

Circadian Variability of the Initial Glasgow Coma Scale in Traumatic Brain Injury Patients

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Learning Objectives

1) Describe the relevance of circadian rhythm considerations on Glasgow Coma Scale (GCS) evaluation for traumatic brain injury (TBI) patients; 2) Discuss the independent effect of nighttime admissions on emergency department GCS after TBI; 3) Identify implications for the assessment and triage for TBI patients admitted at night.

Introduction

The Glasgow Coma Scale (GCS) is the primary method of assessing consciousness after traumatic brain injury (TBI) and is the current clinical standard for assessing TBI severity. The GCS forms the basis for clinical management decisions following TBI, e.g. neuroimaging, serial exams, medical and/or surgical management. Circadian rhythmicity is an endogenous oscillation of consciousness across a 24-hour period. Studies have demonstrated that circadian rhythm of melatonin production is disrupted following both TBI and ICU admission following trauma. Hence it is not unreasonable to extrapolate that nighttime hours may be associated with reduced levels of alertness. To date, there is scant literature discerning the influence of circadian rhythms or emergency department (ED) arrival hour on the ED GCS score. We utilized the National Sample Program (NSP) of the National Trauma Data Bank (NTDB) to evaluate the effects of ED arrival hour on ED GCS score, controlling for demographics, medical comorbidities, and injury severity factors. Our data indicate a circadian distribution of GCS score across ED arrival hours, that ED arrival hour independently associates with GCS, and that nighttime ED admissions associate with increased likelihood of ICU admission.

Methods

Retrospective cohort analysis of blunt TBI using the NSP years 2003-06. ED GCS was characterized by midday (10am-4pm) and midnight (12am-6am) cohorts (N=24,548). Multivariable regression assessed associations between ED arrival hour and GCS. Statistical significance at p<0.05.

Prior Medical History	Total (N=24,548)	12am-6am (N=11,047)	10am-4pm (N=13,501)	Sig. (p)
Congestive Heart Failure	130 (0.5%)	43 (0.4%)	87 (0.6%)	0.006
Coronary Artery Disease	384 (1.6%)	104 (0.9%)	280 (2.1%)	< 0.001
Hypertension	1,473 (6.0%)	439 (4.0%)	1,034 (7.7%)	< 0.001
Cerebrovascular Accident	122 (0.5%)	39 (0.4%)	83 (0.6%)	0.004
Dementia	64 (0.3%)	28 (0.3%)	36 (0.3%)	0.840
Cirrhosis	35 (0.1%)	15 (0.1%)	20 (0.1%)	0.799
COPD	243 (1.0%)	69 (0.6%)	174 (1.3%)	< 0.001
Peptic Ulcer Disease	11 (0.0%)	3 (0.0%)	8 (0.1%)	0.237
Coagulopathy	183 (0.7%)	51 (0.5%)	132 (1.0%)	< 0.001
Diabetes Mellitus	622 (2.5%)	186 (1.7%)	436 (3.2%)	< 0.001
Metastatic Cancer	68 (0.3%)	16 (0.1%)	52 (0.4%)	< 0.001
Psychiatric Disorder	551 (2.2%)	248 (2.2%)	303 (2.2%)	0.997
Illicit Drug Use	304 (1.2%)	160 (1.4%)	144 (1.1%)	0.007
Alcohol Abuse	749 (3.1%)	490 (4.4%)	259 (1.9%)	< 0.001



Multivariable Regression for GCS Score

Parameter	Ν	В	SE	95% CI	Sig. (p)
ED arrival hour					
10am-4pm	13,501	Reference			
12am-6am	11,047	-0.29	0.05	-0.40, -0.19	< 0.001
Age	24,548	0.01	0.00	0.01, 0.02	< 0.001
CCI	24,548	0.11	0.05	0.01, 0.21	0.031
Mechanism of injury					
MVA	12,817	Reference			
Pedestrian/cyclist	374	0.55	0.19	0.17, 0.92	0.004
Fall	5,939	-0.10	0.06	-0.22, 0.02	0.108
Struck by	1,471	0.14	0.10	-0.06, 0.34	0.168
Other	3,947	-0.04	0.07	-0.17, 0.09	0.552
Work-related injury					
No	7,246	Reference			
Yes	2,299	0.14	0.09	-0.04, 0.31	0.119
Unknown	15,003	-0.14	0.05	-0.24, -0.03	0.010
ED SBP					
90+	2,3478	Reference			
<90	635	-2.41	0.15	-2.70, -2.12	< 0.001
Unknown	435	-5.14	0.18	-5.49, -4.80	< 0.001
ED drug screen					
No	2,399	Reference			
Yes	4,216	-0.33	0.09	-0.51, -0.14	< 0.001
Unknown	17,933	-0.07	0.08	-0.23, 0.09	0.408
ED alcohol screen					
No	6,005	Reference			
Yes	5,711	-0.64	0.07	-0.78, -0.50	< 0.001
Unknown	12,832	-0.05	0.06	-0.16, 0.07	0.437
ISS group					
0-8	7,140	Reference			
9-15	6,189	-0.29	0.06	-0.42, -0.17	< 0.001
16-25	7,076	-1.70	0.06	-1.82, -1.58	< 0.001
26-75	4,143	-5.10	0.07	-5.24, -4.96	< 0.001

GCS is the dependent variable. B denotes the mean increase or decrease of each predictor subcategory compared to the reference category. CCI = Charlson Comorbidity Index; ISS = Injury Severity Score.

Results

Patients were 43.5±19.9 years old and 69.5% male. GCS was 12.63±4.20 (median 15, IQR 13-15; 77.2% mild, 5.2% moderate, and 17.6% severe TBI). Overall, 85.7% were admitted to hospital (33.5% ICU). Mechanisms of injury in order of incidence were motor vehicle accidents (MVA, 52.2%), fall (24.2%), struck by or against object (6.0%), and pedal cyclist/pedestrian not otherwise specified as MVA (1.5%); mid-night hours were associated with a higher incidence of MVA (54.1% vs. 50.7%), struck by/against (7.8% vs. 4.5%), and other unspecified mechanisms (19.7% vs. 13.1%). Mid-day hours were associated with more falls (29.7% vs. 17.5%). Mid-night TBI patients associated with higher incidence of ICU admissions (35.5% vs. 31.9%), and a lower incidence of floor (41.6% vs. 43.8%) and operating room admissions (8.8% vs. 9.9%). ISS was 15.65±11.22 and did not differ between day and nighttime admissions.

Mid-night admissions were associated with decreased incidences of cardiac, pulmonary, vascular/coagulopathic, and oncologic comorbidities (p<0.001). In contrast, mid-night patients were more likely to have a history of documented alcohol abuse (p<0.001), as well as positive ED toxicology for illicit drugs and alcohol (p<0.001).

<u>GCS</u> demonstrated a circadian pattern with peak at 12pm (13.03 \pm 0.08) and nadir at 4am (12.12 \pm 0.12). Midnight patients demonstrated significantly lower GCS (12am-6am: 12.23 \pm 0.04, 10am-4pm: 12.95 \pm 0.03, p<0.001). Multivariable regression adjusted for age, mechanism, comorbidities, hypotension and ISS confirmed that midnight-hours were independently associated with decreased GCS (B=-0.29 [-0.40,-0.19]).

In patients who did not die in ED or go directly to surgery (N=21,862), multivariable regression demonstrated midnight-hours (OR 1.73 [1.30-2.31]) associated with increased likelihood of ICU admission, while increasing GCS (per-unit OR 0.82 [0.80-0.83]) associated with decreased odds. Notably, the interaction factor GCS*ED arrival hour independently demonstrated an of OR 0.96 [0.94-0.98], suggesting that the influence of GCS on ICU admission odds is less important at night than during the day.

Conclusions

ED admissions for TBI, and the GCS, demonstrate circadian rhythmicity with a daytime peak and nighttime trough. Nighttime TBI patients present with decreased GCS and are admitted to ICU at higher rates, yet have fewer prior comorbidities and similar systemic injuries. The interaction between nighttime hours and decreased GCS on ICU admissions has important implications for clinical assessment/triage.

Acknolwedgments

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