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Comparison of the predictive strength of total white blood cell count within 24 hours on the outcome of traumatic brain injury with cranial computed tomography scan in a resource-limited tertiary health centre in sub-Saharan Africa

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ABSTRACT

Background: The enormous disease burden of patients with traumatic brain injury (TBI) remains a huge source of concern to the patient and caregivers. Computed tomography (CCT) scan is a valuable investigative tool in patients with traumatic brain injury which can be used to predict the outcome of TBI. The use of total white blood cell as a predictive parameter in patients with TBI is still at a primordial stage. This study aimed to compare the predictive strength of total WBC count within 24 hours of TBI with cranial computed tomography scan.

Methods: This research was done over one-year period at the Lagos University Teaching Hospital, Lagos. One hundred and fifty-eight patient who met the inclusion criteria were studied and the male to female ratio of 3.6:1.

Results: The mean total WBC count was 14,279.94 and the area under the curve of total WBC count and CCT scan was 0.633 and 0.855 respectively.

Conclusion: Our conclusion was that despite both parameters been a predictor of the outcome of TBI, the total white blood cell is a weaker predictor of outcome compared to cranial computerize tomography scan.

Keywords
TBI,
WBC count,
CT scan

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BACKGROUND

Traumatic brain injury (TBI) is likened to an epidemic and it will be the third leading cause of death in the developing world by 20201. It is defined as an alteration of brain function or other evidence of brain pathology caused by an external mechanical force2. It is a time bomb almost happening if left unattended to, with the male productive sector of the population affected1. It causes a huge drain on socioeconomic status of the affected individual, family, and country at large. Total white blood cell (WBC) count have been known to be elevated due to varied reasons in traumatic brain injury3,4,5,6,7 and this have been found to correlate with poor outcome.

Cranial tomography (CCT) scan have been known to predict outcome of traumatic brain injury. Our aim was to establish if the predictive strength of total WBC count can be compared with another known outcome model such as CCT scan.

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METHODOLOGY

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 count was analysed using auto-analyser (MEK-6400 haematology analyser). The patients with traumatic brain injury (TBI) meeting the inclusion criteria were reviewed. Cranial computed tomography (CCT) scan was performed at the radiological department of LUTH using Toshiba Aqillol 128 slice CT scanner. Outcome was determined using standard scale such as the GOS-E at 6 months post injury.

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

1. Patients with TBI who present to the hospital after 24 hours of injury.
2. Patients with TBI who are diagnosed clinically to be brain dead at presentation.
3. Patients with evidence of confirmed/established ongoing infectious processes before injury.
4. Patients with confirmed diseases that may alter white blood cell count such as haematological disorders like leukaemia and lymphoma, and uncontrolled diabetes mellitus.
5. Patients with open wounds and other systems injuries other than TBI.
6. 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. Receiver operating characteristic (ROC) curve was constructed to compare predictive strength of the variables.

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 analysed.

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 40-49years and 60-69years 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. Table 1 shows the age group distribution and Figure 1 shows the gender distribution.

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 1 shows the age distribution of patients with 20.9% and 21.5% between the third and fourth decade respectively.

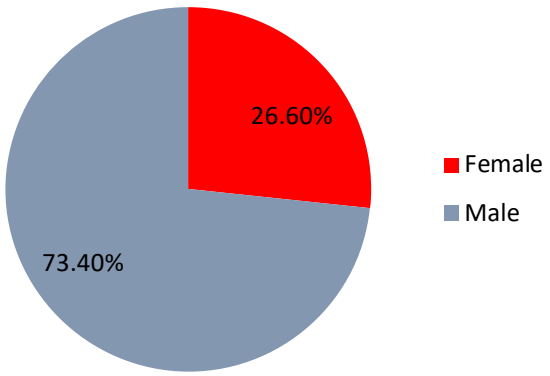

FIGURE 1 showing sex distribution

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: Showing the relationship between the mean total WBC count and CCT scan findings 24 hours post-injury

Marshall CCT scan grading	N (%)	Mean WBC count	Standard deviation
1. Normal findings	23(14.56)	12,672.61	3,923.81
2. Cistern present	63(39.87)	14,552.54	3,773.85
3. Cistern present	21(13.29)	13,585.24	4,049.10
4. >5mm midline shift	3(1.90)	13,266.67	5,262.45
5. Surgically correctable lesion	27(17.09)	15,064.07	4,786.97
6. Non-surgically correctable lesion	21(13.29)	15,053.81	5,531.47
Total	**158(100)**	**14,279.94**	**4,312.06**

FIGURE 2 showing the area under the curve of various TBI outcome predictors

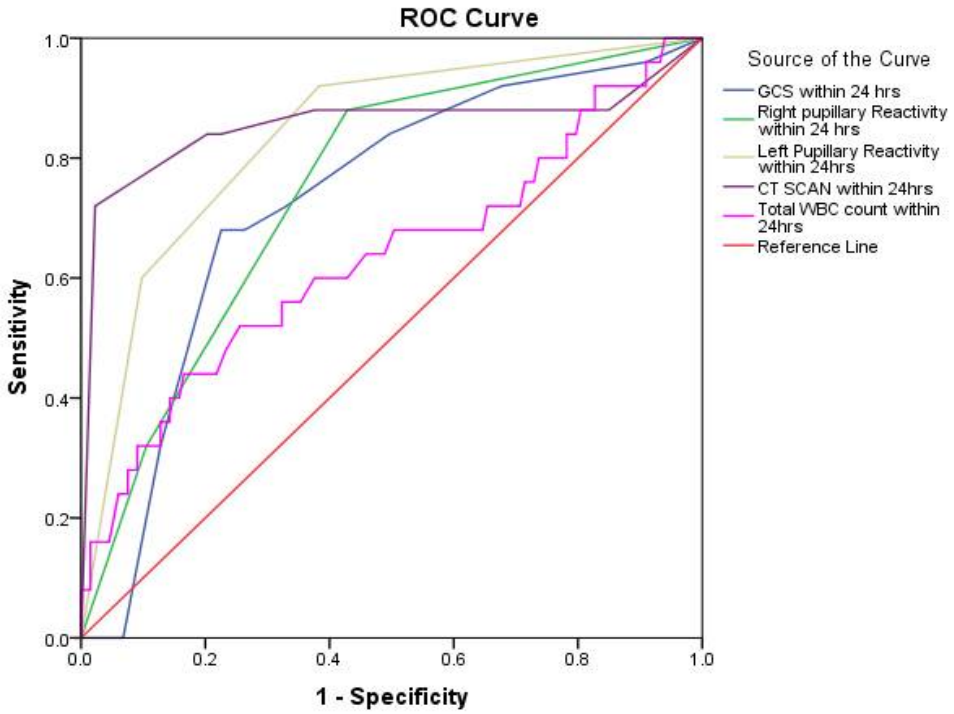

TABLE 3 - Showing area under the curve of the predictive strength of both outcome parameters

Test result variable(s)	Area under curve	Sensitivity	Specificity	P value
CCT Scan within 24 hours	0.855	72	97.74	<0.001
Total WBCC within 24 hours	0.633	44	83.36	<0.001

TABLE 3 revealed area under the curve of total WBC count as 0.633 with a sensitivity and specificity of 44% and 83.33% respectively. While, CCT scan within 24hours has the highest capacity to predict outcome with sensitivity and specificity of 72% and 97.74 % respectively.

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 count3,4,5,6,7. Radiological outcome model such as CCT scan have been identified to help predict the outcome of TBI, however studies comparing the predictive strength of total WBCC is sketchy.

Cranial computed tomography (CCT) scan is a radiological tool which is useful in predicting the outcome of patients with TBI. It is a reproducible, relatively available, although expensive radiological investigative tool which helps to identify the type and severity of TBI9,10.

Studies have shown a higher predictive value with CCT scan in patients with TBI when compared to PR and GCS score in predicting short-term outcome of TBI. Findings on CCT scan such as compressed basal cistern and presence of a mass lesion are predictive of poor outcome. Studies by Van Dongen et al11 and Teasdale G et al12 confirmed strong association between GCS score, PR and CCT scan. These studies showed that predictive strength of CCT scan alone was about 48%.

The CCT scan done within 24 hours has a high area under the curve of 0.855 which was statistically significant $p<0.001$. Sensitivity and specificity of the CCT scan (done within 24 hour) predictive strength was 72% and 97.74% respectively. This showed that the CCT scan has a strong discriminative capability for outcome prediction in traumatic brain injury.

Few studies have predicted the strength of total WBCC. Gunkalar et al13 showed that predictive value of WBC count exceeding 17.5 x106/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 2 and table 3. Therefore, the predictive strength of these parameters to predictive outcome of TBI is strongest with CCT scan findings, 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 radiological tool (CCT) used to predict outcome in TBI.

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