

## ORIGINAL ARTICLE

## 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

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## DISCLOSURE

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## ABSTRACT

**Background:** Clinical parameters such as Glasgow coma score (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. It is known to be elevated due to varied reasons in traumatic brain injury and this has been found to correlate with poor outcome. Our study aimed to establish if the predictive strength of total WBC count can be compared with other known outcome models (GCS score and PR).

**Methodology:** 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 one-year period from October 2014-September 2015. Total white blood cell count was assayed within 24 hours of injury and clinical parameters – GCS and PR were assessed within 24 hours of same injury. Data analysis was done using statistical package for social science (SPSS) Illinois Chicago version 21. The *P* value of <0.05 was taken as significant.

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

**Conclusion:** 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:** Brain trauma, Clinical parameters, Laboratory test, Glasgow Coma Scale

## 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.<sup>1</sup> It is projected by the World Health Organization (WHO) to become the third leading cause of global mortality and disability by the year 2020.<sup>2</sup> The enormity of

this problem goes beyond the hospital treatment because there could arise long term or lifelong complications affecting thought processes, language, emotions, sensation and communication; these may necessitate different forms of support services for the injured. Locomotion, memory and post-traumatic seizures could also become a problem.<sup>3</sup>

National epidemiological data base on head injury is currently scarce in many low and middle income countries (LMICs) including Nigeria.<sup>4</sup> This indeed makes it very difficult to appreciate the scale, determinants and distribution of the problem; and as such, makes an effective intervention even more difficult. The unavailability of data also impedes the objective assessment of the success of any injury reduction intervention put in place.<sup>3</sup>

Clinical parameters such as Glasgow coma score (GCS) and pupillary reactivity have been identified as useful indicators 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 and this has been found to correlate with poor outcome.<sup>5,6,7,8,9</sup>

The role of pupillary reactivity (PR) as an outcome predictor in TBI was observed by Braakman *et al.* in their retrospective study involving 305 patients with TBI. Patients with bilaterally absent pupillary light reflex were noticed to have about 90% mortality.<sup>10</sup>

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.

## METHODOLOGY

This is a hospital based prospective study of 158 patients who presented with isolated TBI within 24 hours of injury over a one-year period from October 2014 to September 2015. The patients with traumatic brain injury (TBI) that met the inclusion criteria were reviewed.

The post-resuscitation Glasgow coma score was assessed and recorded, the pupillary reactivity of both eyes was assessed with pen-torch (using a measurement ranging from pinpoint pupil through 2mm to 10mm pupillary dilatation), after which a phlebotomist was assigned to collect blood sample (5ml) which was obtained in an Ethylene-diamine-tetraacetic acid (EDTA) bottle and sent for full blood count analysis at a specific reference laboratory in Lagos University Teaching Hospital (LUTH) Idi-Araba, Lagos State Nigeria. The total white blood cell (WBC) count was analyzed using auto-analyser (MEK-6400 haematology analyzer).

## Inclusion Criteria

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

## Exclusion Criteria

Excluded from the study include:

Patients with TBI who presented to the hospital after 24 hours of injury; patients with TBI who were diagnosed clinically to be brain dead at presentation; patients with evidence of established ongoing infectious processes before injury; those 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 systemic injuries other than TBI, and patients not consenting to be part of the study.

## Data Analysis

Data collected were analyzed using statistical package for social sciences (SPSS) [Illinois Chicago version 21]. All statistical analyses were done using descriptive and inferential statistics, Receivers Operating Curve (ROC) and Analysis of Variance (ANOVA) for comparing mean. The *P* value of less than 0.05 was taken as significant.

## RESULTS

A total of one hundred and ninety-nine patients were recruited into the study, out of

which 41 (20.6%) of them were excluded from analysis due to incomplete data and loss to follow up. Altogether 158 patients met the inclusion criteria with complete data and so, were analyzed. Age of patients ranged between 5-83 years with a mean age of  $37.04 \pm 18.37$  years. Most of the patients were in the age range 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 decades respectively.

Males accounted for 73.4% of the total patients studied as shown in the pie chart in Figure 1, while 26.6% were females.

Our study shows a direct relationship between grades of TBI based on GCS score with mean total WBC count. Severe TBI with

a GCS of 3-8 had the highest total WBC count (15,614), while mild TBI with GCS 14-15 had the least mean WBC count (13,450) as shown in Table 2.

Also, our study showed that the combined GCS and WBC count predictive strength is greater than GCS alone with area under the curve (AUC) as 0.737 and 0.727, respectively (Table 3).

**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)
<b>Total</b>	<b>158(100)</b>

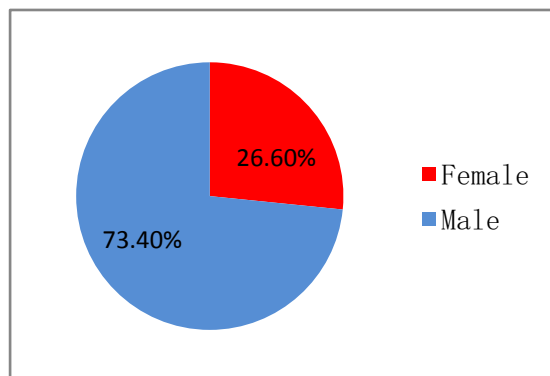
**Table 2.** Showing the relationship between the mean total WBC count and GCS within 24 hours of TBI

Grading of TBI	N (%)	Mean WBC count	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
<b>Total</b>	<b>158(100)</b>	<b>14,279.94</b>	<b>4,312.06</b>	<b>&lt;0.001</b>

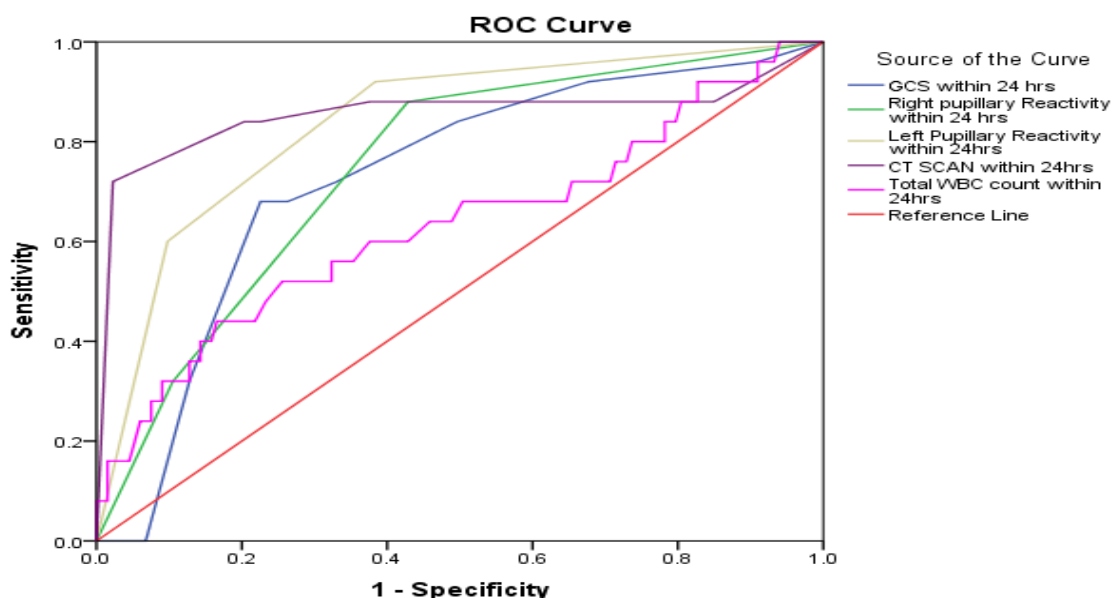
**Table 3.** Showing the predictive strength of combining GCS score and total WBC count versus GCS score alone within 24 hours of TBI

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

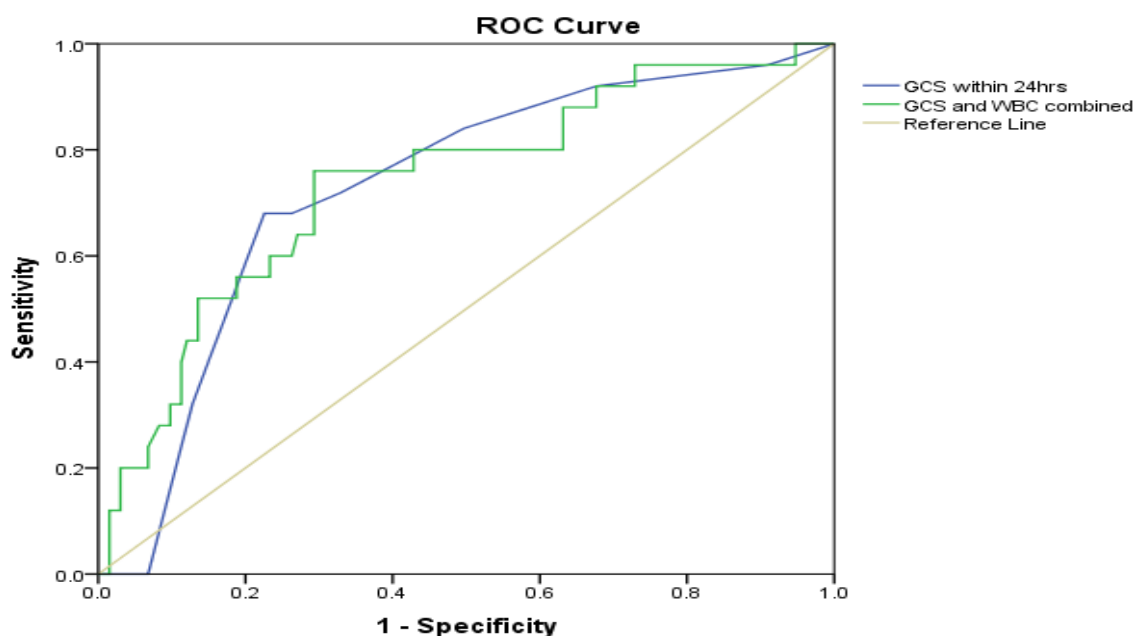
**Figure 1.** Sex distribution



**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 WBC Count<sup>5,6,7,8,9</sup>. Clinical (PR and GCS ) and radiological (Contrast-enhanced computed tomography (CCT) scan) outcome models have been identified to help predict the

outcome of TBI, however, studies comparing the predictive strength of total WBC Count is sketchy.

The role of pupillary reactivity (PR) as an outcome predictor in TBI was observed by Braakman *et al.* in their retrospective study involving 305 patients with TBI.<sup>10</sup> Patients with bilaterally absent pupillary light reflex were noticed to have about 90% mortality.<sup>11,12</sup>

This study also observed a direct correlation between low GCS and abnormal pupillary reactivity, as well as indicating that PR have a high predictive value in patients with TBI.

Studies by Van Dongen *et al.* and Teasdale *et al.* confirmed a strong association between GCS, PR and CCT scan.<sup>13,14</sup> In a study by Gurkanlar *et al.* among TBI patients in which WBC Count was estimated within 24 hours of injury, a high WBC Count greater than 12,096 cells/mm<sup>3</sup> and low GCS of 3-7 was associated with poor outcome.<sup>15</sup>

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

The area under the curve for GCS done within 24 hours was 0.724 with a p value <0.001 at a sensitivity and specificity of 68% and 77%, 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 WBC count and GCS was shown in Table 2. The levels of total white blood cell count were seen to increase with grades of TBI. The higher the GCS, the lower the total white blood cell count, thus predicting a better outcome. This finding is similar to the study by Gurkanlar *et*

*al.* among TBI patients which showed higher value of total WBC count was associated with a poor outcome.<sup>15</sup>

Studies have shown strong association between GCS and outcome using various statistical techniques.<sup>16</sup> Thatcher *et al.* showed in their study involving 161 patients with TBI and 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.<sup>17</sup>

Few studies have predicted the strength of total WBC count. Gunkalar *et al.* showed that the value of WBC count exceeding 17.5 x10<sup>6</sup>/L has a predictive value for poor outcome.<sup>13</sup>

In this study the predictive value of total WBC count 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 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 tools (PR and GCS) used to predict outcome in TBI.

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