

Comparison of the Predictive Strength of Total White Blood Cell Count within 24 hours on Outcome of Traumatic Brain Injury with Glasgow Coma Score and Pupillary Reactivity

Eghosa Morgan^{1*}
Olufemi Bankole^{1,2}
Okezie Kanu^{1,2}
Omotayo Ojo^{1,2}
Edward Poluyi¹

¹Lagos University Teaching Hospital, Idi-Araba Lagos State, Irua
Specialist Teaching Hospital, Edo State, Nigeria

²College of Medicine, University of Lagos, Lagos Nigeria

Abstract

Background: Clinical parameters such as Glasgow coma scale (GCS) and pupillary reactivity (PR) have been identified as useful indicators for predicting traumatic brain injury (TBI). Total white blood cell (WBC) count is a laboratory test whose role in predicting TBI is still at low ebb. Total white blood cell count has been known to be elevated due to varied reasons in traumatic brain injury and this have been found to correlate with poor outcome. Our study aimed to establish if the predictive strength of total WBC count can be compared with another known outcome model such as GCS score and PR.

Methods: This research was done as a hospital based prospective study of 158 patients who presented with isolated TBI within 24 hours of injury over a year period ranging from October 2014-September 2015. Total white blood cell count was assayed within 24 hours of injury and clinical parameters – GCS score and PR were assessed within 24 hours of same injury. P value <0.05 was taken as significant. Data collected were collated using statistical package for social science (SPSS) Illinois Chicago version 21.

Results: In this study the predictive value of total WBC cell was weak, evident by area under the curve of 0.633 compared to that of total WBC count and PR at statistically significant $p < 0.001$.

Conclusion: It can be concluded that the predictive strength of total white cell count in patients with traumatic brain injury is weaker compared to clinical tool (PR and GCS) used to predict outcome in TBI.

Keywords: Traumatic brain injury (TBI), WBC count, Glasgow coma score, Pupillary reactivity.

Introduction

Traumatic brain injury (TBI) is defined as an alteration of brain function or other evidence of brain pathology caused by an external mechanical force [1]. It impacts as an emerging epidemic is huge, and it will be the third leading cause of death by 2020 [2]. Its main target is the vibrant productive sector of any economy with a male preponderance causing a huge drain on socioeconomic status of the affected individual, community and country at large¹. Clinical parameters such as Glasgow coma scale (GCS) and pupillary reactivity have been identified as useful indicator for predicting traumatic brain injury. Total white blood cell (WBC) count is a laboratory test whose role in predicting TBI is still at low ebb. Total white blood cell count has been known to be elevated due to varied reasons in traumatic brain injury [3-7] and this has been found to correlate with poor outcome.

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*Corresponding author: Dr. Eghosa Morgan, Irua Specialist Teaching Hospital, Edo State, Nigeria. Tel: +2348035724104; Email: morganeghosa@gmail.com

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The role of pupillary reactivity (PR) as an outcome predictor in TBI was observed by Braakman, et al [8] in their retrospective study involving 305 patients with TBI. Patients with bilaterally absent pupillary light reflex were noticed to have about 90% mortality. Our study aimed to establish if the predictive strength of total WBC count can be compared with another known outcome model such as GCS score and PR.

Methods

This is a hospital based prospective study of 158 patients who presented with isolated TBI within 24 hours of injury over a year period ranging from October 2014-September 2015. 5mls of blood sample was obtained in an Ethylene Diamine Tetra Acetic Acid (EDTA) bottle and sent for full blood count analysis at a specific reference laboratory in Lagos University Teaching Hospital (LUTH) during which the total white blood cell (WBC) count was analyzed using auto-analyser (MEK-6400 haematology analyzer). The patients with traumatic brain injury (TBI) meeting the inclusion criteria were reviewed. The post-resuscitation GCS score was assessed and recorded, the pupillary reactivity of both eyes was assessed with pen-torch.

Inclusion criteria

Patients with clinical and radiological features of isolated TBI presenting within 24 hours of injury to the Neurosurgical unit of LUTH after obtaining informed consent.

Exclusion criteria

- Patients with TBI who present to the hospital after 24 hours of injury.
- Patients with TBI who are diagnosed clinically to be brain dead at presentation.
- Patients with evidence of confirmed/established ongoing infectious processes before injury.
- Patients with confirmed diseases that may alter white blood cell count such as haematological disorders like leukaemia and lymphoma, and uncontrolled diabetes mellitus.
- Patients with open wounds and other systems injuries other than TBI.
- Patients not consenting to be part of the study.

Data analysis

All statistical analyses were done using descriptive and inferential statistics. P value <0.05 was taken as significant. Data collected were collated using statistical package for social science (SPSS) Illinois Chicago version 21.

Results

Age and sex distribution

A total of one hundred and ninety-nine patients were recruited into the study. 41 (20.6%) of these patients were excluded from analysis due to incomplete data and lost to follow. Altogether 158 patients met the inclusion criteria with complete data and were analyzed. Age of patients

ranged between 5-83 years with a mean age of 37.04 ± 18.37 years. Most of the patients were in the age range of 31-40 years and 20-29 years representing 21.5% and 20.9% respectively. This is closely followed by those between 40-49 years and 60-69 years representing 16.5% and 12.7% respectively. One hundred and sixteen (73.4%) of these patients were males, while 42(26.6%) were females, with a male: female ratio of 3.6: 1. Figure 1 shows the gender distribution. Table 1 shows the age distribution of patients with 20.9% and 21.5% between the third and fourth decade respectively.

Male accounted for 73.4% of the total patients studied as shown in the pie chart in Figure 1, while 26.6% were female. Table 2 shows the relationship between grades of TBI based on GCS score with mean total WBC count, with highest mean total WBC count seen in severe TBI.

Combined GCS score with total WBCC had AUC of 0.737 which is higher compared with GCS score alone AUC of 0.727. Table 3 above showed that the combined GCS score and WBC count predictive strength is greater than GCS score alone with area under the curve (AUC) of combined GCS score and WBCC been 0.737 compared to that of WBCC with area under the curve been 0.727.

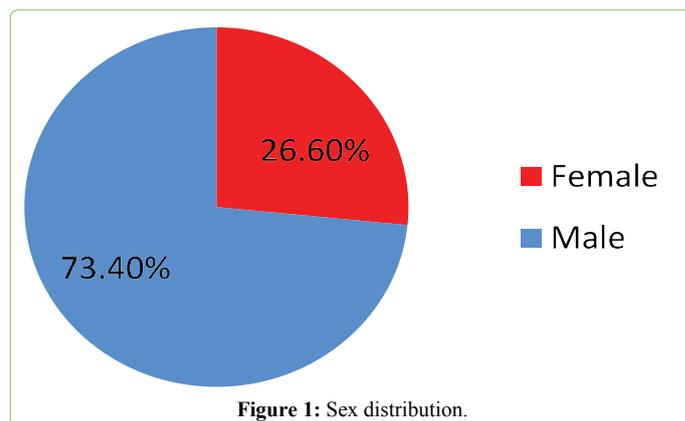


Table 1: Distribution of patients' age group.

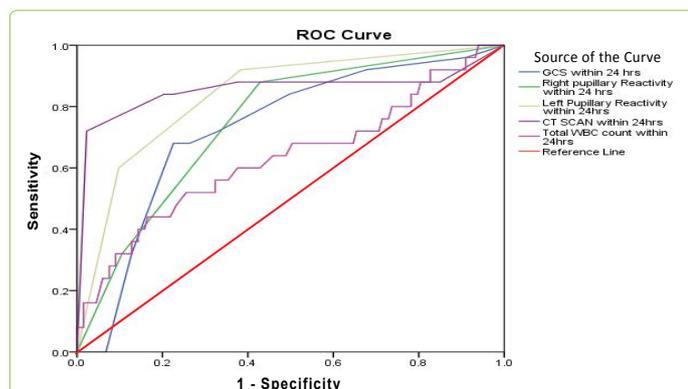
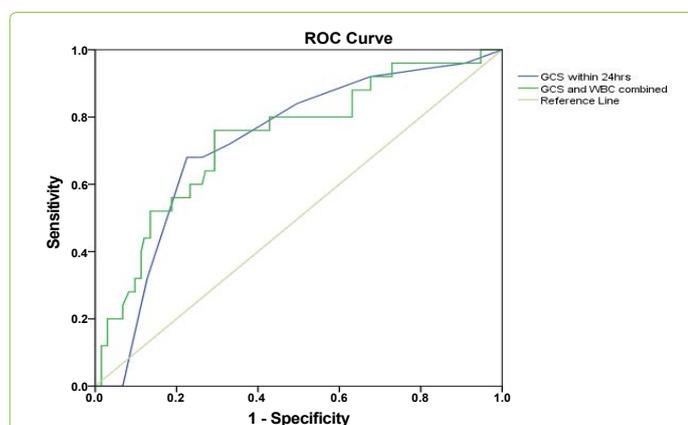
Age group in year(s)	Frequency (%)
0-9	16(10.1)
10-19	9(5.7)
20-29	33(20.9)
30-39	34(21.5)
40-49	26(16.5)
50-59	15(9.5)
60-69	20(12.7)
70-79	4(2.5)
>80	1(0.6)
Total	158(100)

Table 2: Showing the relationship between the mean total WBC count and GCS within 24 hours of TBI.

Grading of TBI	N(%)	Mean count	WBC Standard deviation	P value
Mild TBI: 14-15	45(28.48)	13,450.67	4,811.54	<0.001
Moderate TBI: 9-13	66(41.77)	13,895.30	3,933.90	<0.001
Severe TBI: 3-8	47(29.75)	15,614.04	4,092.22	<0.001
Total	158(100)	14,279.94	4,312.06	<0.001

Table 3: Showing the predictive strength of combining GCS score and total WBC count versus GCS score alone within 24 hours of TBI.

Test result variable(s)	Area under the curve	P value
Combined GCS score and WBC	0.737	<0.001
GCS score	0.727	<0.001

**Figure 2:** Receiver operative characteristic curve showing the predictive strength of outcome parameters.**Figure 3:** Showing the predictive strength of combining GCS score and GCS score alone within 24 hours.

Discussion

Studies have shown that the total white blood cell count increases with severity of traumatic brain injury, several pathophysiological processes have explained these processes responsible for elevated total WBCC [3-7]. Clinical (PR and GCS score) and radiological (CCT scan) outcome model have been identified to help predict the outcome of TBI, however, studies comparing the predictive strength of total WBCC is sketchy.

The role of pupillary reactivity (PR) as an outcome predictor in TBI was observed by Braakman, et al [8] in their retrospective study involving 305 patients with TBI. Patients with bilaterally absent pupillary light reflex were noticed to have about 90% mortality [9,10]. This study also observed a direct correlation between low GCS score and abnormal pupillary reactivity and showed PR to have a high predictive value in patients with TBI.

Studies by Van Dongen, et al [11] and Teasdale, et al [12] confirmed strong association between GCS score, PR and CCT scan. A study by Gurkanlar, et al [13] among TBI patients in which WBCC was estimated within 24 hours of

injury, a high WBCC greater than 12, 096 cells/mm³ and low GCS score of 3-7 was associated with poor outcome

Figure 2 and Table 3 in this study showed that the predictive strength of total WBC count and PR scan was determined using operator receiver's characteristics (ROC) curve.

The area under the curve for GCS done within 24hours was 0.724 with significant $p < 0.001$ at a sensitivity and specificity of 68% and 77.44% respectively. This showed that GCS has a high predictive strength in predicting the outcome of traumatic brain injury. The left and right pupillary reactivity done within 24 hours showed an area under the ROC curve of 0.838 and 0.748 respectively. The relationship between total WBCC and GCS score was shown in Table 2. The levels of total white blood cell count were seen to increase with grades of TBI. The higher the grades of GCS score, the lower the total White blood cell count and thus predicting a better outcome. This finding is similar to the study by Gurkanlar, et al [13] among TBI patients which showed higher value of total WBCC was associated with poor outcome

Studies have shown strong association between GCS score and outcome using various statistical techniques [14]. Thatcher, et al [15] showed in their study involving 161 patients with TBI that initial GCS at a mean of 7.5 days post-injury to predict outcome at one-year post-injury, 68.6% of those to have good outcome and 76.5% of those predicted to have poor outcome actually had such outcomes at one year.

Few studies have predicted the strength of total WBCC. Gunkalar, et al [13] showed that predictive value of WBC count exceeding $17.5 \times 10^6/L$ has a predictive value for poor outcome at $p < 0.001$. In this study the predictive value of total WBCC was weak, evident by area under the curve of 0.633 at statistically significant $p < 0.001$ as shown in Figure 3 and Table 3.

Therefore, the predictive strength of these parameters to predictive outcome of TBI is strongest with PR and followed by GCS, and weakest with total WBC counts assessed within 24 hours of TBI.

Conclusion

It can be concluded that the predictive strength of total white cell count in patients with traumatic brain injury is weaker compared to clinical tool (PR and GCS) used to predict outcome in TBI.

Conflict of Interest

- None of the authors of this paper has a financial or personal relationship with other people or organizations that could inappropriately influence or bias the content of the paper.
- It is to specifically state that "No Competing interests are at stake and there is No Conflict of Interest" with other people or organizations that could inappropriately influence or bias the content of the paper.
- Full disclosure was made and there is no conflict of interest.

Author's Contributions

All authors equally contributed immensely, Morgan E is the Coordinator Lead Surgeon of the case.

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