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Validation of Emergency Severity Index and its Association with Patients' Vital Signs at Triage: A Prospective Observational Study

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Abstract

Background: To reduce bias in triage validity studies, one should focus on measures that can be obtained directly at triage. *Objectives:* To study the validity of Emergency Severity Index, Associations of the Emergency Severity Index triage categories with patients' vital signs at triage. *Methods and study design:* 260 patients were studied from March 2013 to June 2013.Each patient was triaged by the Researcher on duty and assigned a triage category using standard procedures. Immediately after the Researcher finished the triage assessment and reported the ESI triage category, the researcher registered patients' gender, referrer, main complaint, age and measured vital signs that were measured by the triage nurse. The following vital signs were registered: blood pressure, pulse rate, respiratory rate, oxygen saturation, temperature, the AVPU score (Alert, Voice, Pain and Unconsciousness), and pain, the data was analyzed using statistical designs and significant co relations between the study parameters were interpreted. *Results and Conclusion:* There is a significant correlation (p = 0.00) between the ESI scores and WPSS categories the findings of this study support the validity of the ESI as it showed that patients' vital signs are associated with the ESI triage categories. There were strong associations between the ESI triage categories and patients' WPSS scores at triage. However, no associations were found between pain scores and ESI triage categories, which indicates that ESI is a good triaging tool and reliability on pain scores should be revalidated.

Keywords: Severity Index; AVPU score; ESI scores.

Introduction

Emergency departments everywhere are faced with increasing numbers of patients presenting faster than they can be seen. Triage is the rapid and preliminary assessment of patients identifying those who need to be seen quickly and those who can wait. Additionally, there are patients who will not require major resources for assessment and treatment, and could be seen in a low-intensity (fast-track/minor emergency department) area or by physician extenders. Identifying these patients as they present would permit the emergency department to be decompressed, and allow resources to be invested in the sicker patients at the same time that the less acute and less resource-dependent patients have their needs met.

Internationally, several triage models are used, stratifying patients in categories based on acuity (from urgent to non-urgent). To sort the increasing number of patients presenting to emergency departments (EDs) on the urgency of their complaints, several triage systems have been developed and implemented [1,5,6,8]. Frequently mentioned triage systems in the literature are: the Australian Triage Scale, the Manchester Triage System, the Canadian Triage and Acuity Scale and the Emergency Severity Index (ESI) [7,9,10]. Compared to other triage systems, the ESI is different in that, as well as the level of urgency, it estimates the number of resources that patients need. ESI resources are defined as laboratory tests, radiology, intravenous fluids, specialty consultation, a simple or complex procedure

and intravenous, intramuscular or nebulized medications. Patients can be allocated into five urgency categories. For reasons of patient safety, it is important that ED triage systems are reliable and valid. Previous studies of the reliability of the ESI reported k scores 12 representing moderate to almost perfect reliability [2,3,4,8,10]. The reliability places an upper limit on the validity of triage.

To best of our knowledge, the ESI algorithm has been only validated in Dept. of emergency Netherlands and this study was proposed as we could not locate any study in Indian scenario.

Review of Literature

Evolution of triage systems

The French word "trier", the origin of the word "triage", was originally applied to a process of sorting, probably around 1792, by Baron Dominique Jean Larrey, Surgeon in Chief to Napoleon's Imperial Guard. Larrey was credited with designing a flying ambulance: the Ambulance Volante. Baron Francois Percy also contributed to the organisation of a care system for the ongoing management of casualties. Out of the French Service de Santé, not only emerged the concept of triage, but the organisational structure necessary to handle the growing number of casualties in modern warfare. As the complexity of healthcare systems increases, and as patient expectations rise, triage will be a vital tool in the first steps of patient management. Prioritisation and streaming underpinning triage systems must be developed using a common system across whole health economies.

The various triaging methods in vogue today are *Simple triage, Tags, Advanced triage, Continuous integrated triage, Reverse triage, Secondary (in-hospital) triage.*

Simple triage

Simple triage is usually used in a scene of an accident or "mass-casualty incident" (MCI), in order to sort patients into those who need critical attention and immediate transport to the hospital and those with less serious injuries. This step can be started before transportation becomes available. At its most primitive patients may be simply marked with coloured flagging tape or with marker pens. Pre-printed cards for this purpose are known as a triage tag [11].

Tags

Many triage systems use triage tags with specific formats. Triage tags may take a variety of forms. Some countries use a nationally standardized triage tag, [12] while in other countries commercially available triage tags are used, and these will vary by jurisdictional choice [13]. The most commonly used commercial systems include the Mettag, [14] the Smarttag, [15] E/T Light tm [16] and the Cruciform systems [17]. More advanced tagging systems incorporate special markers to indicate whether or not patients have been contaminated by hazardous materials, and also tear off strips for tracking the movement of patients through the process. Some of these tracking systems are beginning to incorporate the use of handheld computers, and in some cases, bar code scanners.

Typical triaging systems

Emergency Triage (E/T) Lights – particularly useful at night or under adverse conditions

Advanced triage

In advanced triage, doctors may decide that some seriously injured people should not receive advanced care because they are unlikely to survive. It is used to divert scarce resources away from patients with little chance of survival in order to increase the chances of survival of others who are more likely to survive. The use of advanced triage may become necessary when medical professionals decide that the medical resources available are not sufficient to treat all the people who need help. The treatment being prioritized can include the time spent on medical care, or drugs or other limited resources. This has happened in disasters such as volcanic eruptions, thunderstorms, and rail accidents.

Continuous integrated triage

Continuous Integrated Triage is an approach to triage in mass casualty situations which is both efficient and sensitive to psychosocial and disaster behavioral health issues that affect the number of patients seeking care (surge), the manner in which a hospital or healthcare facility deals with that surge (surge capacity) [18] and the overarching medical needs of the event.

Reverse triage

In addition to the standard practices of triage as mentioned above, there are conditions where sometimes the less wounded are treated in preference to the more severely wounded. This may arise in a situation such as war where the military setting may require soldiers be returned to combat as quickly as possible, or disaster situations where medical resources are limited in order to conserve resources for those likely to survive but requiring advanced medical care [19].

Undertriage and overtriage

Undertriage is the underestimating the severity of an illness or injury. An example of this would be categorizing a Priority 1 (Immediate) patient as a Priority 2 (Delayed) or Priority 3 (Minimal). Historically, acceptable undertriage rates have been deemed 5% or less. Overtriage is the overestimating of the severity of an illness or injury. An example of this would be categorizing a Priority 3 (Minimal) patient as a Priority 2 (Delayed) or Priority 1 (Immediate). Acceptable overtriage rates have been typically up to 50% in an effort to avoid undertriage. Some studies suggest that overtriage is less likely to occur when triaging is performed by hospital medical teams, rather than paramedics or EMTs [20].

Secondary (in-hospital) triage

In advanced triage systems, secondary triage is typically implemented by paramedics, battlefield medical personnel or by skilled nurses in the emergency departments of hospitals during disasters, injured people are sorted into five categories [21].

Limitations of current practices

Some of these limitations include:

Lacking the clear goal of maximizing the number of lives saved, as well as the focus, design and objective methodology to accomplish that goal (a protocol of taking the worst Immediate - lowest chances for survival - first can be statistically invalid and dangerous. Using trauma measures that are problematic (e.g. capillary refill) and grouping into broad color-coded categories that are not in accordance with injury severities, medical evidence and needs. Categories do not differentiate differences in injury severities and survival probabilities and are invalid based on categorical definitions and evacuation priorities ordering (prioritization) and allocating resources subjectively within Immediate and Delayed categories, which are neither reproducible nor scalable, with little chance of being optimal.

Evidence-based research indicates there are wide ranges and overlaps of survival probabilities of the Immediate and Delayed categories. Poor

Table 1: Emergency Severity Index

	ESI-1	**ESI-2**	**ESI-3**	**ESI-4**	**ESI-5**
Vital functions (ABC) and level of Consciousness	Unstable or unresponsive	Threatened or severe pain/distress	Stable	stable	stable
Life threat or organ threat	obvious	Reasonably likely	Unlikely (possible)	No	No
Requires resuscitation	Immediately	Sometimes	seldom	No	No
Expected resource use—x rays, labs, consultations, procedures	Maximum (>2)	High (>2)	Medium (>2)	Low (1)	Low (none)
Response time	Immediate team effect	minutes	Upto 1 hrs.	Can be delayed	Can be delayed

Table 2: WPSS - Worthing Physiological Scoring System Scores and interventions

Physiological Marker	**Score 0**	**Score 1**	**Score 2**	**Score 3**
Ventilatory Frequency	<19	20-21	>22	
Pulse	<101	>102		
Systolic B.P	>100	<90		
Temperature	>35.3			<35.3
Oxygen saturation in Air	96 to 100	94 to <96	92 to <94	<92
AVPU	Alert			other
Total score			Intervention	
Total score 0-1			Normal	
Total score 2-4			Alert	
Total score >5			Urgent	

assessments, invalid categories, no objective methodology and tools for prioritizing casualties and allocating resources, and a protocol of worst first triage provide some challenges for emergency and disaster preparedness and response.

Study Objectives

Primary

1. To study the validity of Emergency Severity Index.

Secondary

2. Associations of the Emergency Severity Index triage categories with patients' vital signs at triage.

Study Outcome

1. Patients ESI Score in ED.
2. WPSS Score to measure the association of ESI with Vital signs at Triage.

Materials and Methods

Study Design

We will conduct a prospective observational study. The Institutional Scientific And Ethics committees of the study site will approve the protocol, and patients who voluntarily provide written informed consent will be enrolled into the Study. We will perform the study from March 2013 to June 2013 in ED of Max Super Speciality Hospital, Patparganj, Delhi.

Selection of Participants

We will enroll a total of 260 patients from the ED of Max Super Speciality Hospital, Patparganj, Delhi. Patients should meet the eligible inclusion and exclusion criteria;

Inclusion Criteria

1. Age more than 18 years.
2. Presented to the Emergency department for medical ailment.

Exclusion Criteria

1. Patients on Ventilator

Data Collection

The data will be prospectively collected by the researcher on the duty days as per roster. A sample size calculation for regression analysis 20 estimated a minimum required sample size of 260 patients. A dropout rate of 5% due to unforeseen circumstances was taken into account in this calculation. Each patient will be triaged by the Researcher on duty and assigned a triage category using standard procedures. Immediately after the Researcher finished the triage assessment and reported the ESI triage category, the researcher registered patients' gender, referrer, main complaint, age and measured vital signs that will be measured by the triage nurse. The following vital signs will be registered: blood pressure, pulse rate, respiratory rate, oxygen saturation, temperature, the AVPU score (Alert, Voice, Pain and Unconsciousness), and pain. These will be measured by using an automated vital signs monitor, a thermometer and the numerical pain rating scale. The numerical pain rating scale score will be taken by asking patients to allocate a score between 0 and 10, with 0 indicating no pain and 10 the worst pain imaginable. All the data will be registered on to the Study Performa. The Worthing Physiological Scoring System (WPSS) is such a prognostic scoring system (Table 2). The WPSS is based upon identifying physiological markers for mortality at an early stage to undertake timely action. The system has been derived from and prospectively validated in ED patients and is therefore suitable for use in this study. 20 except for pain, the system consists of the vital signs used in the ESI as well as systolic blood pressure

Statistical Plan

Sample Size

On the basis of previous literature the predictive value of ESI score for hospitalization is 84%. For the calculation of sample size this information has been used. So with 5% margin of error and 95% level of significance we will recruit 260 subjects for the study.

- Chi-square and Fisher's exact test (categorical variables), t test (continuous variables).
- Ordinary logistic regression.
- Pearson correlation coefficients to determine the correlations between the ESI Scores and Vital signs.

Results

Male patients were 148 (56.92%) while the number

Table 3: Socio-Demographic profile the study Population

Sex	Freq.	Percent	Cum
Male	148	56.92	56.92
Female	112	43.08	100.00
Total	260	100	

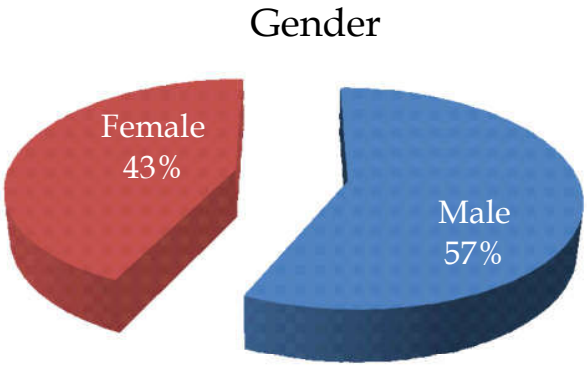

Fig. 3: Socio-Demographic profile the study Population

Table 4: Presenting Complaints

	Freq.	Percent	Cum
Cardiac	37	14.23	14.23
Respiratory	40	15.38	29.62
Gastric	42	16.15	45.77
Neurological	14	5.38	51.15
Poisoning	3	1.15	52.31
Miscellaneous	115	44.23	96.54
Fever	2	0.77	97.31
Renal	7	2.69	100.00
Total	260	100.00	

Table 5: ESI Category

	Freq.	Percent	Cum
ESI 1	9	3.46	3.46
ESI 2	57	21.92	25.38
ESI 3	107	41.15	66.54
ESI 4	84	32.31	98.85
ESI 5	3	1.15	100.00
Total	260	100.00	

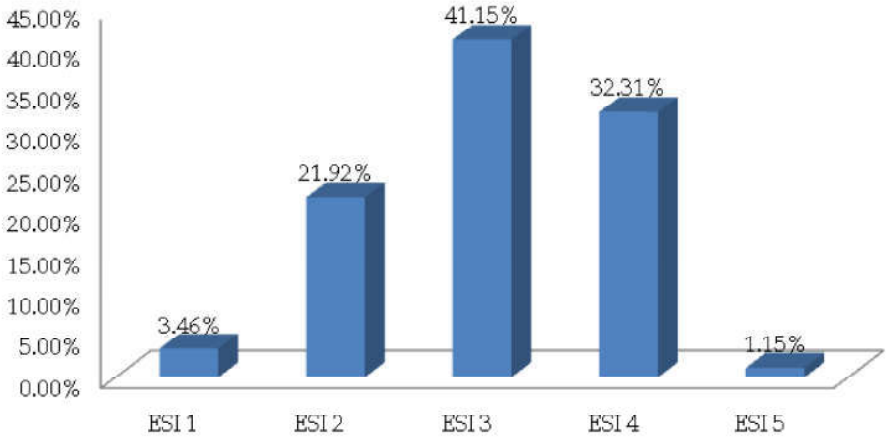

Fig 5: ESI Category

Table 6: Tabulation of WPSS Category

	Freq.	Percent	Cum
Normal	154	59.23	59.23
Alert	63	24.23	83.46
Urgent	43	16.54	100.00

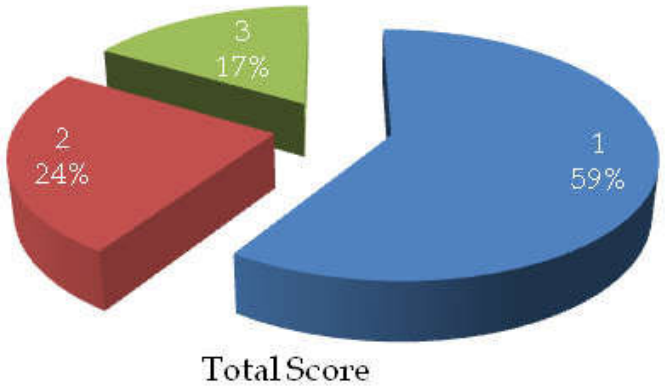

Fig 6: Tabulation of WPSS Category

Table 7: Tabulation of pain Scores

	Freq.	Percent	Cum
0-3	151	58.08	58.08
4-6	83	31.92	90.00
7-10	26	10.00	100.00
Total	260	100.00	

Table 8: Table Correlation of ESI with WPSS category

ESI	Normal	Alert	Urgent	Total
ESI 1	0	0	9	9
ESI 2	15	16	26	57
ESI 3	60	39	8	107
ESI 4	77	7	0	84
ESI 5	2	1	0	3
Total	154	63	43	260

Pearson $chi^2(8) = 135.6130$ Pr = 0.000

Fisher's exact = 0.000

Table 9: Table of ESI Correlation with Pain

ESI	0-3	4-6	7-10	Total
ESI 1	8	1	0	9
ESI 2	32	16	9	57
ESI 3	61	38	8	107
ESI 4	48	27	9	84
ESI 5	2	1	0	3
Total	154	63	43	260

Pearson chi^2 (8) = 7.3360 Pr = 0.501

Fisher's exact = 0.582

of females patients were 112 (43.08%). Most of the patients belong to the Elderly age group 31.92% (83) and middle age groups (from 31-45) 27.31% (71). The patients in the age group 46-60 were third highest to present in the emergency 23.46% (61), while the least patients come to the emergency in the age group 18-60 i.e. 17.31% (45).

Discussion

Most of the patient's falls under the criteria for ESI – 3 category 41.15% (107). The ESI – I category in which resuscitation and immediate attention is needed 9 patients (3.46%) were recorded. Patients in which the need for resuscitation is sometimes; however the risk of life is severe or threaded or in severe distress/pain i.e. ESI-2, are 57 (21.92%).

On correlating the ESI triage category with The WPSS scores it was noticed that the patients with ESI Category 1 were also been rated as Urgent in the WPSS, suggesting that care needed in these individual is urgent and needing immediate team management. In ESI-2 category which needs care in minutes as per the triage category, the WPSS scores were also reflecting the same with exception of One-fourth of patients (15/57) which is rated as WPSS category Normal. However, most, around Three-Fourth (16 plus 26 /57) were labeled as requiring urgent care.

Where as per Triage Category more Resources are utilized and patient can be managed till one hour we have seen that more than half of them were in the Normal category (60/107) of WPSS scoring and only less than 10% (8 /107) were labeled as urgent category. The same features have been noticed in ESI-4 and ESI -5,out of total 79 (77 in ESI-4 and 2 in ESI-5) none was labeled as the URGENT as the urgent intervention as per WPSS, and only 8 out of 89 were labeled as ALERT.

Most of them were in the WPSS category as Normal again reflecting that synchrony in the two scales. Same is also been proven as per results of statistical analysis, which shows the significant correlation between WPSS and ESI Triage Category ($p = 0.00$). Similar results has also been supported by the study by Inekewulp and Rullman 2012. These results are comparable to the findings of the Kim et al. who studied the ESI triage categories and APACHE II scores. the highest mean APACHE II scores were found in the highest triage Categories.

The correlation between the ESI category and the pain scores however does not reflect the same. As none of the patients with severe Pain were categorized in ESI triage category 1. Most of the Patients have been placed in Triage Category ESI-3 & 4.

Half of the patients with the moderate level of pain were placed in the ESI category -3, as these patients needs more of resource utilization and investigation to ascertain the cause of pain, however, they were not requiring the attention and management urgently.

Pain in some patients 9/84 though very disturbing however received ESI triage category 4 in view of stability of the vital signs and other parameters. Thus, supporting that pain alone may not be taken as parameter as escalation of higher ESI category.

Also as per the statistical analysis there is no co-relation between the ESI Triage category and the Pain Scores ($p = 0.582$). The Above finding are in line with study by Inekewulp and Rullman 2012.

A remarkable finding of this study is that pain, a discriminator of the system (ESI category 2), was not associated with urgency. The ESI guidelines state that it is up to the discretion of the triage nurse to indicate whether a patient's pain score is supported by his/her clinical condition and warrants triage in higher ESI categories. However, the guidelines have not specified how to make this decision. This could be an explanation for the lack of association between pain scores and urgency. To increase this association, and consequently the validity of the ESI, a revision of the guidelines is necessary. More specifically, the guidelines should describe symptoms or patient behaviour related to severe pain. Further studies will be needed to measure the effects of such a revision on the reliability and validity of the ESI.

Limitations

The Results of the study has to be interpreted carefully because of several limitations.

Firstly it was an unicentric study, data was collected from one emergency during day hours, so hospital factors or factors associated with data collection shifts could not be accounted.

Secondly, the researcher is present in the triage Area to collect data and direct contact with study objects. Blinding in this study was not a possibility as it may resulted in other major biases.

Conclusions

This study clearly shows the strong association of patients' vital signs with the ESI triage categories. Study findings failed to support any association between pain scores and ESI triage categories, which indicated that apart from a revision of Triage guidelines, pain scoring systems should not be relied upon for triaging patients.

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