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Original Research Article

A Comparative Study between New Injury Severity Score (NISS) and Injury Severity Score (ISS) to Predict the Outcome in Polytrauma Patients

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Abstract:

Introduction: Polytrauma is a major cause of morbidity and mortality worldwide. The ISS and New Injury Severity Score are most commonly used to assess the gravity of trauma and serve in the estimation of outcomes. This study tries to compare the predictive validity of the NISS to the ISS among polytraumatized patients regarding mortality, admission to the ICU, and duration of hospitalization.

Methods: It is a prospective observational study done in the Department of General Surgery, Dr. B.R.A.M. Hospital, Pt. J.N.M. Medical College, Raipur, from January 2022 to December 2022. We found 155 polytrauma cases in our series. In each case, ISS and NISS were calculated on the basis of their injuries. Predictive outcomes like mortality, need for ICU care, and length of hospital stay were analyzed. The scoring systems were compared using ROC curve analysis, logistic regression, and Pearson's correlation coefficient.

Results: The study showed that the mean ISS score for survivors was 16.22 ± 5.63, while the mean ISS for nonsurvivors was 34.86 ± 7.54. In the same vein, the mean NISS for survivors was 22.61 ± 8.67, and that of nonsurvivors was 43.51 ± 9.62. The AUC of the ROC curve for mortality prediction in relation to ISS was 0.825, while that for NISS was 0.904, showing that there is a statistically significant difference between them, as shown by $p < 0.05$. NISS was found to have better predictive value than ISS as regard to mortality, need for ICU admission, and length of hospital stay. The Pearson's correlation coefficient of ISS and NISS scores was 0.826 and reached statistical significance at $p < 0.001$, indicating a strong positive correlation.

Conclusion: ISS and NISS are helpful scoring systems in outcome prediction in polytrauma patients. However, the predictive performance enhanced significantly with the advantage of NISS regarding mortality and admission to intensive care. Moreover, it can also be a marker for the severity of trauma more reliably than any score; thus, its use in clinical practice should be put into practice to make any progress in the management of polytrauma patients.

Keywords: Polytrauma, Injury Severity Score, New Injury Severity Score, trauma outcomes, mortality prediction.

Introduction

Trauma has been termed the "neglected disease of modern developing nations." Trauma continues to be a priority public health concern in many low- and middle-income countries. Trauma accounts for 11% of all DALYs, thus placing immense pressure not only on the health system but also on economies [1]. The leading cause of death in India is due to accidents, and among accidents, RTIs are the most common.

The incidence of RTIs is rising alarmingly by 3% each year, which works out to a trauma-related death every 1.9 minutes. India has one of the highest global mortality rates due to RTIs and recorded 161,736 deaths in 2010 alone as per the National Crime Records Bureau [2]. Polytrauma is defined as multiple traumatic injuries and accounts for 13.3% of all adult trauma with an overall mortality rate of 12.4% in various urban trauma centers of India. In patients with severe injury, defined by ISS above 16, the mortality is six times higher in developing countries like India compared to the developed world [3]. Apart from mortality, the burden of long-term disability is huge, which also further taxes the resources of healthcare and economic stability. The estimated financial burden of road traffic injuries themselves in India was 2-2.5% of the nation's GDP,

with other trauma causes like falls, agricultural accidents, firearms, and assaults further contributing to the national trauma burden [4,5].

Trauma scoring systems provide standardized means for injury severity assessment and prediction of clinical outcomes in trauma patients. Of these, the most widely used anatomical scoring system has been the ISS, introduced in 1974. The ISS ranks injury severity is based on an injury's AIS score for the following six body regions: head and neck, face, thorax, abdomen, extremities (including pelvis), and external injuries. The ISS is defined as the sum of squares of the three highest AIS scores, with a maximum score of 75. In spite of its wide application, disadvantages of ISS exist, especially in multiple injuries within the same body region, with underestimation of overall injury severity [6].

To overcome these shortcomings, Osler et al. proposed, in 1997, the New Injury Severity Score (NISS). The NISS differs from the ISS in that it takes into consideration the three most serious injuries regardless of location within the body. This modification enables a much broader assessment, especially where multiple severe injuries occur within the same region. Indeed, many studies have shown that the NISS often reflects more accurately the severity of injury and is at least as good, if not better than the ISS, at predicting outcomes [7, 8].

The current study is, therefore, designed to compare the predictive efficacy of ISS versus NISS in polytrauma patients and identify which score better predicts outcomes related to trauma care. Appreciation of the advantages and shortcomings of each system would be important for the refinement of trauma evaluation protocols, especially in resource-constrained settings where trauma care needs to be both effective and efficient [9, 10].

Methods

Study Design and Setting

This is a prospective observational study conducted in the Department of General Surgery, Dr. B.R.A.M. Hospital and Pt. J.N.M. Medical College, Raipur, starting from January 2022 and ending in December 2022, thus completing one year.

Study Population

All consecutive patients aged 18 years and above who were admitted with polytrauma in the trauma center during the study period were recruited into the study. Patients who refused treatment, did not consent to being subjects, or left the hospital against medical advice (LAMA) were excluded from the study.

Inclusion criteria

All the patients with the history of polytrauma who were admitted in the Trauma Centre of the Department of General Surgery, Dr. B.R.A.M. Hospitals during the period of study were enrolled for the study. The study has taken into account the patients aged 18 years and above. In fact, to ensure proper evaluation and management only those who had given consent to stay in the study were enrolled.

Exclusion Criteria

Thus, the exclusion criteria included patients who were unwilling to give informed consent, those below the age of 18 years, and those who had LAMA. Also, patients brought dead to the hospital were excluded in the study.

Sample Size

By two-proportion method, sample size was calculated using R statistical software for this study. For this study, 131 polytrauma patients fulfilling the inclusion criteria were enrolled.

Data Collection and Management

The patients were enrolled after admission using a pre-designed proforma, which included demographics, history regarding injury, mode of trauma, and clinical outcome. Resuscitation on admission was done to stabilize the patients: maintaining airway, breathing, and circulation-the ABC protocol. Needed interventions like airway adjuncts, intercostal chest drain (ICD) insertion, and intravenous fluid administration were used when required.

Investigations in the form of CXR, USG, and NCCT head were conducted to assess the severity of injury. Other imaging studies such as computed tomography chest and CECT abdomen were done if clinically indicated by physical examination.

Calculation of ISS and NISS Scores

In the next step, injury severity was measured according to the AIS. Afterward, ISS and NISS for each patient were calculated as follows:

- **ISS:** the sum of squares of the three highest AIS scores from different body regions. (ISS = $AIS1^2 + AIS2^2 + AIS3^2$).
- **NISS:** The sum of the squares of the three most severe AIS scores independent of body region NISS = $AIS1^2 + AIS2^2 + AIS3^2$.

Clinical Interventions and Monitoring

Patients were followed up for developing interventions - ICD insertion, laparotomy, fracture fixation, and need for ventilatory support. The length of stay in hospital, the admission to ICU, morbidity, and mortality were noted for each patient.

Outcome Measures

The primary outcome measures assessed were duration of hospital stay, admission to the Intensive Care Unit, ventilatory support, and mortality or

discharge status-death, disability, or recovery. ISS was compared with NISS regarding the outcome variables mentioned above.

Statistical analysis

The data were entered into a Microsoft Excel spreadsheet and then analyzed using SPSS version 27.0 software (SPSS Inc, Chicago, IL, USA).

Quantitative variables were presented as mean ± SD, while categorical variables were expressed as frequencies or percentages. Where available, two-sample t-test and chi-square test and one-way ANOVA were used to find the relationship of ISS and NISS with the clinical outcome. ROC curves were plotted to determine sensitivity, specificity, and cutoff values of ISS and NISS in predicting outcomes in polytrauma patients. The p-value was statistically significant when below 0.05.

Ethical Considerations

This study has been approved by the Institutional Scientific Committee and Ethics Committee of Pt. J.N.M. Medical College, Raipur. Patients or their legal guardians had given informed written consent prior to the inclusion of the patients in the study. Data have been presented anonymously, ensuring the confidentiality of the patients.

Results

The 31-40 years age group consists of the majority of polytrauma patients, 31.53%, followed by 21-30 years, 23.07%, and 40-50 years, 22.30%. Only 8.46% were in the youngest age group of 16-20 years and 14.50% were older than 50 years. This suggests that individuals in their 30's and 40's are most commonly affected by polytrauma (Table 1).

Table 1: Age Wise Distribution of Polytrauma Patients

Age Group	No. of Polytrauma Patients	Percentage
16-20	11	8.46%
21-30	30	23.07%
31-40	41	31.53%
40-50	29	22.30%
>50	19	14.50%
Total	131	100%

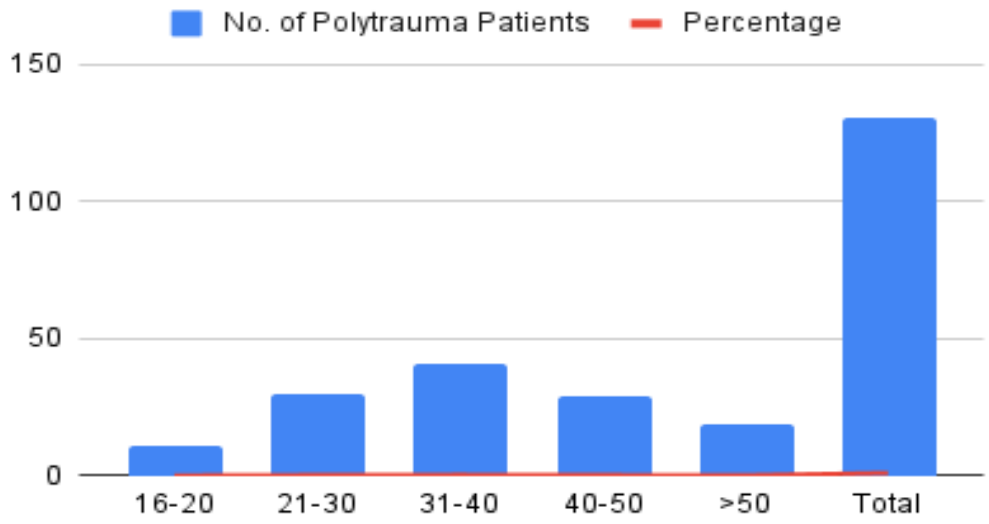

Figure 1: Bar chart of showing age Wise Distribution of Polytrauma Patients

Males were 80.2% whereas females were 19.8% of polytrauma cases, and that males are more prone to polytrauma injury as shown in Table 2.

Table 2: Sex Distribution of Polytrauma Patients

Sex	No. of Polytrauma Patients	Percent
Female	26	19.8%
Male	105	80.2%
Total	131	100.0%

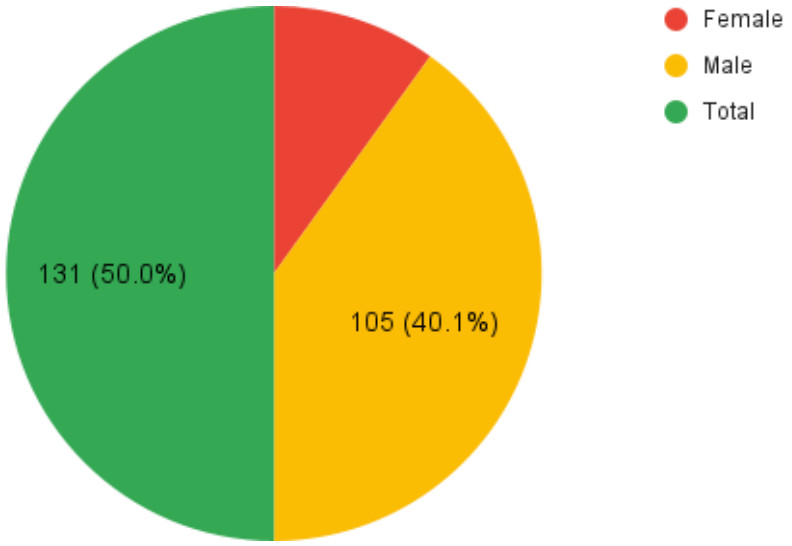

Figure 2: Pie chart of showing sex Distribution of Polytrauma Patients

RTA contributed to 83.2% of the total number of polytrauma cases, followed by fall from height at 11.4%, followed by an assault and train accident at 4.6% and 0.8%, respectively, as shown in Table 3.

Table 3: Distribution of Polytrauma Patients Based on Mode of Trauma

Mode of Trauma	No. of Polytrauma Patients	Percent
Assault	6	4.6%
Fall from height	15	11.4%
Road Traffic Accident (RTA)	109	83.2%
Train accident	1	0.8%
Total	131	100.0%

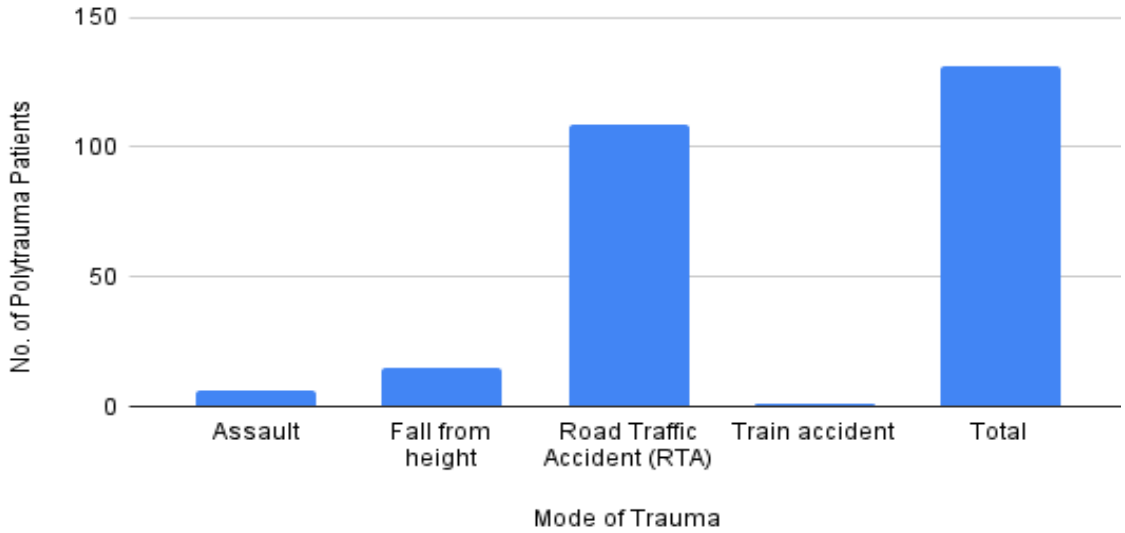

Figure 3: Bar chart of showing distribution of Polytrauma Patients Based on Mode of Trauma

Of these, the most frequent combination of injuries was head, chest, and extremity, which accounted for 35.12% of the patients, followed by head, chest, and abdomen injuries, seen in 32.06%, and head, abdomen, and extremity injuries, seen in 23.66%. This shows that the commonest injured parts in polytrauma are the head and chest (Table 4).

Table 4: Distribution of Polytrauma patients based on Body Region injured

Body Region Injured	No. of Polytrauma Patients	Percent
Abdomen, Chest, Extremity	12	9.16%
Head, Chest, Extremity	46	35.12%
Head, Chest, Abdomen	42	32.06%

Head, Abdomen, Extremity	31	23.66%
Total	131	100%

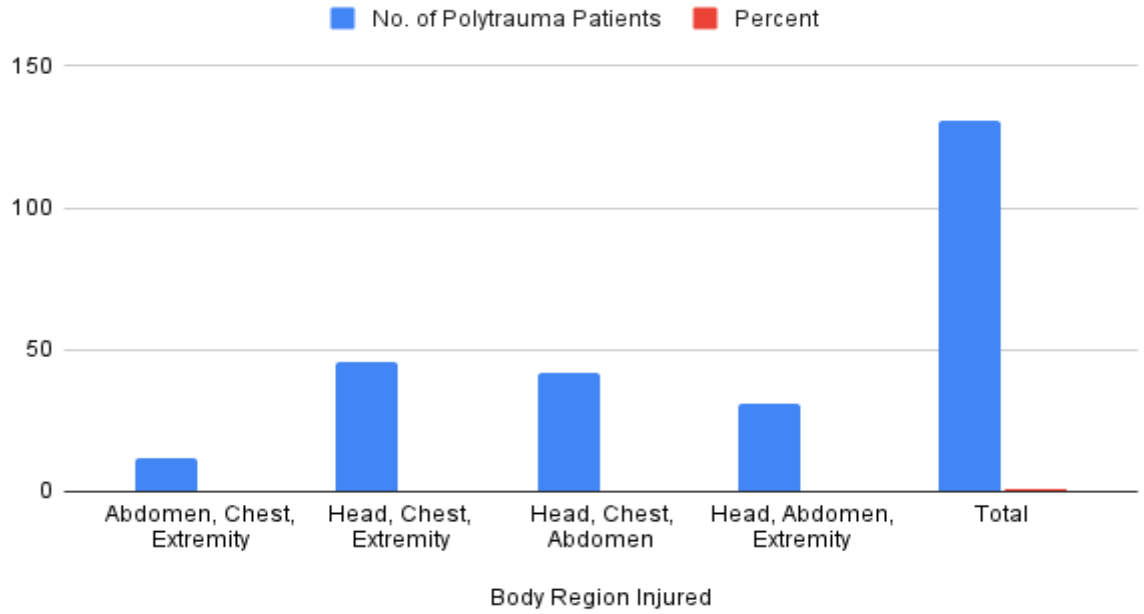

Figure 4: Bar chart of showing distribution of Polytrauma patients based on Body Region injured

Most common X-ray finding was rib fracture in 31.29% followed by hemothorax in 28.2% and pneumothorax in 20.6%. Hollow viscus perforation was present in only 7.7% of cases (Table 5).

Table 5: Distribution of Polytrauma Patients based on X ray Findings

X-Ray Findings	No. of Polytrauma Patients	Percent (%)
Hollow Viscus Perforation	10	7.7%
Pneumothorax	25	20.6%
Hemothorax	37	28.2%
Rib Fracture	41	31.29%
Pelvis Fracture	2	1.5%
Femur Fracture	6	4.58%
Tibia Fracture	4	3.05%
Humerus Fracture	4	3.05%
Spine Injury	2	1.01%

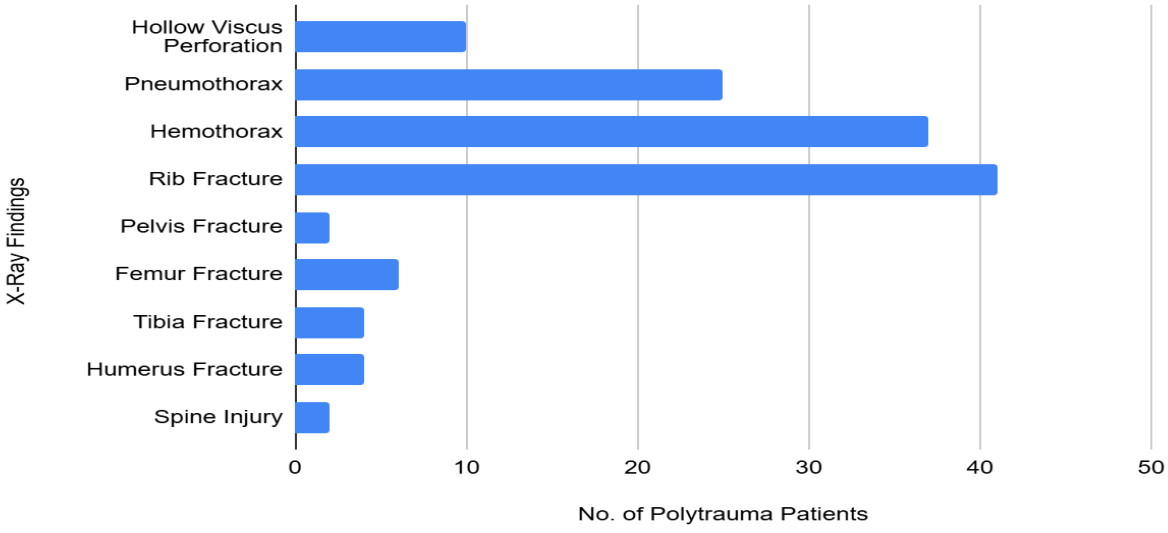

Figure 5: Bar chart of showing distribution of Polytrauma Patients based on X ray Findings

USG found collection in the pleural cavity in 50.38% of patients, collection in peritoneal cavity in 25.95% of the patients, while 23.67% had normal ultrasound study with no significant finding (Table 6).

Table 6: Distribution of Polytrauma Patients based on USG Findings

USG Findings	No. of Polytrauma Patients	Percent
Collection in pleural cavity	66	50.38%
Collection in peritoneal cavity	34	25.95%
Normal Study	31	23.67%
Total	131	100%

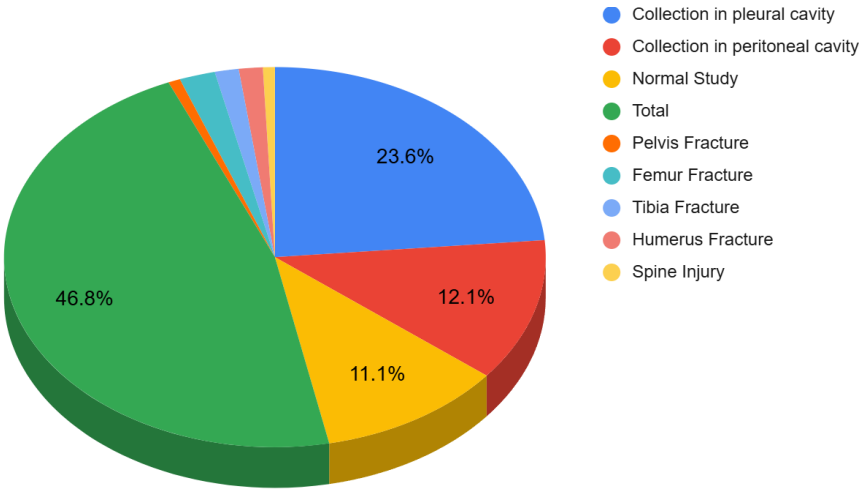

Figure 6: Pie chart of showing distribution of Polytrauma Patients based on USG Findings

Of these patients, 30.53% had multiple head and neck injuries. 8.39% showed maxillofacial trauma whereas common findings such as extradural hematoma (EDH), subdural hematoma (SDH) and contusions were relatively less frequent. Normal head/neck NCCT findings were encountered in 50.38% of patients (Table 7).

Table 7: Distribution of Polytrauma Patients based on NCCT Head/Neck Findings

NCCT Head/Neck Finding	No. of Polytrauma Patients	Percent
EDH	6	4.50%
SDH	3	2.29%
Contusion	4	3.05%
Cervical Injury	2	1.52%
Maxillofacial Trauma	11	8.39%
Multiple	40	30.53%
Normal	66	50.38%
Total	131	100%

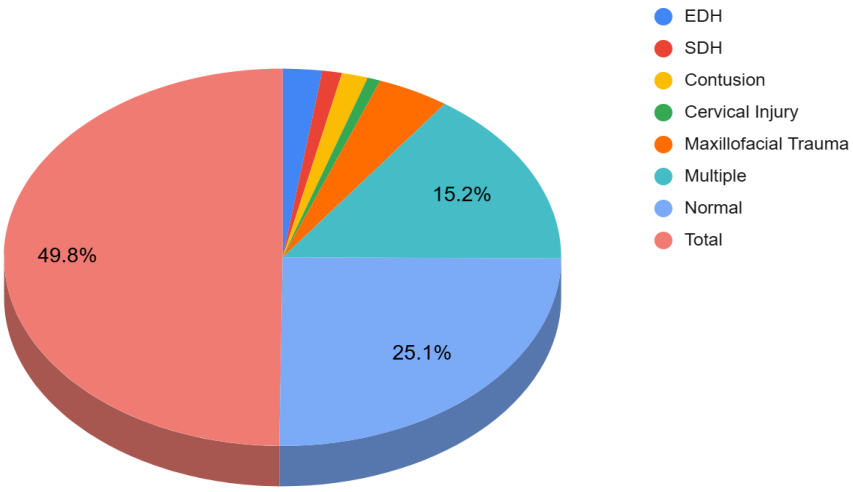

Figure 7: Pie chart of showing distribution of Polytrauma Patients based on NCCT Head/Neck Findings

Of them, multiple chest injuries were identified in 34.71% of cases; single rib fractures in 8.26%; and multiple rib fractures in 14.04% of the patients. Whereas, pneumothorax and hemothorax were less frequent findings seen in less than 5% each; and 35.53% patients had normal findings (Table 8).

Table 8: Distribution of Polytrauma Patients based on NCCT Chest Findings

NCCT Chest Finding	No. of Polytrauma Patients	Percent (%)
Single rib fracture	10	8.26%
Multiple rib fracture	17	14.04%
Pneumothorax	5	4.13%
Hemothorax	4	3.30%
Multiple injuries	42	34.71%
Normal	43	35.53%
Total	121	100%

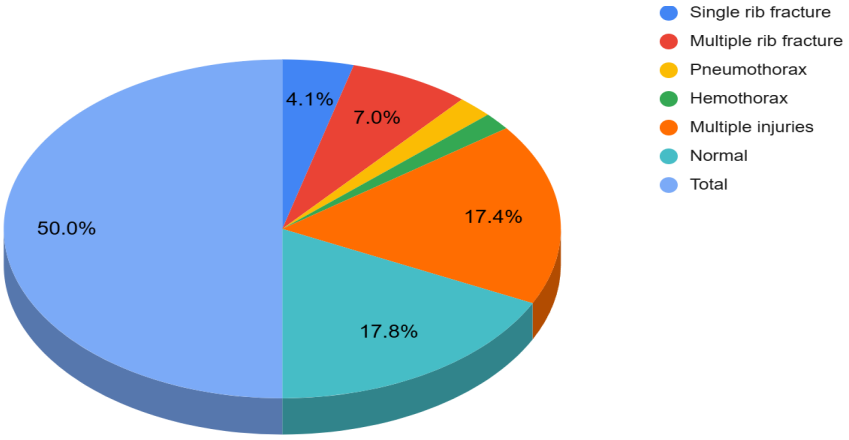

Figure 8: Pie chart of showing distribution of Polytrauma Patients based on NCCT Chest Findings

The spleen injury was the most common finding seen in 34.48% cases while reviewing the CECT abdomen, followed by bowel injury found in 31.03% and liver injury in 17.24% of patients. The kidney injuries accounted for 17.42% of the cases (Table 9).

Table 9: Distribution of Polytrauma Patients based on CECT Abdomen Findings

CECT Abdomen Finding	No. of Polytrauma Patients	Percent (%)
Liver Injury	5	17.24%
Spleen Injury	10	34.48%
Kidney Injury	5	17.42%
Bowel Injury	9	31.03%
Total	29	100%

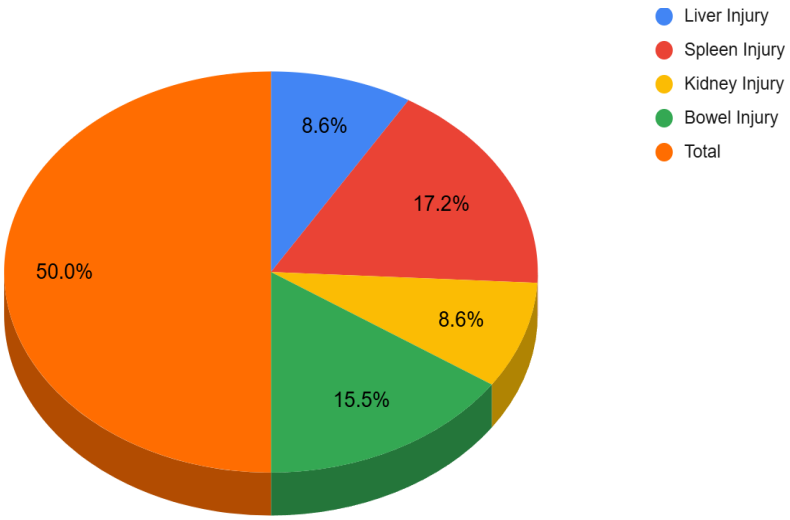

Figure 9: Pie chart of showing distribution of Polytrauma Patients based on CECT Abdomen Findings

Comparisons of injury severity scores include the following: 51 patients had an ISS score of 15-24, while 53 had a NISS score of > 24. This difference indicates that NISS tends to capture more severe cases. The mean ISS and NISS scores were 19.73 and 23.76, respectively, indicating the severity of the injuries (Table 10).

Table 10: Summary of Polytrauma Patients Based on ISS and NISS Scores

Score Range	ISS Count	NISS Count	Mean ISS	Mean NISS	Median ISS	Median NISS
<9	3	2	19.73	23.76	19.00	22.00
9-15	47	25				
15-24	51	49				
>24	30	53				
Total	131	131				

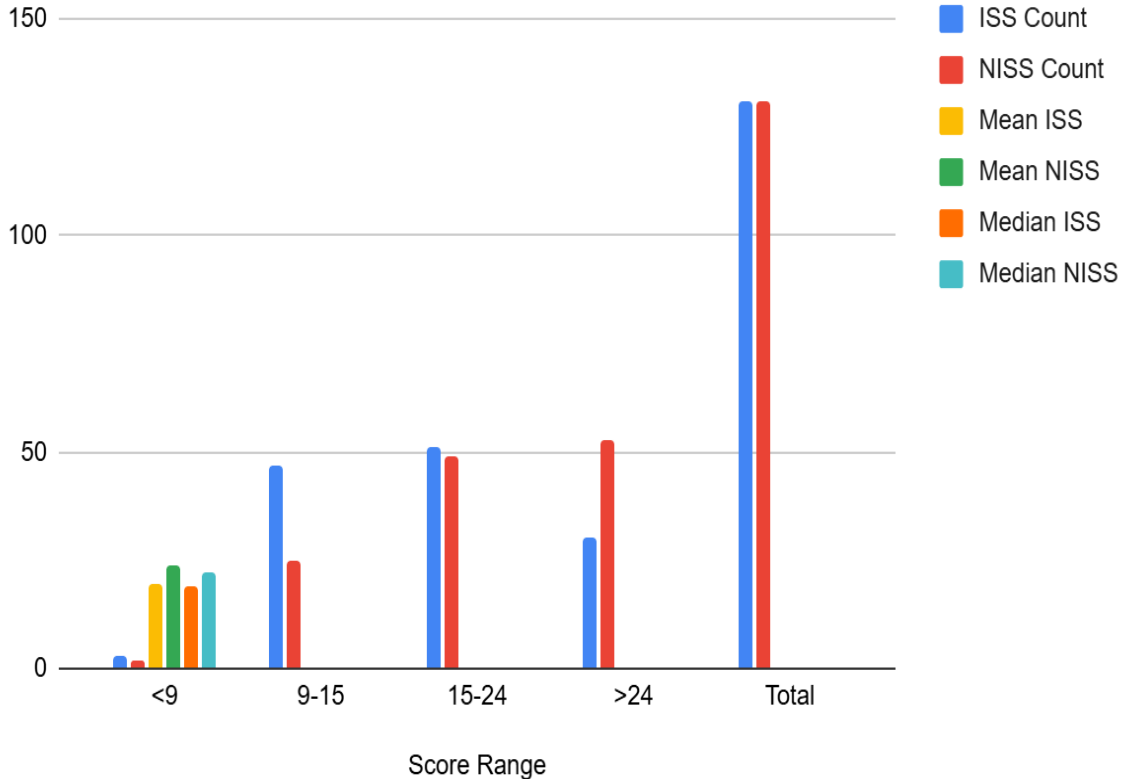

Figure 10: Bar chart of showing summary of Polytrauma Patients Based on ISS and NISS Scores

A large proportion, 58%, of the polytrauma patients required admission to ICU care and 36.6% needed ventilatory support, indicating the severity of the injury and the requirement for critical care management (Table 11).

Table 11: Distribution of Polytrauma Patients Based on ICU Admission and Requirement of Ventilatory Support

Category	No. of Patients	Percent
ICU Admission		
No	55	42.0%
Yes	76	58.0%
Total ICU Patients	131	100.0%
Ventilatory Support		
No	83	63.4%
Yes	48	36.6%
Total Ventilated	131	100.0%

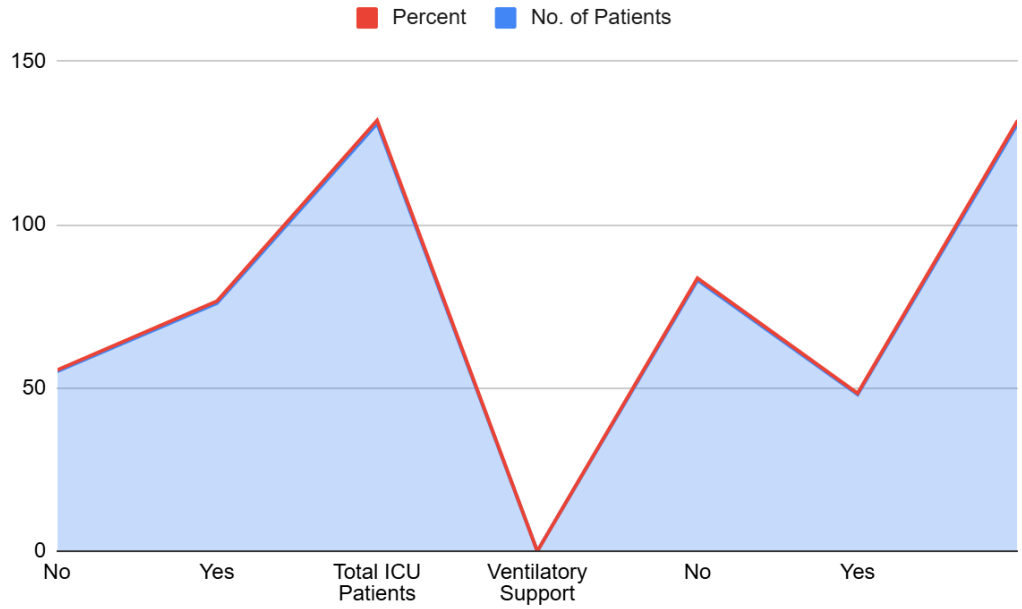

Figure 11: Stacked area chart of showing distribution of Polytrauma Patients Based on ICU Admission and Requirement of Ventilatory Support

70.8% of the polytrauma patients were discharged, 23.1% died, while 6.2% were left with a disability. 79.4% of the patient's required operative interventions, showing surgical treatment was required in the majority of cases. The length of stay in hospital was clearly related to the injury severity. The patients with ISS and NIIS scores greater than 10 had longer lengths of stay in the hospitals, and a significant number of them had their stay more than 25 days (Table 12).

Table 12: Summary of Polytrauma Patient Outcomes, Operative Interventions, and Hospital Stay by ISS and NISS Scores

Parameter	Outcome	Operative Intervention
Discharge	91 (70.8%)	No: 27 (20.6%)
Disability	8 (6.2%)	Yes: 104 (79.4%)
Death	30 (23.1%)	Total: 131 (100.0%)
Hospital Stay (Days)	ISS < 5: 2, 9-15: 9, 16-24: 9, >25: 11	
	ISS 5-10: 0, 9-15: 26, 16-24: 20, >25: 6	
	ISS >10: 1, 9-15: 12, 16-24: 22, >25: 13	
	NISS < 5: 2, 9-15: 5, 16-24: 9, >25: 15	
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	NISS >10: 1, 9-15: 6, 16-24: 20, >25: 22	

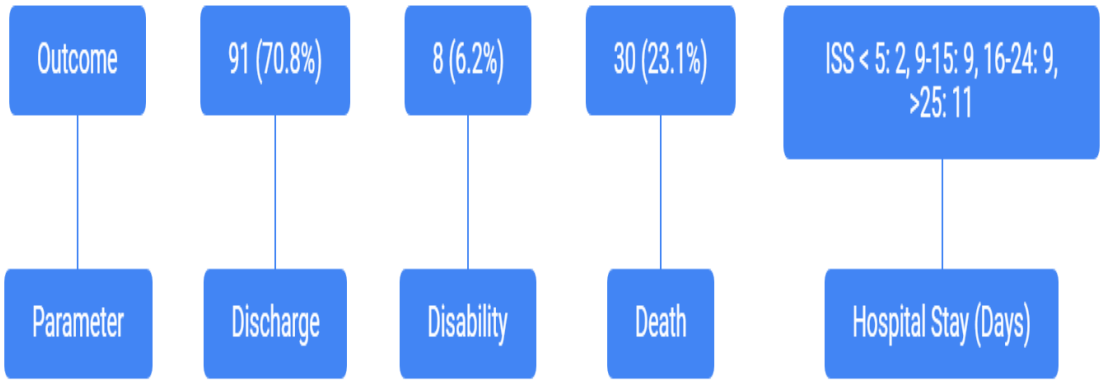

Figure 12: Organizational chart of showing Summary of Polytrauma Patient Outcomes, Operative Interventions, and Hospital Stay by ISS and NISS Scores

Discussion

The present investigation evaluated 131 cases of polytrauma and further compared the predictive values of ISS and NISS regarding several outcomes, including ICU admission, ventilatory support, operative interventions, and mortality. Our findings reveal valuable data on age distribution, sex prevalence, trauma mechanism, injury patterns, and predictive capability of ISS and NISS in polytrauma cases [11].

The commonest age group in the polytrauma patients was 31-40 years of age group, which constituted 31.53%, followed by 21-30 years with 23.07%. This is paralleled by a study undertaken by Madane et al., where the average age in their series of trauma patients was 32.39 years. The high percentage in young adults can be explained by the fact that they are more involved in outdoor activities and vehicular travels, thus leading to a high incidence of road traffic accidents [12]. The male patients accounted for 80.2% in this series, which agrees with other studies such as Bolandparvaz et al., who reported a prevalence of males at 73.1%. This male preponderance doubtless reflects behavioral factors, including higher involvement in dangerous activities and occupations [13].

RTAs were the most frequent cause of trauma, accounting for 83.2% of the cases, and falls from height accounting for 11.4%. This compares with Mangane et al. and Kanikomo et al., who found in their studies 74.4% and 59.7%, respectively. The reasons for the high occurrence of RTAs in this region could be due to rapid urbanization, increased vehicle traffic, and nonobservance of the road safety regulations [14]. As for the injury pattern, it was the head that was most involved, 45.4%, followed by the chest, 31.5%, and extremities. This predominance of head injuries is probably related to the inappropriate use of a helmet among motorbikers. Chest trauma-rib fractures 31.29%, hemothorax 28.2%, and pneumothorax 20.6%-was also among common findings. Maxillofacial injuries were the most frequently encountered craniofacial trauma, 8.39%, in consistency with previous studies [15].

Also, as far as the severity scoring is concerned, the mean ISS was 19.73 ± 7.93 and mean NISS was 23.76 ± 10.41, thus demonstrating a persistently higher value of NISS than ISS. It was also stated by Whitaker et al. and Pawan et al. in series that the NISS were generally higher with better predictive value for morbidity and mortality. Our study also showed that the patients with NISS scores above 24 had higher mortality rates, thus establishing NISS as a more sensitive predictor of mortality compared to ISS. This finding was statistically significant, with a p-value of less than 0.0001 [16, 17]. Moreover, the ICU admission rate was 58%, while 36.6% required ventilatory support. The scores of ISS and NISS were higher among the patients who needed ICU admissions and ventilatory support, which is also represented in several literatures by H. Li and Y. F. Ma. Moreover, NISS > 15 tended to predict ICU admission better than ISS > 15, which gave further evidence that NISS is superior in critical situations [18].

Of them, 79.4% required operative intervention. Of these patients taken to surgery, 67.8% were discharged whereas 23.1% died due to their injuries. In all the patients who died, NISS values were higher than the ISS values, with mean NISS value of 33.6 ± 11.34 vs. mean ISS of 25.43 ± 9.38, corroborating the finding of Pawan et al [19].

The length of stay in the hospital was also longer among patients with higher ISS and NISS, particularly in the case of scores above 16. Many of them had to stay in the hospital for more than 10 days, which gives evidence of the seriousness of the injury and the time needed for medical care. Herein, a good correlation between ISS and NISS was determined by the Pearson coefficient of 0.919 and $p < 0.0001$. It thus seems that while both scores are related, injury severity and outcome is more accurately determined by NISS [20].

Despite these best efforts, some limitations to this study remain. The most significant concern is the relatively small sample size-only 131 cases are included-which might be too few to guarantee statistically robust results. The setting of this study is a tertiary care hospital, which may introduce selection bias, with limited generalizability to larger populations. This might also affect the gravity of the cases and could, hence, provide biased results. The present results would require larger samples in multicenter studies to give more complete information and further validate these results.

In the end, our current study demonstrates that in polytrauma patients, NISS enjoys high predictive superiority over ISS, especially for mortality, ICU admissions, and hospital stay duration. The findings are really supportive to impress upon all trauma centers that NISS should no longer remain a tool to be used only for research activities, but should be a part of the armamentarium of trauma assessment tools for appropriate prognosis in polytrauma cases.

Conclusion

Polytrauma still continues to be one of the most important causes of morbidity and mortality among middle-aged men. This study emphasizes that timely and accurate assessment by trauma scoring systems could help in the management of such patients, and NISS emerged as a more promising predictor compared to ISS, especially for mortality, ICU admission, and hospital stay extending beyond a week. Incorporation of NISS in regular trauma assessment could perhaps improve the

prognostication and lead to more effective management strategies for polytrauma patients. Our findings show that though ISS is more in vogue, NISS is more predictively accurate, especially for severe trauma. These findings need further confirmation due to the limited sample size and short duration of the study in multicenter research studies. More importantly, preventive measures like popularization of helmets and implementation of traffic rules would go a long way to lessen the load of road traffic-related polytrauma in our country.

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