Original Research Article

A prospective observational study of assessment of morbidity & mortality pattern in trauma cases in a tertiary care hospital

Tejas Patel[1], Hitesh Tadvi[2], Chirag Parikh[3*]

[1]Assistant Professor, Department of General Surgery, Parul Institute of Medical and Surgical Research, Wadhodia, Vadodara, Gujrat, India
[2]Assistant Professor, GMERS medical college, Gotri, Vadodara, India
[3]Associate Professor, Department of General Surgery, Parul Institute of Medical and Surgical Research, Wadhodia, Vadodara, Gujrat, India

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Abstract

Introduction: Trauma is the study of medical problems associated with physical injury. The injury is the adverse effect of a physical force upon a person. There are a variety of forces that can lead to injury, however the force involved in most injuries is mechanical. The subject of trauma therefore centers upon the deleterious effects of kinetic energy on the human frame. The main objective of this study is to assess the morbidity & mortality in such cases of trauma by using NISS check association between NISS and outcome of patients. Correlation Coefficient will be obtained to check relationship between NISS and time post admission. **Materials and Methods:** This study is prospective observational study follow up after 1 and 2 month. All the patients presenting to emergency department will be admitted and initial resuscitation done. Investigation such as X-ray chest, abdomen and pelvis, both hips, USG chest & abdomen will be done apart from other Routine Investigations. Preliminary data for each patient will be first Recorded in the trauma data collection form, which will also accompany the patients clinical Record. This single sheet form contains the patient's vital information and physiological data gathered by rescuers at the scene of the accident. Data on this form will be updated daily and all injury diagnoses will be recorded and calculated from which New injury severity score (NISS) obtained for every single patients and mortality & morbidity in each case will be assessed by using the softwear Microsoft Excel. **Results:** The most common age group involved was 21- 30 years [46.09%] followed by 11-20 years [16.7%] The incidence reduced sharply after 40 years. Most of the study population was males 287 [77.36%]. Out of 371 cases, majority sustained head injury 127 [34.23%] followed by blunt abdominal trauma 95 [25.6%], stab injuries were seen in 69 [18.6 %] cases and 63 [16.9%] cases suffered assault. Total 78 [21.02%] cases died. Majority of the deaths occurred after 72 hours of admission 18 [23.1%] and 12 [15.4%] deaths happened within 1 hour of admission. Seventeen [21.8%] deaths occurred between 24-72 hours of admission. **Conclusion:** The NISS and ISS system of scoring was applied on the entire trauma cases of this study, it was found that NISS has excellent predictive ability for hazardous outcome [death] which is better than ISS. The NISS takes after the ISS in its simplicity and ease of computation while increasing its ability to deal with multiple injuries. In a more severely injured population, with a higher proportion of multiple injuries caused by penetrating trauma, the NISS would clearly outperform the ISS.

Key Words: Trauma, NISS, ISS, head injury

Introduction

Trauma is the study of medical problems associated with physical injury. The injury is the adverse effect of a physical force upon a person. There are a variety of forces that can lead to injury, however the force involved in most injuries is mechanical. The subject of trauma therefore centers upon the deleterious effects of kinetic energy on the human frame[1].Trauma is injury or damage to a biological organism caused by physical harm from an external source. Major trauma is injury that can potentially lead to serious long-term outcomes including death. It has potential to cause prolonged disability or death[2].

Types of Trauma: There are many causes of trauma, Blunt and penetrating, including Falls, Motor vehicle collisions [RTA], and Gunshot wounds. Depending on the severity of injury, quick management and transport to an appropriate medical facility may be necessary to prevent loss of life or limb. The initial assessment involves a physical evaluation and can also include the use of imaging tools to accurately determine a type of injury and to formulate a course of treatment[3].

Scoring systems of Injury severity: An identifying feature in the study of trauma is time. At time zero the person/patient is at their normal baseline. There is then some interaction with an external force leading to injury. The subsequent development of pathology, the response of the body by way of compensation and healing, and the external responses by health professionals all have a timeline; that timeline originates at time zero, the moment of injury[4]. Various classification scales exist for use with trauma to determine the severity of injuries, which is used to determine the resources used and for statistical collection[5,6] The initial assessment is critical in determining the extent of injuries and what will be needed to manage an injury, and treating immediate life threats[7].The study of circumstances of deaths in trauma victims may be very useful in survival prediction in clinical practice. Till now, the glasgow coma scale (GCS) has been accepted internationally in trauma centers to assess the severity of the brain injury or general medical condition. But there are few drawbacks with the GCS and the assessing

**Correspondence*
Dr.Chirag Parikh
Associate Professor, Department of General Surgery, Parul Institute of Medical and Surgical Research, Wadhodia, Vadodara, Gujrat, India
E-mail: drchiragms@yahoo.co.in

consciousness. Firstly, it is not a straightforward clinical exam and also not reliable in sedated patients in ICU. Over the years, clinicians and researchers have developed various methods of assessing and describing the severity of injuries incurred during high-speed motor vehicle collision and other forms of trauma. Among the areas which benefited from these studies included the development of objective and quantitative methods for the evaluation of care, the standardization of quality of care assessments, and injury research. Injury description is a formidable task, given the number of possible injuries or combination of injuries a person may sustain in a fall or a motor vehicle collision. Individual variations in the severity of injuries received, degree of organ involvement and physiologic response to the injury may likewise occur[8].

ISS: Injury severity scoring (ISS) is a process by which the complexity of traumatic patients will be reduced to a single number. This number is precisely designed to characterize the patient's clinical grade of illness. In reality, achieving this level of informative accuracy may be useful in the process of clinical staging **.**In 1974, Baker et al (1974) published the Injury Severity Score (ISS), which provided for a better description of severity and probability of death in patients with multiple injuries. Originally designed for mortality studies, the ISS made possible the retrospective comparison of injuries and outcomes among different population groups. The simplicity by which ISS was calculated made it accessible and acceptable to clinicians, epidemiologists and injury researcher. As proof of its validity, the ISS has been the standard used for trauma scoring for more than 20 years. The ISS was described as the sum of the squares of the highest Abbreviated Injury Scale (AIS) grade in each of the three most severely injured body regions (head/neck, face, thorax, abdomen, extremities, and external) with possible values ranging from 1 to 75. The patient with an AIS of 6 was automatically assigned an ISS value of 75, which was associated with almost certain mortality. The ISS value and the three AIS used in its calculation do not contain information about the location and nature of the patient's injuries. By doing so, the ISS gives equal importance to all body regions, and provides a means by which different injuries of similar severity but occurring in different body regions can be compared. The main limitation of the ISS was that it only considered three of the patient's most severe injuries. This limitation would result in ISS disregarding more severe injuries that happen to be in the same body region as the most severe injury, in favor of another injury in another body region which may not be of comparative severity. In situations where multiple injuries are confined to a single body region, ISS would underestimate the severity of the patient's condition by taking into account only the most severe injury and not the cumulative effect of these injuries on survival or recovery.The ISS was originally designed to compare injuries caused by blunt or non-penetrating trauma and although subsequent revisions in AIS-85 included coding for penetrating injuries, the extent to which ISS predicted outcome in these groups was limited. In contrast to blunt trauma, which cause more diffuse injuries, penetrating trauma produce injuries that tend to 'cluster' or accumulate in a body area. Stab wounds or gunshot wounds to the chest or abdomen, in particular, may cause damage to more than one structure. A modification of the ISS that tackled these flaws considered the patient's most severe injuries, regardless of body region.

NISS: The New Injury Severity Score (NISS) as it was called, was defined as the sum of the squares of the Abbreviated Injury Scale scores of each of the patient's three most severe injury regardless of the body region in which they occur[9].

Purpose of this study: This study was planned with the aim to assess and analyze the morbidity & mortality pattern in trauma cases by using NISS and to check association between NISS and outcome of patients.

Materials and methods

Study Design: This study is prospective observational study follow up after 1 and 2 month.

Inclusion Criteria: All the patients presenting to emergency department of SSG Hospital Vadodara with history of trauma. Trauma including the Road traffic injury, stab injury, Blunt Abdominal trauma, Assault etc.

Exclusion Criteria: All the patients presenting to emergency department of SSG Hospital including this study but minor injury like superficial skin cut, abrasion, single injury not included only multiple injury taken in to the study.

Study Populations: From July 2015 to March 2016 minimum required number of patients for this study is 370 with assumption that relation between NISS & time 0.28 with 0.1% Risk and 99% Power. Using statistical softwear nMaster 2.0

Statistical Analysis: Chi square test will be used to check association between NISS and outcome of patients. Correlation, Coefficient will be obtained to check relationship between NISS & time post admission.

Methods: All the patients presenting to emergency department will be admitted and initial resuscitation done. Investigation such as X-ray chest, abdomen and pelvis, both hips, USG chest & abdomen will be done apart from other Routine Investigations.Preliminary data for each patient will be first Recorded in the trauma data collection form, which will also accompany the patients clinical Record. This single sheet form contains the patient's vital information and physiological data gathered by rescuers at the scene of the accident. Data on this form will be updated daily and all injury diagnoses will be recorded and calculated from which New injury severity score (NISS) obtained for every single patients and mortality & morbidity in each case will be assessed by using the softwear Microsoft Excel.

Objectives: The aim of the study is to assess the morbidity & mortality in such cases of trauma by using NISS check association between NISS and outcome of patients. Correlation Coefficient will be obtained to check relationship between NISS and time post admission

Outcome: From the study we can predict that highest NISS has more chances of mortality than lowest NISS, also correlates with hospital stay and other measures of severity.

Results

Table 1: Age wise distribution of cases

Age in years	No of cases	%
<10	4	1.08
11--20	62	16.71
21-30	171	46.09
31-40	58	15.63
41-50	32	8.63
51-60	28	7.55
>60	16	4.31
Total	371	100.00

Youngsters were commonly involved in the trauma. The most common age group involved in the study was 21- 30 years [46.09%]. This is financially most productive group of society. But it is usually involved in accidents due to careless behavior especially in traffic. Eg- rash driving and non usage of helmet, alcoholism etc.The next most common age group was 11-20 years [16.7%] and 31-40 years [15.6 %], the incidence reduced sharply after 40 years.

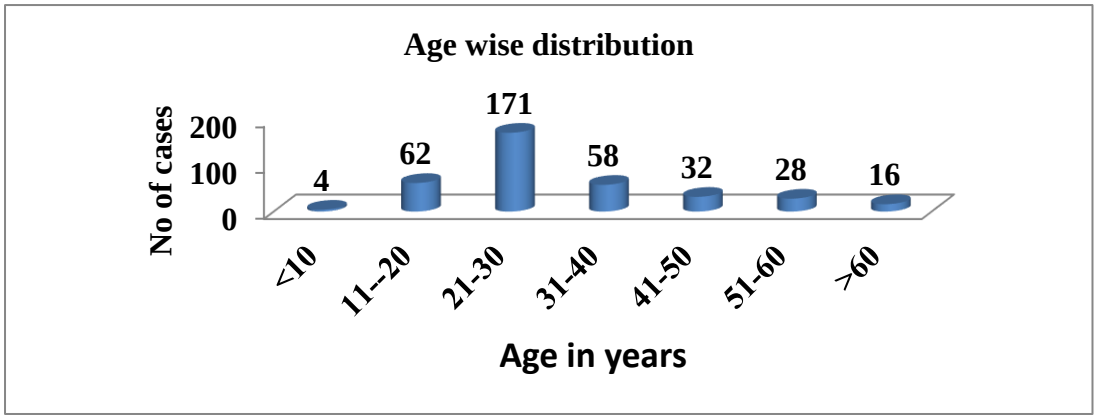


Fig 1:Age wise distribution

Table 2: Sex wise distribution of cases

Sex	No of cases	%
Male	287	77.36
Female	84	22.64
Total	371	100.00

Most of the study population was males 287 [77.36%] and only 84 [22.6%] were females. This represents the outgoing activities of the males. Also depicts higher aggression and intolerance behavior of the males.

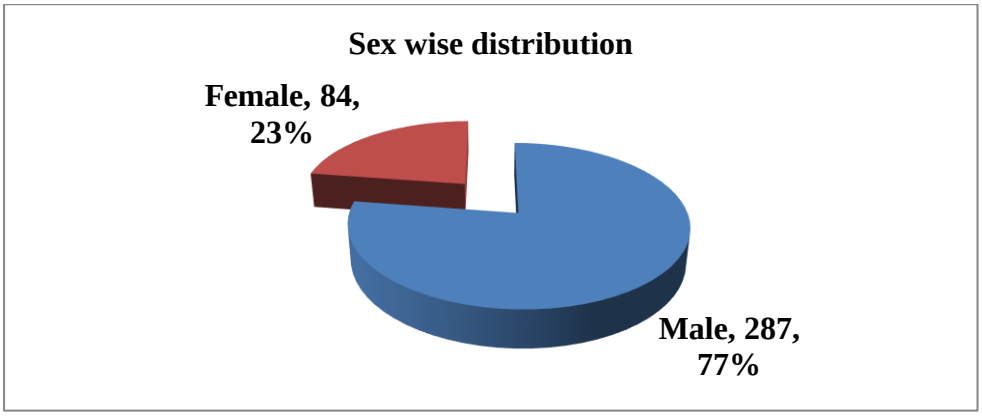


Fig 2:Sex wise distribution

Table 3: Type of trauma of cases

Type of Trauma	No of cases	%
Head Injury	127	34.23
Blunt Abdo.Trauma	95	25.61
Assault	63	16.98
Stab Injury	69	18.60
0thers	17	4.58
Total	371	100.00

Out of 371 cases in the study, majority sustained head injury 127 [34.23%] followed by blunt abdominal trauma 95 [25.6%] stab injuries was seen in 69 [18.6 %] cases and 63 [16.9%] cases suffered assault.

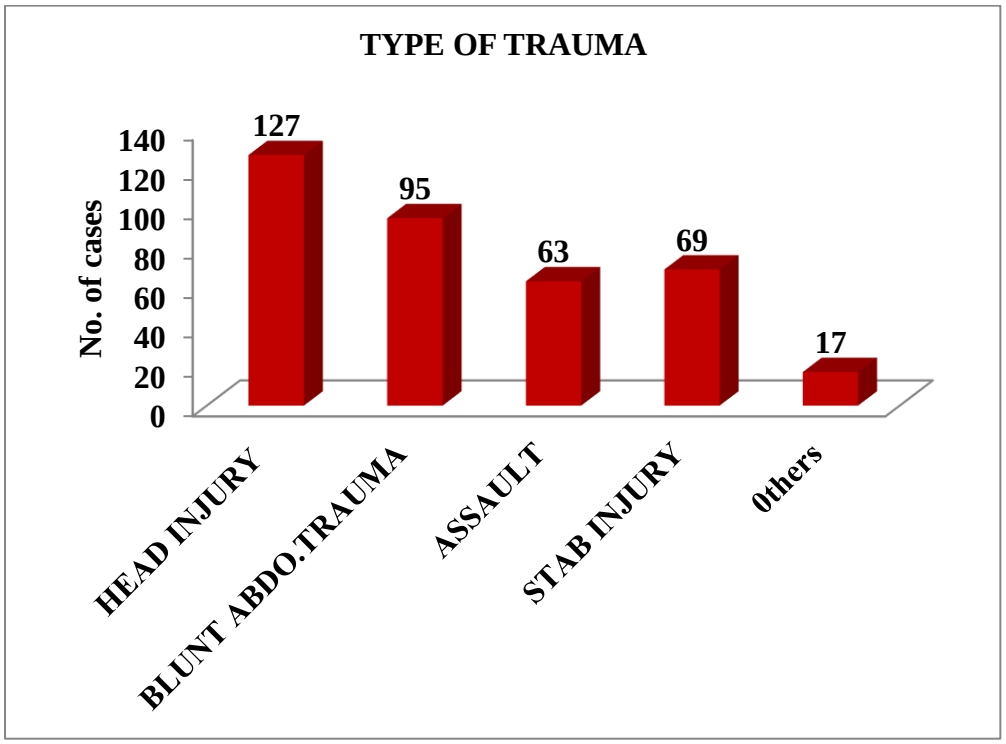


Fig 3:Types of trauma

Table 4: Type of vehicle used in RTA

Type of Vehicle Used in RTA	No of cases	%
Cycle	28	11.72
Two wheeler	164	68.62
Four wheeler	47	19.67
Total	239	100.00

Out of total cases 239/371 [64.4%] were of road traffic accident. Out of them two wheeler riders were most common 164 [68.6%], followed by four wheelers 47 [19.67%] and 28 cases [11.7%] were cyclists.

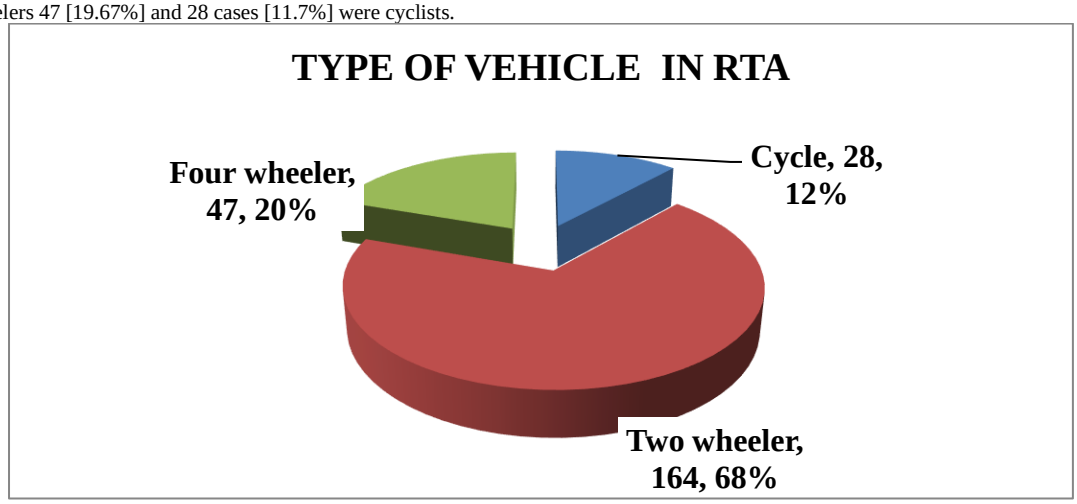


Fig 4:Types of vehicle in RTA

Table 5: Type of collision

Type of Collision	No of cases	%
Head on Collisions	172	71.97
Single Vehicle Collisions	22	9.21
Intersection Collisions	45	18.83
Total	239	100.00

Out of 239 cases of RTA majority were victim of head on collision -172 [71.2%], followed by intersection collisions in 45 [18.8%] cases. Single vehicle collision was seen only in 22 [9.2 %] of cases.

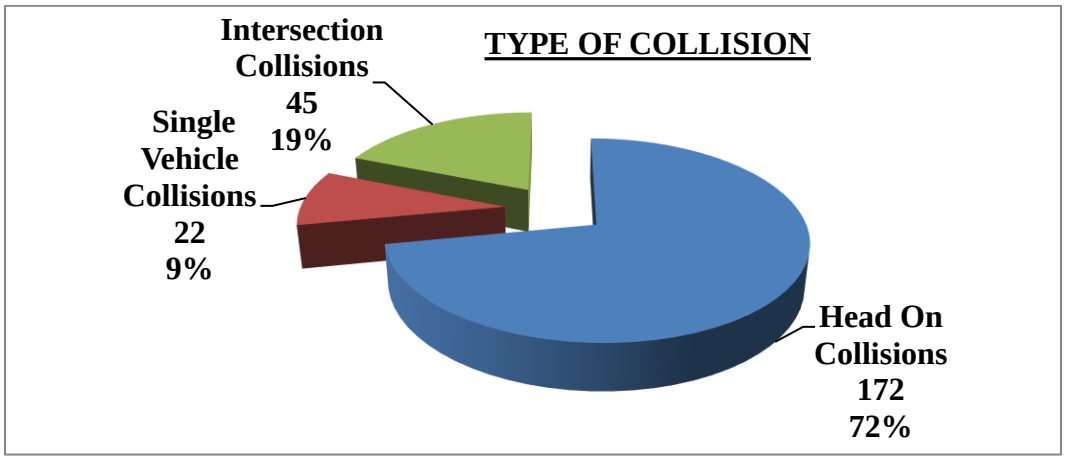


Fig 6:Types of collision

Table 6: Type of person injured

Person Injured	No of cases	%
Driver	146	61.09
Pillion Driver	93	38.91
Total	239	100.00

In the RTA the most common person to be injured is the driver 146 [61.1%] and only 93 [38.9%] were pillion drivers.

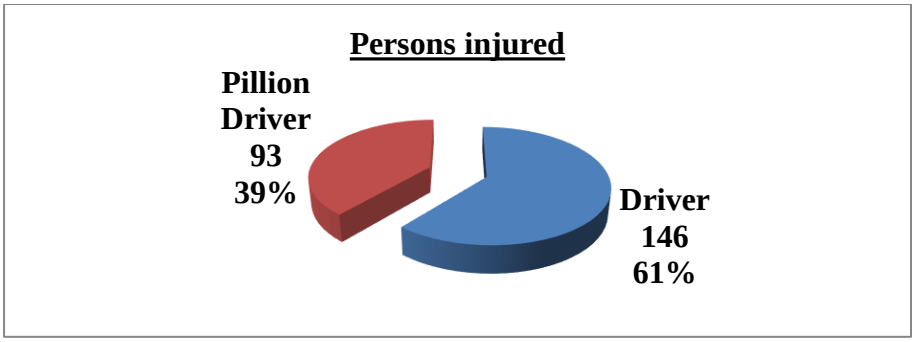


Fig 7:Persons injured

Table 7: Follow up summary

Patients Visit	No of cases present	% present	Drop out/ Expired	% Drop out/ Expired
First visit	371	100.00	78 [Expired]	21.02
Survived	293	78.98	-	-
Follow up 1 month	256	87.37	33	11.26
Follow up 2 month	213	83.20	41	16.02

Totally 371 victims of injury arrived in the emergency department which were included in the study. Out of them 78 [21.02%] cases expired. And 293 [78.9%] survived that trauma. Out of the survived cases 256 [87.4%] visited at the first follow up after 1 month and 33 [11.26%] were drop outs. Then at two months follow up only 213 [83.2%] cases turned up for follow up while 16 % were drop outs.

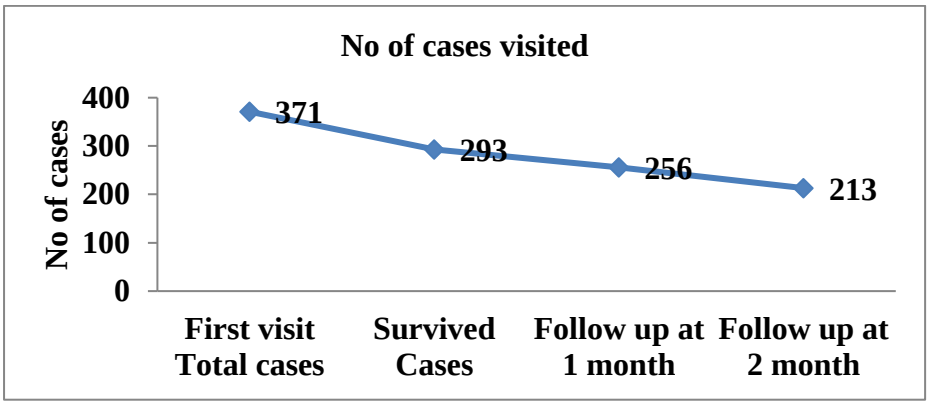


Fig 8:Number of cases visited

Table 8: Final Outcome of the cases

Outcome	No of Cases	% of Cases
Died	78	21.02
Survived	293	78.98
Total	371	100.00

Totally 371 victims of injury arrived in the emergency department which were included in the study. Out of them 78 [21.02%] cases expired. And 293 [78.9%] survived that trauma.

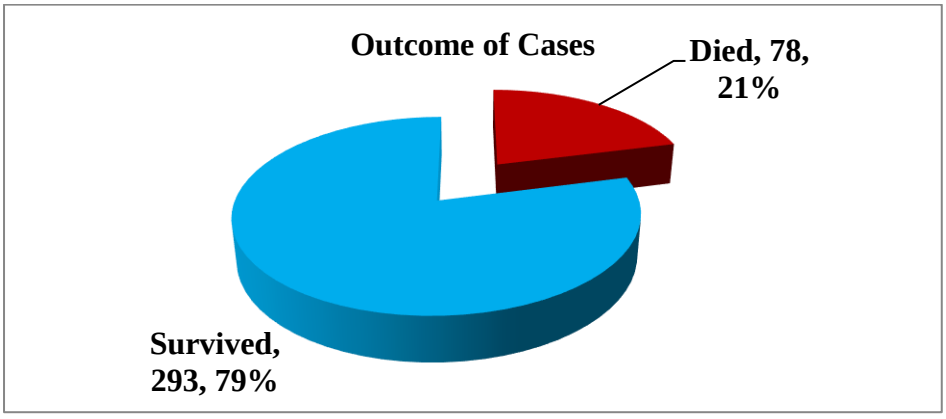


Fig 9:Outcome of cases

Table 9: Glasgow coma scale correlated with death

GCS	Total no of cases	% Total	No of cases Died	% Died	No of cases Survived	% Survived
3--5	121	32.61	47	38.84	74	61.16
6--8	105	28.30	30	28.57	75	71.43
9--11	92	24.80	1	1.09	91	98.91
12--15	53	14.29	0	0.00	53	100.00
Total	371	100.00	78	21.02	293	78.98

On admission, Glasgow coma scale was calculated for every case. Majority 121 [32.6%] of the cases had GCS of 3-5, followed by 6-8 in 105 [28.3%] and 9-11 in 92 [24.8%] 53 cases had GCS scale of 12-15.47 [38.84%] of the cases died whose score was 3-5. While 30 [28.57%] cases died whose score was 6-8. Only one case of score 9-11 died. No cases expired with GCS >11.

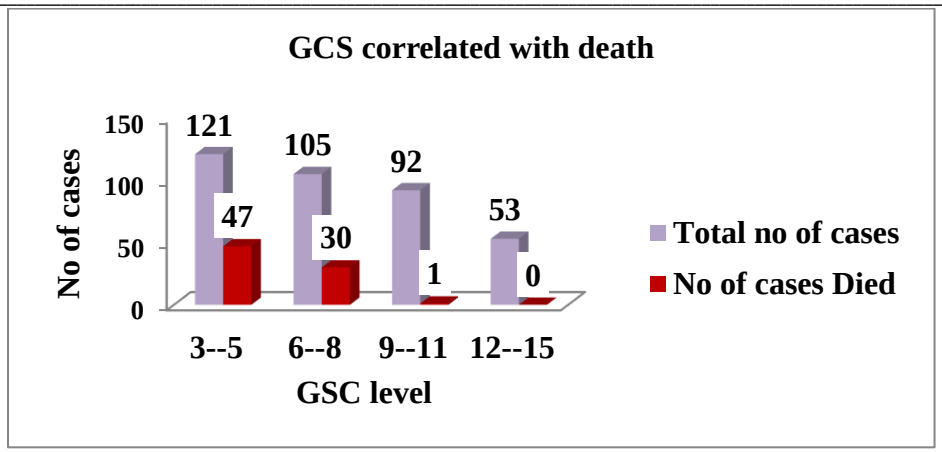


Fig 10:GCS correlated with death

Table 10: ISS correlated with death

ISS	Total no of cases	% Total	No of cases Died	% Died
<15	15	4.04	0	0.00
16-30	25	6.74	0	0.00
31-45	92	24.80	4	4.35
46-60	126	33.96	25	19.84
>60	113	30.46	49	43.36
Total	371	100.00	78	21.02

Abbreviated injury score [AIS] and Injury severity score [ISS] was also calculated for every case. Most of the cases had ISS > 45, 239 [64.42 %] cases and 113 [30.4%] had ISS above 60.Among cases with ISS >60, 49 [43.3%] expired and among cases with ISS 46-60 25 [19.8%] expired. Four [4.35%] cases expired with ISS 31-45. No cases expired with ISS < 30.The positive predictive value of ISS >60 for death is found to be 43.4 % and negative predictive value was 88.7%.

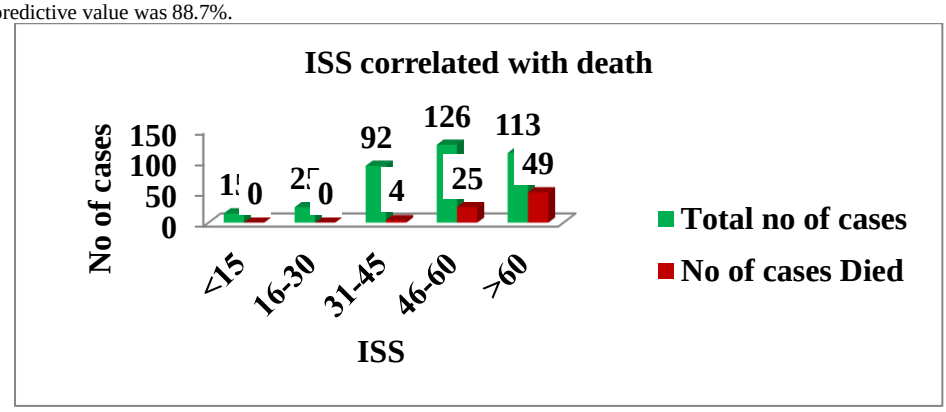


Fig 11:ISS correlated with death

Table 11: New ISS correlated with death

NISS	Total no of cases	% Total	No of cases Died	% Died
<15	13	3.50	0	0.00
16-30	27	7.28	0	0.00
31-45	88	23.72	2	2.27
46-60	118	31.81	11	9.32
>60	125	33.69	65	52.00
Total	371	100.00	78	21.02

New Injury severity score [ISS] was also calculated for every case. Most of the cases had NISS > 45, 243 [65.5 %] cases and 125 [33.69%] had NISS above 60.

Among cases with NISS >60, 65 [52.0%] expired and among cases with NISS 46-60 11 [9.3%] expired. Two [2.2 %] cases expired with NISS 31-45. No cases expired with NISS < 30.The positive predictive value of NISS >60 for death was found to be 52 % and negative predictive value was 94.7%.

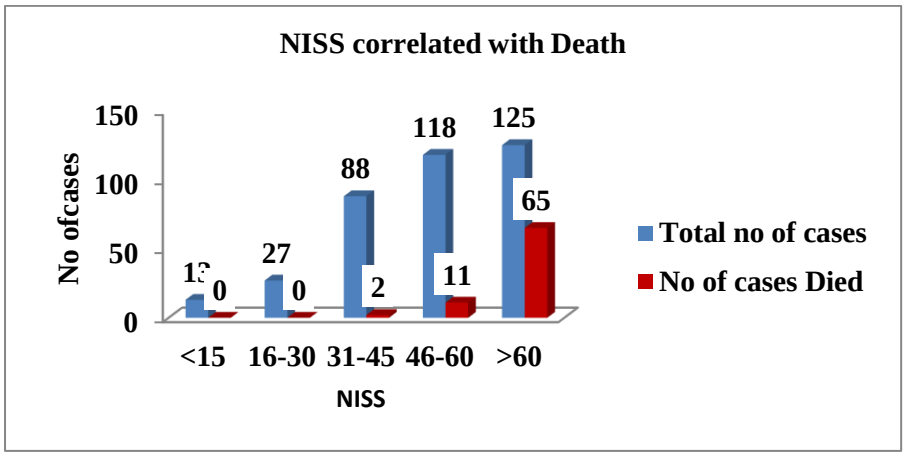


Fig 12:NISS correlated with death

Table 12: Mean NISS at various time and follow up

Patients Visit	Mean NISS	± SD
First visit [Total cases]	57.42	4.8
Survived cases	42.64	5.7
Follow up 1 month	34.72	5.1
Follow up 2 month	29.71	3.4

The mean NISS at various intervals was studied. It was 57.42 ± 4.8 at the time of admission for all cases. It was 42.6± 4.8 of the cases who survived. On 1 month follow up mean NISS was 34.7 ± 5.1 and on 2 month follow up it decreased to 29.7 ± 3.4.

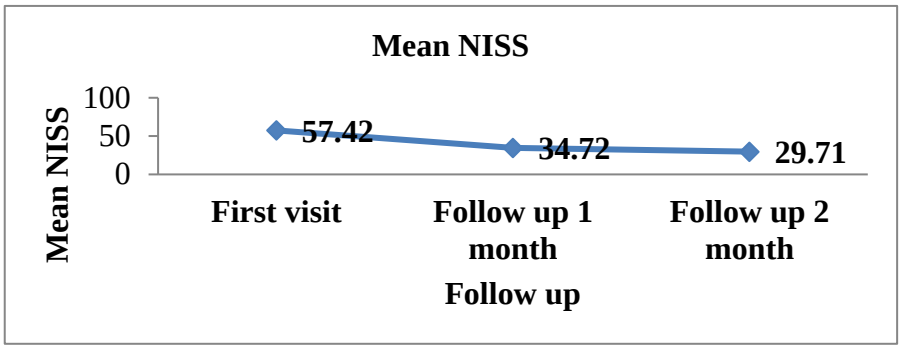


Fig 13:Mean NISS

Table 13: Correlation of NISS with duration of hospitalization

NISS	Total no of cases	Mean Duration of Hospitalization [days]	± SD
<15	13	2.1	0.20
16-30	27	3.3	0.80
31-45	88	4.5	1.10
46-60	118	7.4	1.90
>60	125	11.8	2.70
Total	371	5.87	1.4

The duration of hospitalization was directly proportional to the NISS score. The higher the score, the longer the duration of hospitalization. Hospitalization duration was 11.8 ± 2.7 days among cases with NISS > 60, It was 7.4 ± 1.9 days in cases of NISS 46-60 but it was only 2.1± 0.21 days in cases of NISS <15.

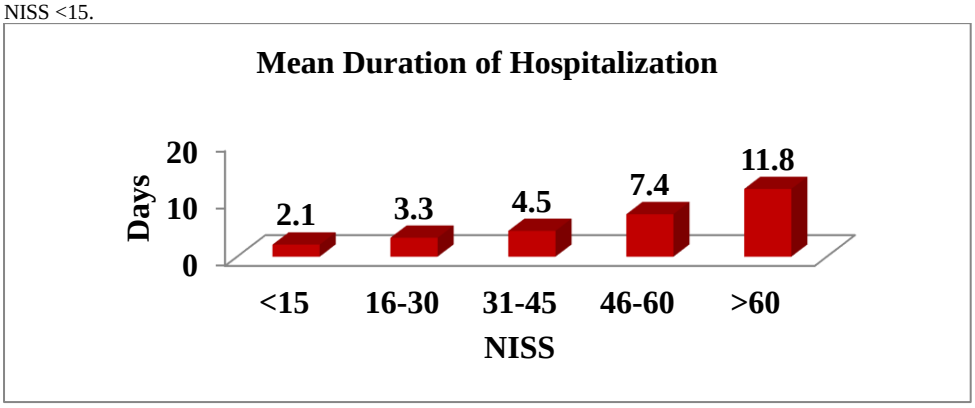


Fig 14:Mean duration of hospitalization

Table 14: Correlation NISS with Mortality

NISS	Expired	Survived	Total
>60	65	60	125
<60	13	233	246
Total	78	293	371

Majority of the cases had NISS > 45, 243 [65.5 %] cases and 125 [33.69%] had NISS above 60. Among cases with NISS >60, 65 [52.0%] expired but among cases with NISS 46-60 11 [9.3%] expired. Two [2.2 %] cases expired with NISS 31-45. However no case expired with NISS < 30.The positive predictive value of NISS >60 for death is found to be 52 % and negative predictive value was 94.7%.

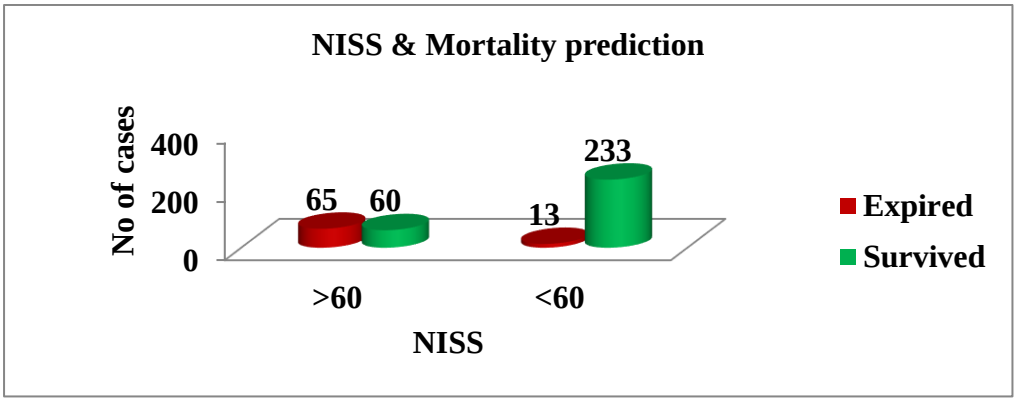
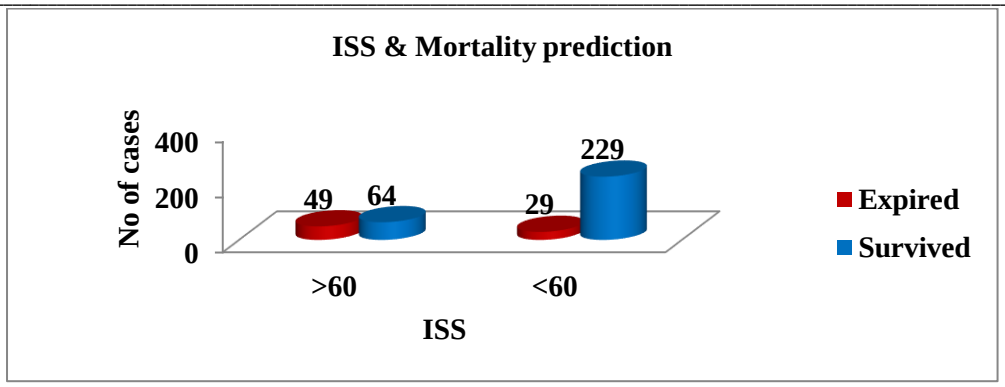


Fig 15:NISS and mortality prediction

Table 15: ISS & Mortality prediction

ISS	Expired	Survived	Total
>60	49	64	113
<60	29	229	258
Total	78	293	371

Among cases with ISS >60, 49 [43.3%] expired and among cases with ISS 46-60 25 [19.8%] expired. Four [4.35%] cases expired with ISS 31-45. However no cases expired with ISS < 30. The positive predictive value of ISS >60 for death is found to be 43.4 % and negative predictive value was 88.7%.



Discussion

This study was conducted on 371 patients of trauma who attended the emergency department of SSG Hospital, Vadodara with the aim to assess the morbidity & mortality in cases of trauma by using NISS and to check association between NISS and outcome of patients. All the patients presenting to emergency department with history of trauma were admitted and initial resuscitation was performed. NISS score was assessed for all the cases and follow up was conducted for all the survived cases[9].

Sample size: In our study a total of 371 patients were enrolled who attended the emergency for management of trauma.

While Oliver A. Samin et al enrolled larger number of cases a total of 1,482 patients, in the study of Orhon et al of 633 patients were studied. Large sample size was studied by Wong et al, total 11,398 blunt trauma patients, with 1114 patients meeting the anatomical criteria for polytrauma, and 1073 patients meeting either the physiological or the age criteria in the Berlin definition of polytrauma. In the study of Koksal et al a total of 5425 patients were entered into the trauma registry, and of these, 135 (2.5%) were firearm injuries. Mica et al studied in total, 770 patients of trauma.

Age: Youngsters were commonly involved in the trauma. The most common age group involved in the study was 21- 30 years [46.09%]. The range of age was 3 to 67 years. The next most common age group was 11-20 years [16.7%] and 31-40 years [15.6 %] , The incidence reduced sharply after 40 years. The mean age was 24.57 ± 2.4 years. Similarly in the study of Oliver A. Samin et al the study population was relatively young with only 350 patients over 55 years old. The youngest patient was 15 years old and the oldest was 90. In the study of Orhon et al the mean age values of 633 individuals were 39.65±17.07 (16-87) years[10].In the study of Koksal et al the mean age of the patients included in the study was 34.54±1 (with range of 9-69 years) while in the study of Mica et al the mean age was 39 years (range 16–89).

Sex: Most of the study population was males 287 [77.36%] and only 84 [22.6%] were females. This depicts the outgoing activities of the males. Also depicts higher aggression and intolerance behavior of the males. Similarly in the study of Oliver A. Samin et al two-thirds of the patients were male, accounting for 970 admissions (65.45%) and females with 512 (34.55%). Also close to our study findings 482 (%76.1) patients were male and 151 (23.9%) females in the study of Orhon et al. In the study of Wong et al there were more males [61%] than females, and this was the case for all age groups up to age 75.In the study of Koksal et al the male proportion was much higher with 11% (n=15) female and 89% (n=120) male. While In the study of Mica et al 573 [74.4%] were men and 197 [25.6%] were women.

Type of trauma: Out of 371 cases in the study, majority sustained head injury 127 [34.23%] followed by blunt abdominal trauma 95 [25.6%] stab [penetrating] injuries was seen in 69 [18.6 %] cases and 63 [16.9%] cases suffered assault. In the study of Oliver A. Samin et al Blunt trauma was responsible for injuries in 1,343 patients (90.8%), while in 136 patients (9.2%), penetrating trauma was the cause. The proportion of the population that sustained blunt trauma had a median ISS of 5 and NISS of 8. Injuries caused by penetrating trauma are usually confined to a certain body region but would often involve damage to more than one structure or organ within that area. In the study of Orhon et al 531 (83.8%) cases had blunt trauma, whereas 102 (16.1%) suffered from penetrating trauma.Wong et al found that the majority of injuries were falls, followed by motor vehicle injuries, and Mica et al observed that 84 patients suffered a penetrating trauma and 686 patients suffered a blunt trauma.

Mortality :Totally 371 victims of injury arrived in the emergency department which were included in the study. Out of them 78 [21.02%] cases expired. And 293 [78.9%] survived that trauma.Oliver A. Samin et al observed that one thousand four hundred and thirty four (1,434) patients survived until the time of discharge (96.9%) and only 45 patients died (3.04%). This was very low than rate mortality in our study. The mortality was also low in the study of Orhon et al where only eight patients (1.3%) could not survive. In the study of Koksal et al the mortality rate was 12.6% (8 of these patients died in emergency and 9 after hospitalization)[11].The mortality was pretty high in the study of Mica et al where In total, 512 patients (66.5%) survived the first 72 hand rest expired.

New ISS correlated with death:New Injury severity score [ISS] was calculated for every case. Most of the cases had NISS > 45, 243 [65.5 %] cases and 125 [33.69%] had NISS above 60.Among cases with NISS >60, 65 [52.0%] expired and among cases with NISS 46-60 11 [9.3%] expired. Two [2.2 %] cases expired with NISS 31-45. No case expired with NISS < 30. Median NISS for survivors was 9 and that of non survivors was 52.In the study of Oliver A. Samin et al Median ISS for survivors was 4, and for non-survivors was 26, while median NISS was 8 and 41, respectively. Median values for survivors and non-survivors are more widely separated with NISS than with ISS. Of the 45 deaths, 42 (93.3%) sustained blunt injuries with ISS ranging from 5 to 75, and 3 (6.7%) sustained penetrating injuries to the head with ISS values of 25, 26 and 26. The computed NISS for these three were 29, 42, and 57, respectively. The study population was composed of relatively less severely injured patients with the median ISS of 4 and NISS of 8[12].Orhon et al observed that the minimum score for all trauma scores was 0.0 point; the maximum scores were 41.0, 48.0, 7.84, and 99.7 points for ISS, NISS, RTS, and TRISS, respectively. The mean NISS score of non survivors was significantly higher than non survivors. All mean trauma scores of the death patients were significantly higher than survived patients (p=0.001). Accordingly, all trauma scores were equal for predicting the mortality. In the study of Mica et al patients who died at admission showed the highest NISS values (median 50.0, range 41.0–66.0, mode 58.8), followed by the patients who died

within the first 72 h (median 50.0, range 41.0–59.0, mode 50.6), and then by those who survived for > 3 days (median 41.0, range 29.0–50.0, mode 31.6).

Correlation of NISS with duration of hospitalization: In our study the duration of hospitalization was directly proportional to the NISS score. The higher the score, the longer the duration of hospitalization. Hospitalization duration was 11.8 ± 2.7 days among cases with NISS > 60, It was 7.4 ± 1.9 days in cases of NISS 46-60 but it was only 2.1± 0.21 days in cases of NISS <15.Oliver A. Samin et al also found that the duration of hospital stay was observed to increase in proportion to the severity of the injuries sustained, meaning, more severely injured patients (higher ISS and NISS) were confined to the hospital for longer periods than less injured ones (lower ISS and NISS). In the study of Orhon et al the trauma scores of the discharged and hospitalized patients were calculated and compared. The scores of ISS and NISS were significantly higher among hospitalized patients.

Similarity in ISS and NISS:In our study 219 [59.1 %] cases have displayed same ISS and NISS score and 152 [40.9%] had unequal values of ISS and NISS. Very much similar to our study Oliver A. Samin et al found that Eight hundred and seventy-one (871) patients had similar ISS and NISS (58.9 %), while 608 had dissimilar values (41.1%)[13].NISS values were higher than ISS values because NISS took into account injuries that were not included in the calculation of ISS. Similarly in the study of Koksal et al Seventy-two (53.3%) cases were in the ISS=NISS group and 63 (46.7%) in the ISS<NISS group.

Conclusion

The NISS and ISS system of scoring was applied on all the trauma cases of this study, It was found that NISS has excellent predictive ability for hazardous outcome [death] which is better than ISS. The NISS takes after the ISS in its simplicity and ease of computation while increasing its ability to deal with multiple injuries. In a more severely injured population, with a higher proportion of multiple injuries caused by penetrating trauma, the NISS would clearly outperform the ISS.

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