consciousness, is the simplest and the fastest method for assessment of neurologic status (1,11). Nonetheless, its value has been limited by the broad range of definitions for each grade. This prompted us to develop an enhanced AVPU modification for more precise assessment of consciousness level in poisoned patients. Hence, the objectives of this study are first to evaluate how the AVPU scale corresponds with the GCS and RASS scores in drug-poisoned patients and second to devise an augmented AVPU scale.

METHODS

Subjects

In this prospective single-center observational study, patients with diagnosis of acute drug poisoning admitted to Medical Toxicology Center (MTC) and general ICU of Imam Reza Hospital, Mashhad, Iran, were included. The patients' consciousness level was assessed by the researchers (ARK and JT) upon their admission. Patients younger than 18 years or older than 65 years were excluded. In addition, patients required immediate anesthesia for surgical interventions were excluded. For patients transferred directly from emergency department to ICU, the level of consciousness was assessed as soon as possible prior to intubation.

Assessment measures

The GCS, RASS and AVPU scales were recorded for all patients as outlined in table 1. If the patients were alert or agitated, they were scored from 0 to + 4 based on their level of agitation. If they were not spontaneously alert, they were

Table 1. Assessment measures used in the study (Glasgow Coma Scale (GCS), Richmond Agitation Sedation Score (RASS) and Alert\Verbal\Painful\Unresponsive (AVPU) scale (1,2,7)

Scale	Clinical parameter	How to assess	Score/ Grade
GCS	Eye response	Opens spontaneously	4
		Opens to verbal command	3
		Opens to pain stimulus	2
		No response	1
	Verbal response	Oriented, converses normally	5
		Confused, disoriented	4
		Inappropriate speech (utters inappropriate words)	3
		Incomprehensible sounds	2
		No sound	1
	Motor response	Obeys to verbal command	6
		Localizes pain to painful stimulus	5
		Flexion withdrawal to painful stimulus	4
		Abnormal flexion to painful stimulus (decorticate rigidity)	3
		Extension to painful stimulus (decerebrate rigidity)	2
		No movement	1
AVPU	Alert	Eyes open spontaneously, orientated speech, obeys commands	A
	Verbal	Any verbal, motor, or eye response to verbal stimulus	V
	Painful	Any verbal, motor or eye response to painful stimulus	P
	Unresponsive	Unresponsive to any stimulus	U
RASS	Combative	Combative or violent; immediate danger to staff	+4
	Very agitated	Pulls to remove tube(s) or catheter(s) or has aggressive behavior towards staff	+3
	Agitated	Frequent non-purposeful movements or patient-ventilator dyssynchrony (fights ventilator)	+2
	Restless	Anxious, apprehensive, but movements not aggressive or vigorous	+1
	Alert and calm	Alert and relaxed; spontaneously pays attention to caregiver	0
	Drowsy	Not completely alert, but has sustained (more than 10 seconds) awakening with eye contact to voice	-1
	Light sedation	Briefly (less than 10 seconds) awakens with eye contact to voice	-2
	Moderate sedation	Movement or eye opening to voice (but no eye contact)	-3
	Deep sedation	No response to vocal stimulation, but any movement or eye opening to physical stimulation	-4
	Unarousable	No response to vocal or physical stimulation	-5

called by their names to look at the investigator, with the duration of eye contact measured; and then based on this duration, the sedation level of the patients was scored from -1 to -3. If the patients did not respond to verbal stimulation, they were stimulated physically and were scored according to their response as -4 or -5. For the assessment of AVPU, if a patient did not respond to a verbal stimulus, a gentle shake was given without applying any form of painful stimulus. This was performed to ensure that the unresponsiveness of the patients was not due to impairment in his hearing sense. If no response observed at this stage, painful stimuli were applied. The required time for all these assessments was about one minute.

Ethics

Ethics approval was obtained from ethics committee of the Mashhad University of Medical Sciences (No. 186310). All patients or their legal guardian gave their informed consent prior to recruitment. Data collection did not interfere with ongoing clinical approach and treatment to the patients.

Statistical analysis

Data were analyzed using SPSS for windows (SPSS Inc., Chicago, IL). Results are descriptively reported with mean and standard deviation (SD) for normal variables and median [IQR] for non-normal variables.

Table 2. Drugs ingested by the poisoned patients (n = 165)

Drug	N (%)
Benzodiazepines[1]	39 (23.6)
Tramadol	25 (15.2)
Acetaminophen	18 (10.9)
Opioids[2]	14 (8.5)
Multi-drug	12 (7.3)
Antidepressants[3]	9 (5.5)
Antipsychotics[4]	6 (3.6)
Anticonvulsants[5]	5 (3.0)
Unknown	23 (13.9)
Others	14 (8.5)

[1] Mainly included clonazepam, lorazepam and alprazolam
[2] Mainly included raw opium and methadone
[3] Either cyclic antidepressants or selective serotonin reuptake inhibitors
[4] Mainly included risperidone and clozapine
[5] Mainly included phenobarbital and gabapentin

RESULTS

Study population

Overall, 165 poisoned patients (59% female) were studied. Mean (± SD) age of the patients was 26.5 ± 10.7 years. The most common drug ingested by the patients was benzodiazepines (23.6%) followed by tramadol (15.2%) and acetaminophen (10.9%) (Table 2).

Level of consciousness

According to AVPU scale, 123 patients (74.5%) were graded as “alert”, 26 patients (15.8%) as “responsive to verbal stimulation”, 10 patients (6.1%) as “responsive to painful stimulation”, and 6 patients as “unresponsive” (3.6%).

The GCS and RASS scores of the patients plotted against their concurrent AVPU grades are shown in table 3. As can be seen and predictably, “alert” patients had the highest GCS and RASS scores and “unresponsive” patients received the lowest scores. GCS scores of equal or less than 8 were only seen in “responsive to painful stimulation” or “unresponsive” grades.

According to table 3, "alert", "responsive to verbal stimulation", "responsive to painful stimulation" and "unresponsive" grades of AVPU scale corresponded with median [IQR] GCS scores of 15 [15–15], 13 [12–13], 8 [7–10] and 6 [5–6], and median [IQR] RASS scores of -1 [-1 – +1], -2 [-3 – -1], -3 [-4 – -1], -5 [-5 – -5], respectively. It is worth mentioning that there were minor overlaps of corresponding ranges of GCS and RASS scores between the AVPU grades.

All 6 patients with AVPU grade of "unresponsive" and half of patients with AVPU grade of "responsive to painful stimulation" required intubation. All intubated patients had a GCS score of less than or equal to 6. Median [IQR] GCS score of these patients was 3 [3–5].

AVPU plus

By taking the median of RASS scores corresponding with each AVPU grade of consciousness, an augmented scale for the assessment of consciousness was devised (Table 4). By application of this modified AVPU scale or AVPU plus, clinicians can evaluate both the alertness/attentiveness and arousal/excitability of poisoned and critical patients.

The first proposed version of AVPU plus includes 14 qualitative grades of consciousness. These 14 grades are the results of combination of AVPU and RASS grades with no

Table 3. GCS and RASS scores plotted against AVPU grades

	Level of consciousness according to AVPU scale*			
	A	V	P	U
Number of patients (%)	123 (74.5)	26 (15.8)	10 (6.1)	6 (3.6)
Number of patients with GCS ≤ 8	0	0	3	6
GCS; median [IQR], (range)	15 [15–15], (10–15)	13 [12–13], (9–13)	8 [7–10], (4–11)	6 [5–6], (5–7)
RASS; median [IQR], (range)	-1 [-1 – +1], (-1 – +2)	-2 [-3 – -1], (-3 – +2)	-3 [-4 – -1], (-4 – +2)	-5 [-5 – -5], (-5 – +4)

* A: alert, V: responsive to verbal stimulation, P: responsive to painful stimulation, U: unresponsive

Table 4. Recommended AVPU (+) consciousness level and sedation state

Clinical parameter	How to assess	Grade
Alert & Calm	Eyes open spontaneously, orientated speech, obeys commands + relaxed and spontaneous paying attention to caregiver	AC
Alert & Restless	Eyes open spontaneously, orientated speech, obeys commands + but anxious and apprehensive	AR
Alert & Drowsy	Orientated speech, obeys commands + interrupted awakening* with eye contact to voice	AD
Verbal & Calm	Any verbal, motor, or eye response to verbal stimulus + lied calmly	VC
Verbal & Restless	Any verbal, motor, or eye response to verbal stimulus + anxious and apprehensive	VR
Verbal & Agitated	Any verbal, motor, or eye response to verbal stimulus + involuntary and non-purposeful movements	VA
Verbal & Drowsy	Any verbal, motor, or eye response to verbal stimulus + interrupted awakening with eye contact to voice	VD
Verbal & Lightly Sedated	Any verbal, motor, or eye response to verbal stimulus + brief interrupted awakening** with eye contact to voice	VLS
Verbal & Moderately Sedated	Any verbal, motor, or eye response to verbal stimulus + no eye contact	VMS
Painful & Agitated	Any verbal, motor or eye response to painful stimulus + patient-ventilator dyssynchrony (fights ventilator)	PA
Painful & Deeply Sedated	Any verbal, motor or eye response to painful stimulus + no response to verbal stimulus and lied calmly	PS
Unresponsive & Combative	Unresponsive to any verbal or physical stimulus and command + combative or violent; immediate danger to staff	UC
Unresponsive & Highly Agitated	Unresponsive to any verbal or physical stimulus and command + aggressive behavior towards staff	UA
Unresponsive & Unarousable	Unresponsive to any verbal or physical stimulus	UU

* More than 10 seconds awakening to verbal stimulus
** Less than 10 seconds awakening to verbal stimulus

or only minor changes in their definition. In this phase, it is hardly possible to allocate a unique and appropriate score to each grade. For this purpose, it is necessary to assess and titrate the value of each grade on the prognosis of poisoned or critically ill patients in future studies.

DISCUSSION

In this study, we investigated the level of consciousness in poisoned patients by using GCS, AVPU and RASS scales. To the best of our knowledge, this is the first study in which these three scales are compared with each other. We proposed that augmentation of AVPU with RASS parameters, would provide a more detailed system for evaluating consciousness status of poisoned patients. This was primarily due to the fact that among these three scales, agitation can only be assessed by RASS. In our experience, it has always been problematic to correctly assess the consciousness level of agitated poisoned patients by GCS or AVPU scales. Therefore, supplementation of AVPU with RASS has extra advantages.

Comparison of the three scales

The GCS is the most widely used scoring system for comatose patients in critical care settings (12). The GCS was developed for rapid neurologic assessment of acute head injury. Hence, its applicability might be challenged for other critical patients with reduced consciousness and no head injury (13). Although in trauma, a GCS of 8 or less indicates a need for endotracheal intubation, this might not be applicable for poisoned patients as for example, patients with drug or alcohol poisoning and GCS ≤ 8 might have adequate oxygenation and maintained ventilation (10,14,15). This is consistent with our findings. On the other hand, Adnet and Baud concluded that airway management in poisoned patients with GCS higher than 8 should never be neglected as 15% of the drug-poisoned patients admitted to their center with a GCS score greater than 8 developed aspiration pneumonia (16).

AVPU has been successfully validated to be used in toxicology settings (1,5,17). It can be considered as the simplified version of the GCS which is easy to remember and apply to patients. It helps to assess the neurologic status of a critical patient more rapidly. However, it is not suitable for long-term neurologic observation of the patient, as for instance, a patient who localizes pain to painful stimulus in accordance with GCS, is still graded as "P" in AVPU scale even if he showed abnormal flexion to painful stimulus (similarly graded as "P" in AVPU) at the presentation to the emergency setting (some hours before). Hence, although the neurologic status of the patient has improved over time, AVPU shows no change.

RASS is a validated and reliable method to assess patients' level of consciousness in the context of sedation/agitation. The unique feature of RASS is that it monitors the consciousness by taking both arousal and content of thought, the 2 main components of consciousness, into account (18). In contrast to GCS, AVPU and RASS are not limited to patients with intracranial injuries.

Relationship between the scales

Each of the scales has its own idiosyncrasies and none is

robust enough to account for the variation in neurotransmitter effects on consciousness. In a study by Mackay et al, a large group of patients were assessed out-of-hospital by paramedics using the AVPU and GCS. They found that median GCS scores of 15, 12, 8, and 3 corresponded with A, V, P and U grades of AVPU scale, respectively (19). In a study by McNarry and Goldhill on a group of neurosurgical patients, median GCS scores of 15, 13, 8, and 6 corresponded with the AVPU scale, from "alert" to "unresponsive" grades, respectively (20). Kelly et al found median GCS scores of 15, 13, 8 and 3 corresponding with alert to unresponsive grades of AVPU scale, respectively. Our results closely resembles the findings of these 3 studies, as we found median GCS scores of 15, 13, 8, and 6 corresponded with the 4 consciousness grades of AVPU scale (from "alert" to "unresponsive", respectively).

In the present study, all "unresponsive" patients according to AVPU scale had GCS scores less than 8 and all of them required immediate intubation due to poor ventilation. Although half of patients with "P" grade of AVPU scale required intubation, only 1 of them had GCS < 8. The two remaining patients with GCS ≤ 8 recovered with no incident. This somehow undermines the necessity of intubation for drug-poisoned patients with GCS ≤ 8 (13,14). We also noticed that median RASS scores showed similar trend line to GCS scores as patients with preserved consciousness had higher scores and vice versa. Nonetheless, when the range of RASS and GCS scores are taken into account, an apparent variability can be observed. This is due to the fact that for example, an overtly agitated patients might be as unresponsive to verbal or physical stimuli as a highly sedated patient. In poisoning emergency settings, we routinely encounter highly agitated patients with no attention to the clinician as well as being disobedient to the commands (21,22). Although, these patients are awake and may have some coordinated movements, they are generally unresponsive to verbal and physical stimuli which from this aspect their consciousness is majorly reduced. In this context, patients with amphetamine, cocaine or gamma hydroxybutyrate overdose and alcohol or opioid withdrawal syndrome may display reduced consciousness, be disobedient to commands and be extremely combative when stimulated (21-24). Hence, assessment of these patients with AVPU definitions and determinants might be misleading and thus we tried to introduce an augmented AVPU scale which evaluates arousal of the patients as well.

Features of AVPU plus

Although AVPU scale is a rapidly assessing instrument for evaluation of consciousness, due to broad range of definition in each grade, it cannot illustrate the exact neurologic status of a patient at a time point. For instance, a disoriented drug-poisoned patient who is marked as "responsive to verbal stimulus" according to AVPU might be either restless or sedated. Therefore, by combining the concepts and definitions of AVPU and RASS scales, we developed a new scale, so-called AVPU plus. According to this new scale, if an agitated patient (+2 in RASS) is in verbal consciousness level based on AVPU scale, he will be documented as "VA" (Table 4).

Superiority of the AVPU+ to classic AVPU responsiveness scale can be:

1. It combines the consciousness level with agitation-sedation status.
2. It limits the potential misunderstanding of AVPU responsiveness scale in agitated patients.
3. Beyond consciousness, agitation and its severity can be documented and compared in the sequential visits.

However, we are aware that this proposed scale should be put in practice to clarify its validity, reliability, weaknesses and benefits.

LIMITATIONS

Patients poisoned with different class of drugs were included in this study. However, most of the drugs were effective on neurologic system, suitable for the objectives of the study.

CONCLUSION

The AVPU plus is a new scale designed for more detailed assessment of neurologic status of poisoned and critical patients. The prognostic-ability, reliability and validity of the scale should be investigated in future studies.

ACKNOWLEDGEMENT

Authors are thankful for the kind support of the staff of poisoning emergency center and MTC of Imam Reza Hospital, Mashhad University of Medical Sciences, Mashhad, Iran.

Conflict of interest: None to be declared.
Funding and support: None.

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