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ORGINAL ARTICLE

Early predictors of mortality in polytrauma patients in intensive care units

Khaled Sallam Moselhi[1], Mohamed Mohsen Elmaghrabi[2], Mohamed Ahmed El-Gazzar[3], Abd-Elrahman Mohamed Sobhy El-Zefzaf[4]

[1] Neurology and Psychiatry Department, Benha Faculty of Medicine, Benha University
[2]Neurosurgery Department, Benha Faculty of Medicine, Benha University
[3]Cardiothoracic surgery Department, Benha Faculty of Medicine, Benha University
[4]Intensive care unit ,Shebin Elkom Teacing hospital, Menoufia, Egypt

***Corresponding author**
Mohamed Mohsen Elmaghrabi

Email:
dr_elmaghrabi@yahoo.com

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ABSTRACT

Background: Trauma is a leading cause of morbidity and mortality worldwide. The traumatized patient outcome is multi-factorial through combination of the clinical diagnosis and presence and severity of comorbidities. Mortality predictors among head trauma patients are still far from being reported. Aim**:** This study aimed to enhance the outcome of the polytrauma patients admitted to intensive care unit ICU through construct a predictive model for mortality on the basis of easily available parameters. **Methods:** Our cohort prospective study consisted of 60 Egyptian patients from January2020 to January2021 over 16 years old with Glasgow coma scale (GCS) 4-14 followed traumatic brain injury and full clinical evaluation on admission was done including a full history, clinical examination, radiological and laboratory investigations. All patients were evaluated according to GCS, APACHE II and RTS scores. In addition, all patients were followed-up for 2weeks from the day of admission .The primary outcome assessed the mortality with analysis of different clinical and lab parameters for detection of predictors of mortality. **Results:** Sixty patients were with mean age/year was 40.43 ± 16.9 with 58.3% were males. A mortality rate of 45% as non-survivor was detected with a predominance of road traffic accidents as a mode of injury (51.7%). There is statistically significance of lower scores of GCS and RTS but higher scores of APACHE II in non- survivors than survivors. Multivariate logistic regression detects that diabetes mellitus (DM) is the most significant predictor of non survivors. **Conclusion:** Multiple significant predictors of mortality were found as: advanced age, low PLT count, high renal function tests and radiological CT brain findings. DM is the most significant predictor of mortality.

Keywords: predictors; mortality; polytrauma; ICU.

INTRODUCTION

Trauma is a most common cause of morbidity and mortality worldwide. Annually, about one and half million affected people die while several millions need emergency management[1]. Polytrauma is defined as more than one injury that occurred to different body organs or systems. One of which (as brain) may be life threatening or causing physical, cognitive or psychological impairments and disability[2]. Head injuries lead to immediate death in 25% of acute traumatic injuries. Traumatic brain injury (TBI) is occurred mainly in road traffic accidents by a blow to the head, penetration of the skull, fast acceleration or deceleration of the head, or exposure to a blast. In the United States, there are more than 5.3 million people lived with a disability as a result of a TBI. These injuries lead to short and long term hazards on health, ranging from minimal interference on lifestyle, through to physical, emotional, and psychosocial changes that may interfere with daily activities[1].

The traumatized patient outcome is multi-factorial through combination of the clinical diagnosis and presence and severity of

comorbidities[3].In order to minimize the mortality rate associated with polytrauma, the factors affecting mortality should be well evidenced to take care of polytraumatized patients[4].

Although decision-making of the traumatized patient is mostly based on clinical situation, it can be modulated by using the scoring systems. Decision-making cannot be taken on a numerical scale only as the ideal prognostic scale. Mortality predictors among head trauma patients are still far from being reported[5].

Management of TBI patients is focused on preventing secondary cerebral injury as increased intracranial pressure (ICP), hypotension and hypoxia[6].

PATIENT AND METHODS

Our study is a prospective cohort study conducted on 60 patients admitted to I.C.U at Benha University and Shebin El-KomTeching Hospitals during the period from January 2020 until January 2021, all the studied polytrauma populations were diagnosed to have an acute traumatic brain injury. In addition, all patients were followed-up for 2 weeks from the day of admission.

Inclusion criteria: All head trauma patients older than 16 years, head trauma patients admitted to I.C.U from Emergency room and all patients with Glasgow coma scale of 14 or less with a positive brain computerized tomography (C.T.) finding. **Exclusion criteria:** Post arrest patients, patients with GCS=3, ICU admission > 8 hours after injury, patients with associated cervical spine injury and advanced maxillofacial injury.

ICU Scoring systems: ***Glasgow coma scale (GCS):*** we have divided patients into groups according to severity (GCS code) to compare each group with the outcome; mild group (13-15) moderate severity group (9-12) and severe group (4-8). ***Acute Physiology and Chronic Health Evaluation (APACHE II) Score:*** it was calculated from information on chronic health status, a patient's age and 12 routine physiological variables were measured. ***Revised trauma score (RTS):*** **(**the score is based on 3 variables) Respiratory rate (RR), Glasgow coma score (GCS), Systolic blood pressure (SBP). The worst value was recorded during the first 24 hours of admission and then an estimated approximate mortality percentage was measured.

All patients were subjected to full history taking, complete clinical examination, radiological and laboratory investigations

Mortality & outcome: all ICU mortalities were documented; we divided our patients into two groups: survivors and non-survivors.

Statistical analysis: the collected data were summarized in terms of mean ± Standard Deviation (SD) and range (minimum - maximum) for quantitative data and frequency and percentage for qualitative data. Comparisons between the different study groups were carried out using the Chi-square test (χ^2) and the Fisher Exact Test (FET) to compare proportions when appropriate, the independent t-test (t) was used to detect difference between quantitative data. Receiver operating characteristic (ROC) curve and Multivariate logistic regression were performed. After the calculation of each of the test statistics, the corresponding distribution tables were consulted to get the "P" (probability value). Statistical significance was accepted at P value ≤0.05. A P value ≤0.001 was considered highly significant while a P value > 0.05 was considered non-significant. The statistical analysis was conducted using SPSS version 21.

Ethical consideration: this research accepted by Research Ethics Committee (REC) of faculty of medicine, Benha University. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. A written informed consent was obtained from each patient's relatives after explaining all steps of this study.

RESULTS

Sixty patients were included in this study with table 1 shows that mean age/year was 40.43 ± 16.9 with 58.3% were males. Diabetes mellitus was reported in 30%, 26.7% were hypertensive and other co-morbidities like ischemic heart disease (IHD), hepatic diseases, chronic kidney disease (CKD), asthma, CODP and down syndrome have been reported in 6.7%, 6.7%, 11.7%, 5%, 3.3% and 1.7% respectively. A mortality rate of 45% (n=27) who presented as non-survivor was detected in the studied group with a predominance of road traffic accidents (RTA) as a mode of injury (51.7%).

Regarding co-morbidities, significant statistical difference has been detected between survivors and non-survivors regarding diabetes mellitus, hypertension, IHD, hepatic disease, CKD and asthma (p = 0.001, 0.005, 0.02, 0.02, 0.02, 0.049 respectively) as in figure 1.

Table 2, regarding laboratory results, shows that 29.6% of non-survivors had platelets $<150\times10^3$ / mm^3 and 59.3% had INR ≥ 1.2 which is statistically significant while 29.6% had renal impairment as serum creatinine level ≥1.5mg\dl and serum urea (mg/dl) mean±SD was 70.26 ± 34.62 which is statistically highly significant.

In table 3 there is statistically significance of lower scores of GCS and RTS but higher scores of APACHE II in non- survivors than survivors.

Radiological investigations as in table 4 detect (by CT brain) intracerebral hemorrhage (ICH) in 17/27 patients (63% of non survivors) but in 4/33 patients (12.1% of survivors) which is statistically highly significant and midline shift in 4/27 patients (14.8% of non survivors) but none in survivors which is statistically significant. ICH and midline shift are most significant predictors of mortality according to radiological finding.

Roc curve detected cut-off points of ICU Scores which lead to mortality as the cut-off point of GCS score is 7, which yielded a sensitivity of 74.07% and a specificity of 78.79%, with the area under curve (AUC) at 0.851, while the cut-off point of APACHE II score is 16, but The optimal cut-off point of RTS score is 6, which are statically significant. The ROC curve (figure 2) shows that the most accurate score for outcome of mortality is GCS then APACHE II.

Multivariate logistic regression (Table 5) detects that DM is the most significant predictor of non survivors.

100% of non survivors' required mechanical ventilation compared with 73% of survivors. Complications as chest infection, acute respiratory syndrome (ARDS), septic shock, pulmonary embolism and arrhythmias were occurred during ICU stay with chest infection was the most complication affecting mortality especially in ventilated patients.

Table (1): Comparison between survivors and non-survivors regarding demographic characteristics (n=60).

Variable		Survivors (n=33)		Non-survivors (n=27)		Test	P-value
		No.	%	No.	%		
Sex	**Male**	20	60	15	55.6	$\chi2 = 0.155$	0.69
	Female	13	39.4	12	44.4		
Co-morbidities	**DM**	3	9.1	15	55.6	$\chi2 = 15.3$	0.001**
	HTN	4	12.1	12	44.4	$\chi2 = 7.9$	0.005*
	IHD	0	0.0	4	14.8	$\chi2 = 5.24$	0.02*
	Hepatic	0	0.0	4	14.8	$\chi2 = 5.24$	0.02*
	CKD	1	3.0	6	22.2	$\chi2 = 5.31$	0.02*
	Asthma	0	0.0	3	11.1	$\chi2 = 3.85$	0.049*
	CODP	0	0.0	2	7.4	$\chi2 = 2.52$	0.11
	Down syndrome	0	0.0	1	3.7	$\chi2 = 1.24$	0.26
Mode of injury	**RTA**	17	51.5	14	52	$\chi2 = 0.00$	0.9
	FFH	16	48.5	13	48		
Age (years)	**Mean ±SD (Range)**	33.64 ± 10.3 (20 - 65)		48.74 ± 19.68 (18 - 77)		t=3.82	0.001**

**= significant **=highly-significant*

Table 2: Comparison between survivors and non-survivors regarding laboratory findings (n=60).

Variable		Survivors (n=33)		Non-survivors (n=27)		Test	P-value
		No.	%	No.	%		
Hb(g\dl)	**< 8**	1	3.0	3	11.1	$\chi^2 = 1.55$	0.2
	≥ 8	32	97.0	24	88.9		
	Mean ±SD (range)	10.7 ± 2.16 (6 – 16.7)		11.44 ± 3.11 (5.8 -20)		t = 1.08	0.28
PLT (10^3 /mm^3)	**< 150**	3	9.1	8	29.6	$\chi^2 = 4.18$	**0.04***
	≥ 150	30	90.9	19	70.4		
	Mean ±SD (range)	224.3 ± 69.24 (2.2 – 360)		180.4 ± 70.78 (66- 333)		t = 2.42	**0.02***
WBC (10^3/ mm^3)	**< 12**	5	15.2	7	25.9	$\chi^2 = 1.07$	0.29
	≥ 12	28	84.8	20	74.1		
	Mean ±SD (range)	17.09 ± 6.43 (2.3 – 30)		18.85 ± 17.1 (4 – 99)		t = 0.54	0.58
INR	**< 1.2**	24	72.7	11	40.7	$\chi^2 = 6.25$	**0.01***
	≥ 1.2	9	27.3	16	59.3		
Creatinine (mg\dl)	**< 1.5**	32	97.0	19	70.4	$\chi^2 = 8.24$	**0.004****
	≥ 1.5	1	3.0	8	29.6		
	Mean ±SD (range)	0.83 ± 0.33 (0.3 -2.2)		1.55 ± 1.38 (0.6 – 6.2)		t = 2.9	**0.005****
PH	**< 7.35**	10	30.3	8	29.6	$\chi^2 = 0.003$	0.95
	≥ 7.35	23	69.7	19	70.4		
PT	**Mean ±SD (range)**	86.58 ± 13.4 (30-100)		79.52 ± 13.61 (48-100)		t = 2.02	**0.04***
RBS	**Mean ±SD (range)**	157.8 ± 60.27 (95 – 322)		242.9 ± 119.7 (90 – 450)		t = 3.57	**0.001****
Urea (mg\dl)	**Mean ±SD (range)**	48.7± 21.4 (22 – 95)		70.26 ± 34.62 (24 – 151)		t = 2.95	**0.004****
AST	**Mean ±SD (range)**	71.82 ± 54.94 (17 -230)		60 ± 21.94 (22 -125)		t = 1.05	0.29
ALT	**Mean ±SD (range)**	67.33 ± 45.33 (26 – 233)		55.48 ± 23.42 (28 – 135)		t = 1.22	0.22

= significant** *=highly-significant**

HB (hemoglobin), PLT (platelets), WBCs (White blood cells), INR (International normalization ratio), MV (Mechanical ventilation

Table 3: Comparison between survivors and non-survivors regarding GCS, APACHE II

Score and RTS (n=60).

Variable	Survivors (n=33)		Non-survivors (n=27)		Test	P-value
	Mean ±SD	Range	Mean ±SD	range		
GCS	8.88 ± 1.85	6 – 13	6.07 ± 2	4 - 12	t = 5.6	**0.001****
APACHE II	12.15 ± 3.71	5 – 19	18.78 ± 5.64	7 - 35	t = 5.5	**0.001***
RTS	6.27 ± 0.84	5 – 8	5.48 ± 0.7	4 -7	t = 3.9	**0.003***

= significant* *=highly-significant*

Table 4: Comparison between survivors and non-survivors regarding to radiological findings (n=60).

Radiological findings			Survivors (n=33)		Non-survivors (n=27)		Test	P-value
			No.	%	No.	%		
Chest X-Ray	**Free**		20	60.6	8	29.7	χ^2 = 7.6	0.36
	Pneumonia (chest infection)		1	3.0	2	7.4		
	Unilateral pneumothorax		3	9.1	3	11		
	Bilateral pneumothorax		3	9.1	2	7.4		
	Aspiration		4	12.1	7	26		
	Flail chest		1	3.0	2	7.4		
	Unilateral Hemothorax		0	0.0	1	3.7		
	Bilateral Hemothorax		1	3.0	2	7.4		
U/S Abdomen (Intraperitoneal collection)	**Free**		23	69.7	17	63	χ^2 = 6.3	0.09
	Minimal		8	24.2	3	11.1		
	Moderate		2	6.1	4	14.8		
	Marked		0	0	3	11.1		
CT brain findings	**Brain edema**	**+ve**	29	87.9	20	74.1	χ^2 =1.8	0.16
		-ve	4	12.1	7	25.9		
	ICH	**+ve**	4	12.1	17	63	χ^2 = 16.8	**0.001****
		-ve	29	87.9	10	37		
	SAH	+**ve**	17	51.5	12	44.4	χ^2 = 0.29	0.58
		-ve	16	48.5	15	55.6		
	SDH	**+ve**	1	3	3	11.1	χ^2 = 1.5	0.21
		-ve	32	97	24	88.9		
	EDH	+**ve**	5	15.2	3	11.1	χ^2 = 0.2	0.64
		-ve	28	84.8	24	88.9		
	Contusion	+**ve**	8	24.2	4	14.8	χ^2 = 0.82	0.36
		-ve	25	75.8	23	85.2		
	Midline shift	+ve	0	0	4	14.8	χ^2 = 5.23	**0.02***
		-ve	33	100	23	85.2		
	IVH	**+ve**	2	6	2	7.5	χ^2 = 0.04	0.83
		-ve	31	94	25	92.5		
	Skull fracture	**+ve**	0	0.0	1	3.7	χ^2 = 1.24	0.26
		-ve	33	100	26	96.3		

*= significant **=highly-significant

ICH (Intracerebral hemorrhage), SAH (subarachnoid hemorrhage), SDH (Subdural hemorrhage), EDH (Extradural hemorrhage), BE (Brain edema), IVH (Intraventricular hemorrhage

Table 5: Multivariate logistic regression for the predictors of non survivors

Variables	Sig.	Exp(B)	95% C.I. for EXP(B)
Age	.003**	3.356	1.519 - 7.413
DM	.002**	5.387	2.511- 11.559
HTN	.02*	.177	.046 - .681
IHD	.03*	.992	.984 - 1.000
Hepatic disorders	.042*	1.390	1.199 – 1.612
CKD	.046*	1.588	.768 – 2.36
ICH	.003**	.657	.447 - .967
GCS	.002**	.600	.440 - .817
RTS	.004**	.500	.315 - .932
APACHE II	.005**	1.613	1.236 – 2.85

*Significant ** Highly Significant

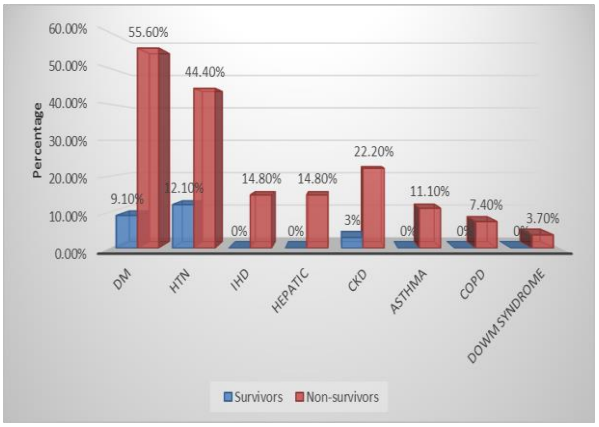

Figure 1: Frequency distribution of the studied groups as regard to co-morbidities.

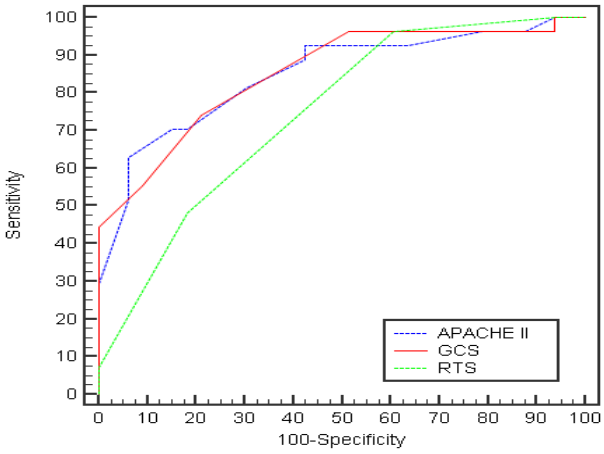

Figure (2): ROC curve for ICU Scoring systems and mortality outcome

DISCUSSION

Predicting outcome after traumatic brain injury is so difficult, as the nature of the primary brain injury is extremely heterogeneous, no two injuries will be exactly the same and the primary injury will be modified by secondary insults.

Our study was conducted on 60 patients with mortality was the primary studied outcome and was documented in 27 patients (45%), This was in agreement with ***Tobi et al.[7]*** study who showed 47% mortality.

Diabetes had a significant effect on mortality in our study, where 55.6% of non survivors had diabetes compared to only 9.1 % of survivors. Similarly, ***Simin et al.***[8] found that diabetes was a significant predictor of mortality with 65.8% of non survivors with RBS>200 vs. 23.7% of survivors. On the contrary ***Jordan et al.[9]*** showed that DM had no significant impact on outcome as he had 24.7% diabetic. Hyperglycemia itself might contribute to morbidity and mortality by generating a noxious cellular environment which causing electrolyte irregularities and depressing the body immunity[10].

Hypertensive patients constituted 26.7% of our studied population with a significant effect on mortality, where 44.4% of non survivors had HTN compared to 12.1 % in survivors which is statistically significant. Our results were in concordance with ***Barmparas et al.*** *[11]* who found that pre-hospital hypertension in TBI was associated with a higher mortality risk. On the contrary, a study performed by ***Strnad et al.[12]***showed that patients with a history of hypertension had no impact on mortality. Arterial HTN can also have damaging effects by raising cerebral perfusion pressure so it leads to enforced dilation of cerebral arterioles with a rise in cerebral blood volume and thus increasing intracerebral pressure. This leads to impaired function of the blood brain barrier and inversion of the hydrostatic gradients then formation of cerebral edema ± hemorrhage[13].

Non survivors had significant lower PLT count than survivors (180±70.78 vs. 224.3±69.24).

Our results were in agreement with ***Hampton et al. [14]*** who found that decreased PLT count significantly affect mortality (mean value of PLT in non-survivors 178±35 vs. 235 ±50mm^3 in survivors). On the contrary, in the study performed by ***Da Costa et al.[15]***found that there was no impact of PLT count on mortality.

Regarding ICU Scoring systems, our study showed that low GCS was associated with increased mortality with cut-off point (GCS; 7) which had 74.07% sensitivity and 78.79% specificity in predicting mortality through the ROC curve. Our results were in agreement with Also, in a study was done by ***Da Costa et al. [15]***on 200 patients had moderate and severe TBI showed that decreasing GCS had a significant effect on mortality and ***Yuan et al.* [16]** found that decreasing GCS had a significant impact on mortality (p< 0.001). On the contrary, in a study done by ***Freitas and Franzon[17]*** on 851 patients, they found that GCS had no significant effect on mortality with (Mean in non-survivors was 7.4 vs. 8.3 for survivors with p=0.371).

Our study showed that APACHE II score had significant association with increased mortality (mean value of APACHE II was in non survivors 18.78±5.64 vs. 12.15± 3.71 in survivors) with cut-off point (16) as a predictor of mortality. This results were in agreement with ***Nik et al.[18]*** study who found that APACHE II had a significant impact on mortality in TBI (Mean value for non- survivors 19.4±5.5 vs. 12.4±5.5 in survivors). In the same context, ***Jovanovic et al.[19]*** found that APACHE II had a significant impact on mortality in TBI (p<0.001).

In addition, low RTS was associated with high mortality in our study with mean value of 6.27±0.84 vs. 5.48±0.70 in survivors and non survivors respectively (p<0.001) with cut-off point (6) as predictor of mortality. Similar finding was documented by ***Kim et al.[20]***who showed a significant difference regarding RTS score in patients with TBI. Also ***Orhon et al.[21]***found that low RTS score had significant effect on mortality (survivors mean value was 7.75±0.46, vs. 5.62±1.31 in non-survivors, p<0.001).

When comparing brain CT findings, we found that ICH and midline shift had significant effect on mortality, where 63% in non survivors had ICH compared to only 12 % in survivors and 14.8% in non survivors had midline shift. Our results were in agreement with ***Mata-Mbemba et al.[22]*** who found that brain CT finding of ICH and midline shift in patients with TBI had significant effect on mortality (non-survivor with ICH constitute 13.5% and non-survivor patient with mid line shift 12.7% with which had statistical significant value. On contrary ***Helmy et al.[23]*** found that brain CT finding in patients with TBI had no significant effect on mortality (p=0.6).

Concerning chest and abdominal injuries, we found that none of them had a statistically significant impact on the outcome. Our results were in agreement with ***Freitas and Franzon[17]***.

In our study patients who were subjected to mechanical ventilation had a significant impact on mortality, 52.9% of non survivors were ventilated compared to 47.1% of survivors (p=0.007). Our results were in concordance with ***Bader et al.[24]*** who found that 35.4% of non-survivors were subjected to mechanical ventilated compared to 13.1% in survivors group (p<0.001). But ***Haddad et al.[25]*** found that Length of stay on MV had no significant effect on mortality of 702 patient had a TBI (p=0.79).

Regarding complications we found that septic shock, pulmonary embolism, ARDS, Arrhythmias and sudden cardiac death (SCD) had significant effect on mortality in our study. Our results were in agreement with data collected by ***Mondello et al.[26]*** who found that pulmonary embolism, cardiac arrest after TBI had a higher risk of mortality (p<0.001), while sepsis have no effect on mortality with (p=0.79). But in a study performed by ***Meghan and Guohua[27]*** found that sepsis, DVT have significant effect on mortality (p<0.001).

CONCLUSIONS

The polytrauma patients' outcome can be highly variable, particularly in more severely head injured patients with prognostic predictions are difficult to make. We found multiple significant predictors of mortality as: advanced age, low PLT count, prolonged INR, high blood sugar and high renal function tests, GCS<7, APACHE II score>16 and RTS score<6 and radiological CT brain findings. DM is the most significant predictor of mortality. Also ICU complications are affecting the mortality.

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Competing interests:

The authors declare that they have no conflict of interest.

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