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Research Article

Domestic Animal Inflicted Neurotrauma – A Retrospective Analysis of Five Years Neurosurgical Experience in a Tertiary Care Centre of Northern India

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Abstract

Introduction: Neurotrauma from animal interactions, including domestic incidents, is underexplored and inadequately documented. The aim of this study is to explore epidemiology, clinical manifestations, and outcomes of neurotrauma caused by domestic animals.

Methods: Reviewed data from 23 neurotrauma patients (January 2017-2021) due to domestic animal incidents. Analysed outcomes using Glasgow Outcome Scale and SPSS 28 software.

Results: During the study, 118 out of 7602 neurotrauma patients (1.6%) experienced animal-related trauma, with 95 from animal vehicle collisions/wild animal attacks and 23 from domestic animals (study population). The mean age of study population was 48±17.5 years, with 8.6% paediatric cases and 69.6% males. The majority (86.9%) were rural residents. On presentation, 60.9% had head injuries, 34.8% had spine injuries, and 4.3% had both. Of head injury cases, 64.3% had severe TBI (GCS < 8). A Rotterdam CT score ≥5 correlated with unfavourable outcomes (p=0.03) and mortality (p=0.05). Surgery (4 cases) significantly improved Rotterdam CT scores (p=0.001). Among CT score ≥5 cases, conservative management led to mortality, while surgery resulted in good outcomes (p=0.001). Most of spine injuries fell into ASIA Grade C.

Discussion: Animal-related trauma incidence varies globally, ranging from 1% to 2.7% in developed nations and around 0.2% in developing nations. Munivenkatappa et al.in 2013, reported an incidence of 0.4% in Bangalore. In our neurotrauma ward, it ranks as the fourth most common cause of inpatient admission. Severe TBI were prevalent within it causing high mortality rate. Rotterdam CT Score proved valuable in assessing the need for surgery, correlating positively with the requirement for intervention. It reliably predicted outcomes in head injury patients and demonstrated excellent predictive ability for mortality.

Conclusion: Distinct consideration for domestic animal-related neurotrauma is crucial. The Rotterdam CT Score proved valuable in assessing the need for surgery, correlating positively with the requirement for intervention.

1. Introduction

Animal-related trauma encompasses various forms of injuries involving animals. While existing studies predominantly focus on vehicular accidents associated with stray animals, either resulting from direct collisions or attempts to avoid them, the literature is rich in multiple case reports and case series detailing wild animal attacks on humans [1]. However, when considering isolated domestic animal attacks on humans, the available literature is notably scarce. This scarcity can be attributed to several reasons. Firstly, domestic animals are generally known for their friendliness towards humans and typically refrain from aggression unless provoked or when feeling threatened or insecure. Such insecurity may stem from survival instincts, such as hunger, territorial concerns, protecting offspring, or simple stranger anxiety [2]. Secondly, these incidents are less common compared to animal-induced vehicular accidents [3]. Furthermore, the severity of injuries sustained in domestic animal attacks is usually less intense than those resulting from wild animal attacks or high-velocity vehicle-animal collision accidents. This discrepancy in severity is a primary reason for the underreporting of such cases. The dearth of literature on domestic animal trauma prompted our investigation and served as the primary motivation for this article.

Around 70% of Indians live in rural areas animals are domesticated for various purposes, including serving as a food source (providing milk, eggs, and meat), assisting in agriculture (such as bulls and donkeys), offering companionship (dogs and cats), providing security (dogs), aiding in transportation (horses, mules, and camels), contributing to clothing and textiles (such as sheep), holding religious significance (as seen with cows in Hinduism), being used for research and experimentation (mice), controlling pests (cats), and, last but not least, providing entertainment (as seen with dolphins and seals) [4]. It is crucial and imperative to approach the study of domestic animal attacks differently from wild animal attacks due to variations in injury patterns, severity, grievousness, complications (such as infections), and outcomes [4]. Say for example neck injuries are much more common in wild animal attack [1]. Similarly, vehicular animal collision accidents exhibit distinct characteristics influenced by both vehicle velocity and collision mode. Whiplash injury, carotid dissection and brachial plexus injuries are much more common because of sudden deceleration [3]. Unfavourable land topography in rural areas and sudden obstructions by stray animals, combined with traffic chaos, govern these accidents in urban settings [3].

For neurotrauma purposes, it is crucial to recognize domestic animal attacks as a distinct entity and study them independently from vehicular animal collisions and wild animal attacks. This approach ensures a comprehensive understanding of the unique aspects and implications associated with each type of animal-related trauma.

2. Materials and Methods

Data of all the patients admitted in neurosurgery ward between January 2017 and January 2021 was retrieved from the medical record section of King Georges Medical University, Lucknow. Data of patients with a diagnosis of domestic animal inflicted neurotrauma was segregated from all other forms of animal related neurotrauma (wild animal attack and vehicle animal collision) and non-animal neurotrauma (road traffic accidents, fall from height, assault and firearm injuries). Our study population included only those patients who suffered a direct attack from domestic animal. Rest of them were excluded. Thus, this is a retrospective descriptive single centre study. Data was charted in excel sheet, analysed using IBM SPSS 28 software. Outcome was assessed using Glasgow Outcome Scale.

3. Results

During the study period 7602 patients were admitted for neurotrauma in our institute, out of which 118 patients (1.6%) experienced animal related trauma (figure no.1). Within animal related trauma group there were two subgroups. The first subgroup included those patients who were riding a vehicle (mostly two-wheeler like motorbike), or was a pillion on a two-wheeler and confronted an animal on the way. The vehicle either collided with the animal or the accident happened in an attempt to avoid the animal. It also included patients suffering from an attack of a wild animal like a wild dog, leopard or a tiger. We did not include this subgroup of patients. The second subgroup consisted of those patients who inflicted neurotrauma from direct attack of a domestic animal. These patients formed our study population. The first subgroup had 95 patients (1.2%) and the second subgroup had 23 patients (0.3%). Within animal related trauma group the first subgroup formed 80% of patients and second subgroup formed 20% of patients (figure no.1).

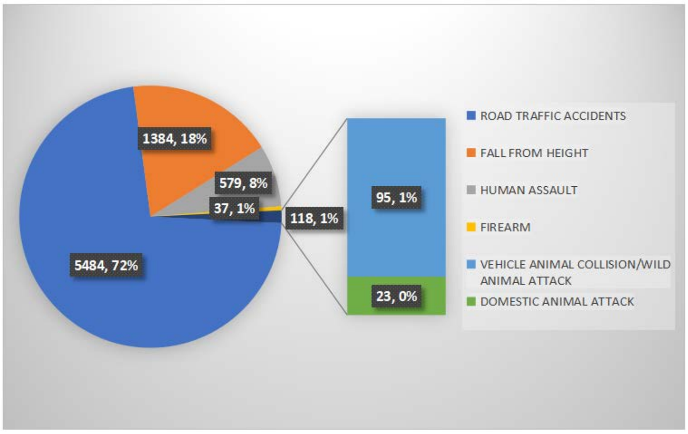

Figure 1: Pie Chart Showing Etiological Distribution of Neurotrauma Patients during the Study Period.

Mean age of study population was 48±17.5 years ranging from 4 years to 70 years. 2 (8.6%) patients were of paediatric age group (<18 years). 69.6% (16) of patients were males while 30.4% (7) were females (table no.1). 86.9% (20) of them belonged to rural area or villages. Bull was the culprit in 65.2% (15) of cases, buffalo and cow shared 17.4 % (4) cases each (table no.1). 19 patients were referred to us from other hospitals while 4 came to us directly. Average time to visit primary medical facility was 7.90±10.32 hours with a median of 4 hours (range- 1 hour to 48 hour). Mean time to visit our trauma centre was 66.34±97.51 hours with a median of 36 hours (range- 4 hours to 16 days). 60.9% incurred head injury, 34.8% suffered spine injury and 4.3% had both.

Table 1: Showing Patient Particulars Along With Mechanism of Injury with Animal Involved.

S. No	Age (Years)	Gender (M-Male; F-Female)	Mechanism of Injury
A	45	F	Hit By Buffalo
B	60	M	Hit By Bull
C	50	F	Hit By Bull
D	70	M	Hit By Bull
E	70	M	Hit By Cow
F	50	M	Hit By Bull
G	65	M	Hit By Bull
H	30	F	Hit By Bull
I	67	M	Hit By Bull
J	50	F	Hit By Bull
K	60	F	Hit By Bull
L	55	F	Hit By Cow
M	30	M	Hit By Buffalo
N	25	M	Hit By Bull
O	60	M	Hit By Bull
P	60	M	Hit By Buffalo
Q	45	M	Hit By Bull
R	17	M	Hit By Buffalo
S	4	M	Hit By Cow
T	50	F	Hit By Cow
U	55	M	Hit By Bull
V	30	M	Hit By Bull
W	55	M	Hit By Bull

We divided our study population into head injury and spine injury group. This approach allowed a more focused analysis, as the hospital course, management, and outcomes are likely to vary significantly between these two groups. By creating uniform groups for comparison, we increased the internal validity of our study. This means that any observed differences in outcomes can be more confidently attributed to the specific type of injury rather than confounding variables related to different management approaches or hospital courses.

Head injury group (14 patients): Time Interval between injury and first imaging (CT Brain) is depicted in figure no.2. Within head injury group 64.3 % (9/14) had severe TBI (traumatic brain injury) with a GCS < 8 while 35.7% (5/14) had mild to moderate TBI with a GCS (Glasgow Coma Score) of ≥8. History of loss of consciousness was present in all the patients, vomiting was present in 42.8% (6) and ear or nose bleed in 21.4% (3).

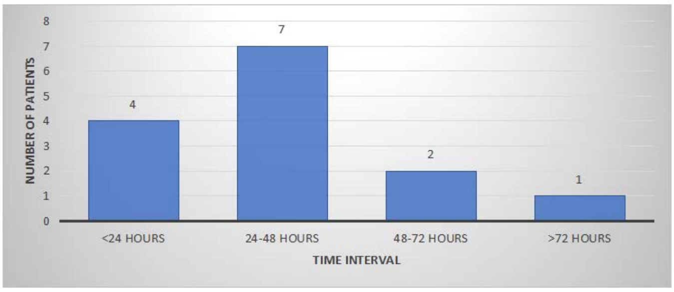

Figure 2: Time Interval between Injury and First Imaging (Ct Brain).

Distribution of TBI according to radiological diagnosis is shown in figure no.3. Average volume of intraparenchymal hematoma was 20 ml, Acute Subdural hematoma was 35 ml and extradural hematoma was 28 ml.

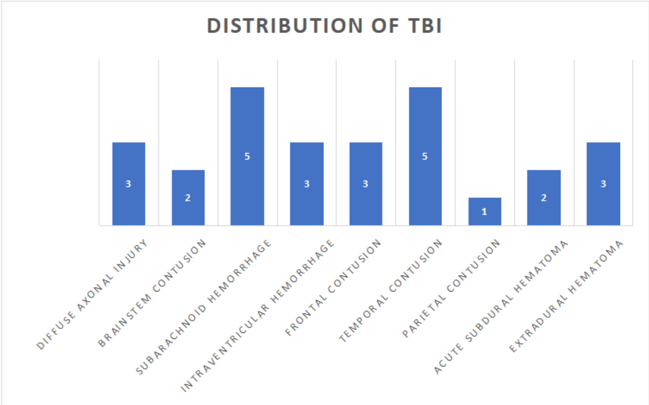

Figure 3: Bar Diagram Showing Prevalence Of Various Types Of Tbi In Study Group.

Plain CT brain was used as primary modality not only to make radiological diagnosis but also to decide the primary mode of management. Mid line shift (MLS) was used as a primary marker for assessing mass effect and raised intracranial pressure. Mean MLS was 5.03±5.24 mm with a median of 3.35 mm (range- 0 to 18 mm). Rotterdam CT score was used to evaluate the severity of injury, need for surgery and predict the prognosis.

Rotterdam CT score, Mortality rate at 3 months and final outcome and disability in form of Glasgow Outcome Score (Unfavourable Outcome) at 3 months were charted (table no.2) and correlated using statistical analysis. A Rotterdam CT score of more than 4 was significantly associated with unfavourable outcome (p value-0.03) and mortality (p value-0.05).

Table 2: Correlation of Rotterdam CT score, Mortality rate and Unfavourable outcome.

Rotterdam CT score	Number of patients	Mortality rate	Unfavourable outcome (GOS≤3)
2	1	0%	0%
3	4	0%	25%
4	3	0%	67%
5	5	40%	100%
6	1	100%	100%

Five out of fourteen patients needed surgery however one patient refused surgery. Thus, only four patients underwent surgery for cranial trauma. A brief description of relevant individual parameters is given in table no.3.

Table 3: A Brief Summary of Clinical Profile of Patients Who Underwent Surgical Intervention (*C- Patient Has an Associated Spine Injury Which Was Also Manged by Surgery).

Patient	Age	Gender	Animal	Diagnosis	Surgery
A	60	Male	Bull	Left Fronto-Temporal Contusion	Craniotomy With Contusectomy With Augmentation Duroplasty
B	60	Female	Bull	Bilateral Fronto-Parietal Contusion (right>left)	Craniotomy With Contusectomy With Augmentation Duroplasty (right side)
C*	45	Male	Bull	Right Temporo-Parietal Extradural Hematoma	Craniotomy And Evacuation Of Extradural Hematoma
D	4	Male	Cow	Posterior Fossa Extradural Hematoma	Midline Suboccipital Craniotomy With Evacuation Of Extradural Hematoma

Surgery was associated with significant improvement in Rotterdam CT score (19/24 vs 7/24) with a p value of 0.001 (table no.4). There was significant clinical improvement at 3 months follow up post-surgery which was reflected by an improvement in Glasgow Coma Score (GCS), Glasgow Outcome Score (GOS) and Rotterdam CT Score (table no.4).

Table 4: A comparison of pre and post operative GCS, Rotterdam CT score and GOS.

Patient	GCS (pre-op)	GCS (3 months)	Rotterdam CT Score (pre op)	Rotterdam CT Score (post op)	GOS (3 months)
A	E1V1M3	E4V2M5	5/6	2/6	3
B	E1V1M2	E4V4M5	5/6	3/6	3
C	E4V2M5	E4V5M6	4/6	1/6	4
D	E2V2M5	E4V5M6	5/6	1/6	5

An important observation in our study was 6 patients had Rotterdam CT score of more than 4 at presentation, out of which 3 were managed conservatively and rest 3 surgically. All 3 patients who were managed conservatively died while all 3 who were managed with surgery had good outcome (p value- 0.001). Thus, non-surgical management was a good option in patients with a Rotterdam CT score of less than 5, however surgical intervention was required to salvage the patient if it was 5 or more.

Spine injury group (9 patients): Out of 23 patients, 9 patients sustained isolated spine injury. 1 patient sustained both head and spine injury. Distribution of types of spine injury is summarized in figure no 4.

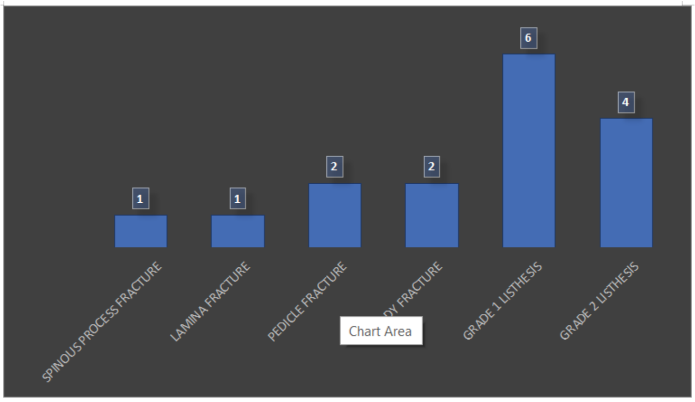

Figure 4: Frequency of Various Types of Spinal Injuries Amongst Study Population.

Listhesis was the most common spine injury occurring in all the ten patients. The frequency in form of number of patients and different level of listhesis is shown in Figure no.5

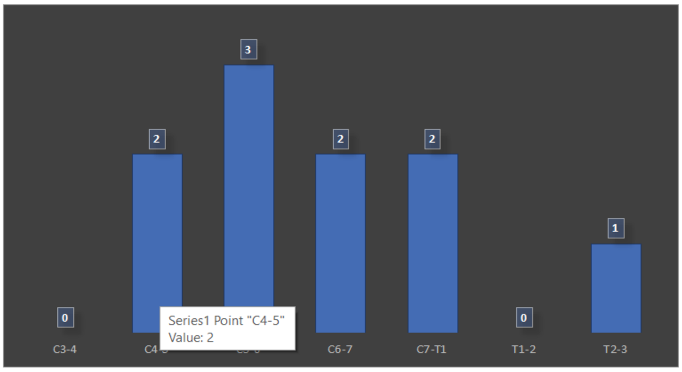

Figure 5: Frequency Distribution of Patients at Each Level of Listhesis.

Neurological deficit at presentation was represented in form of ASIA grade. Maximum number of patients fell in ASIA Grade C type of injury. None of the patient had Grade A and Grade E type of cord injury. A diagrammatic representation of patient distribution according to ASIA score is depicted in figure no.6.

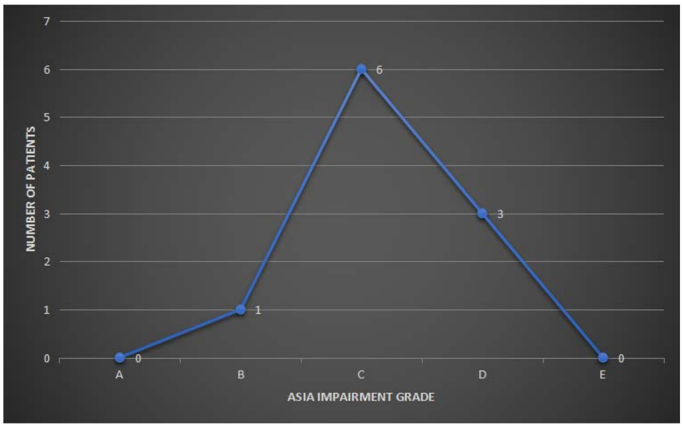

Figure 6: 3-D Line Diagram Representing the Type of Neurological Deficit in Form of Asia Impairment Grade Amongst the Study Population.

Bradycardia and hypotension were present in 3 patients and respiration was involved in 2 patients. 6 patients improved with conservative management while 2 patients succumbed to death because of respiratory involvement. Surgery was required in only 2 patients. Both the patients improved after surgery. There was one patient (out of these 2) who underwent both cranial and spinal surgery. He was having Right Temporo-Parietal Extradural hematoma and C5 body fracture along T2-T3 grade 1spondylolisthesis (with Grade D ASIA cord injury). He underwent craniotomy and evacuation of extradural hematoma followed by C5 corpectomy and C4-C6 fixation using expandable cage and screws. Patient did well following surgery with a GOS of 5 at 3 months follow up. His ASIA grade remained D at 3 months follow up. The second patient who underwent only spinal surgery had improvement in ASIA score from Grade C preoperatively to Grade D at 3 months follow up.

4. Discussion

Animal-related trauma ranks as the fourth most common cause of inpatient admission in our neurotrauma ward, following road traffic accidents, falls from height, and human assault. Despite comprising only 1.6% of our overall ward admissions, 20% of these cases constituted our study population (0.3%). While relatively rare, managing such cases presented a significant challenge, and the prognosis was guarded if not handled meticulously. Notably, our study revealed a high overall mortality rate of 21.7% (5/23) in this specific population, emphasizing the critical importance of understanding and addressing this issue.

A substantial majority of our study population, 86.9%, hailed from villages, highlighting the continued dependence of our rural population on animal husbandry for various reasons. Of the study population, 60.9% presented with TBI, 34.8% had spine injuries, and 4.3% experienced both. Among head injury patients, nearly two-thirds had severe TBI with a Glasgow Coma Scale (GCS) less than 8. The selective mortality rate among head injury patients was 21.4% (3/14), reinforcing the notion that these patients may sustain significantly severe injuries. However, with timely and careful management, mortality can be mitigated.

The study underscored the utility of the Rotterdam CT Score in assessing the need for surgery. A score exceeding 4 showed a positive correlation with the requirement for surgery (p-value: 0.001). The Rotterdam CT Score emerged as a gold standard tool for predicting outcomes in head injury patients. A score above 4 was significantly associated with an unfavourable outcome, defined as a Glasgow Outcome Scale ≤3 (death, vegetative state, or severe disability) with a p-value of 0.03. Furthermore, it proved to be an excellent predictive tool for mortality (p-value: 0.05).

In spine injury patients, the selective mortality rate was 25% (2/8). Cardiorespiratory involvement associated with spinal shock was the primary reason for mortality. However, 75% of patients demonstrated a positive outcome, either stabilization or improvement in ASIA score. Surgery significantly improved the ASIA score in the spinal injury group.

We encountered two cases (8.7% of our study population) involving paediatric patients, with one being a 4-year-old child who suffered both cranial and spinal trauma. Notably, this child was the sole participant in our study who required surgical intervention for both conditions. Post-surgeries, the child demonstrated positive progress, achieving a GOS of 5 at the 3-month follow-up. This particular case taught us two invaluable lessons simultaneously. Firstly, it underscored the potential severity of injuries in paediatric cases, necessitating prompt surgical intervention. Secondly, with meticulous care and proper management, the outcomes can be remarkably favourable. A study by Ameh also highlighted similar insights. However, out of 17 children with animal-related trauma, only two had head injuries in his study, both of which were managed conservatively [5].

The incidence of animal-related trauma in the literature varies, ranging from 1% to 2.7% in developed nations and approximately 0.2% in developing nations. Nogalski found an incidence of direct animal attack in Poland to be 2.6% [6-8]. A study from eastern Turkey by Mucahit Emet quoted an incidence of 0.2%. However, there is limited specific data on neurotrauma resulting from animal-related incidents that can be cited [7].

Notably, a study conducted by Munivenkatappa in 2013 at the National Institute of Mental Health and Neurosciences in Bangalore reported an incidence of animal-related neurotrauma at 0.4% [9]. This study shares several similarities with our present study; for instance, the majority of patients were males, most hailed from rural areas, and there was an almost equal mean time interval from injury to presentation. However, there are some notable differences between the two studies. The Bangalore study included both patients involved in animal vehicle collisions and those directly attacked by animals, introducing a factor that reduced homogeneity and internal validity. Another limitation of the study was the availability of follow-up data, which was only present for 33% of cases. In contrast, our study focused exclusively on either head or spine injuries, enhancing homogeneity and internal validity. Furthermore, our study identified a higher proportion of severe TBI cases at 39.1%, in contrast to the Bangalore study's 3.3%. This discrepancy may contribute to the variation in mortality rates, with the Bangalore study reporting a mortality rate of 3.3% compared to our study's 21.7%. A summary of the key differences between the two studies is presented in Table 5.

Table 5: A Brief Comparison between Both the Studies.

Study	Munivenkatappa et al.	Our study
Number of patients	30	118
Proportion of neurotrauma	0.5%	1.6%
Animal vehicle collision	15	95
Direct animal attack	15	23
Males	70%	69.6%
Rural areas	96.6%	86.9%
Mean time interval from injury to presentation	7.58 ± 7.14	7.90±10.32
Head injury	50%	60.8%
Severe TBI	3.3%	39.1%
Contusion	26.6%	47.8%
Skull fracture with Extradural hematoma	13.3%	13.0%
Diffuse axonal injury	6.6%	13.0%
Acute subdural hematoma	6.6%	8.7%
Subarachnoid haemorrhage	6.6%	21.7%
Spine injuries	10%	39.2%
Surgical intervention	10%	21.7%
Mortality rate	3.3%	21.7%

5. Conclusion

0Neurotrauma resulting from domestic animal encounters constitutes a distinct category of injury that warrants separate consideration from injuries caused by wild animals or vehicular collisions with animals. This particular type of trauma, while potentially severe and complex, assumes a more favourable prognosis when approached with timely and appropriate management, particularly in cases involving children.

The Rotterdam CT Score emerges as a valuable instrument in guiding the management of such cases. This scoring system proves instrumental in determining the necessity of surgical intervention, predicting prognosis, and evaluating outcomes during follow-up assessments. Notably, surgery can markedly enhance outcomes when applied judiciously to carefully selected patients.

In conclusion, recognizing the unique characteristics of domestic animal-inflicted neurotrauma, utilizing tools such as the Rotterdam CT Score, and implementing timely surgical interventions in suitable cases all contribute to optimizing patient outcomes and ensuring a comprehensive approach to this specific category of injury.

Abbreviations

TBI- Traumatic Brain Injuries
MLS- Mid Line Shift
CT- Computed Tomography
GCS- Glasgow Coma Score
GOS- Glasgow Outcome Score

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