ORIGINAL ARTICLE

Validation of the Emergency Severity Index (ESI) in self-referred patients in a European emergency department

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Emerg Med J 2007;**24**:170–174. doi: 10.1136/emj.2006.039883

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Accepted 16 October 2006

Objective: To validate the Emergency Severity Index (ESI) triage algorithm in predicting resource consumption and disposition by self-referred patients in a European emergency department.

Methods: This was a prospective, observational cohort study using a convenience sample of self-referred emergency department patients >14 years of age presenting to a busy urban teaching hospital during a 39-day period (27 May–4 July 2001). Observed resource use was compared with resource utilisation predicted by the ESI. Outpatient referrals after discharge and hospitalisations were also recorded.

Results: ESI levels were obtained in 1832/3703 (50%) self-referred patients, most of whom were in the less severe ESI-4 (n = 685, 37%) and ESI-5 (n = 983, 54%) categories. Use of resources was strongly associated with the triage level, rising from 15% in ESI-5 to 97% in ESI-2 patients. Specialty consultations and admissions also rose with increasing ESI severity. Only 5% of ESI-5 patients required consultation and <1% were admitted, whereas 85% of ESI-2 patients received a consultation and 56% were admitted, 26% to a critical care bed. Only 2% of the ESI-5 patients underwent blood tests, compared with 76% of the sicker ESI-2 patients. *x* Rays were the most commonly used resource in patients triaged to ESI-4 and ESI-5.

Conclusion: The ESI triage category reliably predicts the severity of a patient's condition, as reflected by resource utilisation, consultations and admissions in a population of self-referred patients in a European emergency department. It clearly identifies patients who require minimal resources, or at most an *x* ray, and those unlikely to require admission.

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). The Emergency Severity Index (ESI; table 1) is one such system. It is based on an expanded triage model that attempts to predict ''not only when should this patient be seen, but also what does this patient need?'' Patients are stratified into five categories, ESI-1 being the most unstable, urgent and resource intensive, and ESI-5 being the least (table 1).[1 2] Vital signs are used adjunctively, and those that exceed the criteria may result in an upgrading from level ESI-3 to ESI-2, but are not required for assignment to the other categories.

To date, the ESI algorithm has only been validated in US emergency departments, primarily in the original research centres.[2–7]

The aim of this study was to validate the ESI triage algorithm in self-referred patients seen by emergency department doctors in a European (Dutch) country. These are the patients who have elected to seek care in the emergency department without first consulting their general practitioner and who make up most of the patients seen in the emergency department. By contrast, the referred patients have seen their general practitioner and have been sent to the emergency department for a direct consultation with the specialist or his service. We also sought to describe in detail the type of resources used as they relate to triage category, which has not yet been described elsewhere.

PATIENTS AND METHODS

This was a prospective, observational cohort study using a convenience sample of self-referred patients presenting to an urban European emergency department located in a major non-university teaching hospital in an urban European country. It is the busiest emergency department in the country, with a census of 42 000 patients, most of whom are self-referred. Before the start of the study, there was no formal triage mechanism in place, and patients were usually brought back from the waiting room in the order they arrived. As part of a pilot project, several emergency department doctors learnt to assign triage categories using the ESI algorithm (fig 1). After a pilot phase of 5 days, data collection was started. None of the doctors, however, were aware of the study outcome parameters being assessed.

All self-referred patients seen during a 39-day period (27 May–4 July 2001) were eligible. In keeping with earlier studies on ESI, we used age >14 years as an inclusion criterion.[2] There were no exclusion criteria. Observed resource use included laboratories, urine analysis, *x* rays and consultations, and these were compared with resource utilisation estimated by the ESI. Hospitalisations and outpatient referrals after discharge were recorded. Statistical analysis was performed using SPSS for Windows V.13.0.

RESULTS

During the study period, ESI levels were obtained in 1832/3703 (50%) self-referred patients. Not all eligible patients were enrolled because some doctors chose not to participate in the

Abbreviations: ECG, electrocardiogram; ESI, Emergency Severity Index

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 effort	Minutes	Up to 1 h	Can be delayed	Can be delayed

ABC, airway, breathing, circulation; ESI, Emergency Severity Index.

triage trial. However, all shifts and days of the week were represented. Data on all eligible patients were captured. Table 2 compares the study group with the rest of the self-referred patients. Patients' characteristics are essentially identical, as is the emergency department assessment and disposition, indicating that overall the study groups were the same and were not treated differently.

Tables 3 and 4 presents the triage results, including relevant confidence intervals. There were only two patients in the ESI-1 category. Both who received a high triage category, had overdoses, subsequent intense but brief care, followed by discharge when they sobered up. They were omitted from most of the calculations and discussion. Consultations are noted twice in the tables, once in relation to subsequent admissions and the second to one of the resources consumed.

Table 3 shows the consultations and hospitalisations correlated with the triage level.

In all, 85% of patients from the ESI-2 group received a specialist's consultation in the emergency department and 56% were admitted. By contrast, the ESI –5 group had a consultation rate of 5% and only 7 (<1%) patients were admitted. Moreover, 26% of ESI-2 patients were admitted to critical care beds, compared with only 1/16 (6%) ESI-3 and no ESI-4 or ESI-5 patients. Consistent with the ESI-2 and ESI-3 predicting more severely ill patients, a much higher percentage received a referral to a specialty outpatient clinic after discharge from the emergency department, whereas the less severe ESI-4 and ESI-5 categories were more likely to be referred to their general practitioner (23%) for follow-up, if they were referred at all (69%).

Table 2 Emergency Severity Index comparison of baseline characteristics between the study population and the other self-referred patients during the study period

	Study (triaged) patients, (%)	Other self-referred patients (%)	p Value
Patients (n)	1832	1871	
Sex (male)	1074 (59)	1090 (58)	NS
Average (range) age (years)	33 (14–92)	33 (14–88)	NS
Use of resources			
None	1112 (61)	1183 (63)	NS
Blood tests	185 (10)	192 (10)	NS
Urine analysis	124 (7)	109 (6)	NS
x Ray	423 (23)	416 (22)	NS
ECG	107 (6)	116 (6)	NS
Specialist consultation	308 (17)	333 (18)	NS
Disposition			
Admission	65 (4)	93 (5)	NS
Discharge—refer to specialist clinic	288 (16)	318 (17)	NS
Discharge—refer to GP	420 (23)	374 (20)	NS
Discharge—no follow-up	1050 (57)	1112 (59)	NS

ECG, electrocardiogram; GP, general practitioner; NS, not significant.

The overall rate of resource utilisation ranges (table 3) also correlated well with the ESI level ranging from a low of 15% in ESI-5 patients to 97% in ESI-2 patients. Both ESI-2 and ESI-3 predict that ⩾2 resources will be used during patient assessment and in fact 85% of ESI-2 and 72% of ESI-3 patients did so. Conversely, 85% of ESI-5 and 38% of ESI-4 patients did not use any resources, and when they did, it was usually not >1. Only 3% of ESI-5 and 22% of ESI-4 used ⩾2 resources. Table 4 describes the types of resources used.

Requested laboratory tests and electrocardiograms (ECGs) are also directly related to the ESI score. In all, 76% of the sicker ESI-2 patients had blood drawn and sent, compared with only 2% of ESI-5 patients. Finally, although 50% of ESI-2 patients had ECGs recorded, only 1% of ESI-5 patients did so. *x* Rays were the most common resource used in ESI-4 and ESI-5.

DISCUSSION

In previous studies on the ESI performed in US emergency departments, hospitalisation rates were clearly predicted by ESI category, with the highest rate of hospitalisation seen in ESI-1 and the lowest in ESI-5. Our results follow this trend, although with a lower admission rate across all categories. Where published studies in adults report admission rates of 58–73% for ESI-2, 22–51% for ESI-3, 5–10% for ESI-4 and 0–5% for ESI-5, we noticed admission rates of 56%, 13%, 2% and <1%, respectively.[2 4–6] This lower admission rate is probably a reflection of the lower acuity seen in the self-referred population who present to the emergency department in The Netherlands.[8] Both ESI-1 patients had intoxications, and were eventually released from the emergency department. Only one other published study reported admission rates to critical care units noting a relationship with ESI categories, with 40% of ESI-1 patients being admitted to the intensive care unit, but only 2% of the ESI-3 and none of the ESI-4 and ESI-5 patients were admitted.[5] In our study, 26% of in ESI-2 and 6% of ESI-3 patients were admitted to critical care beds, but none of the ESI-4 and ESI-5 patients were admitted. The fact that there are self-referred patients requiring admission, some to critical care units, is important. This population therefore cannot be assumed to be made up only of the ''worried well'' and those with minor trauma.

One of the main arguments made for the ESI algorithm is that it predicts resource consumption. However, to date, only three published studies have correlated the use of resources and the ESI category, one of which was in children, and none have described in detail the type of resources used.[2 6 7] In keeping with the results of these studies, we show a direct relationship between triage severity and the total amount of resources consumed. When we looked at the type of resources consumed, clear patterns were noticed. Consultations, blood tests and ECGs were directly related to the predicted severity. Specialists

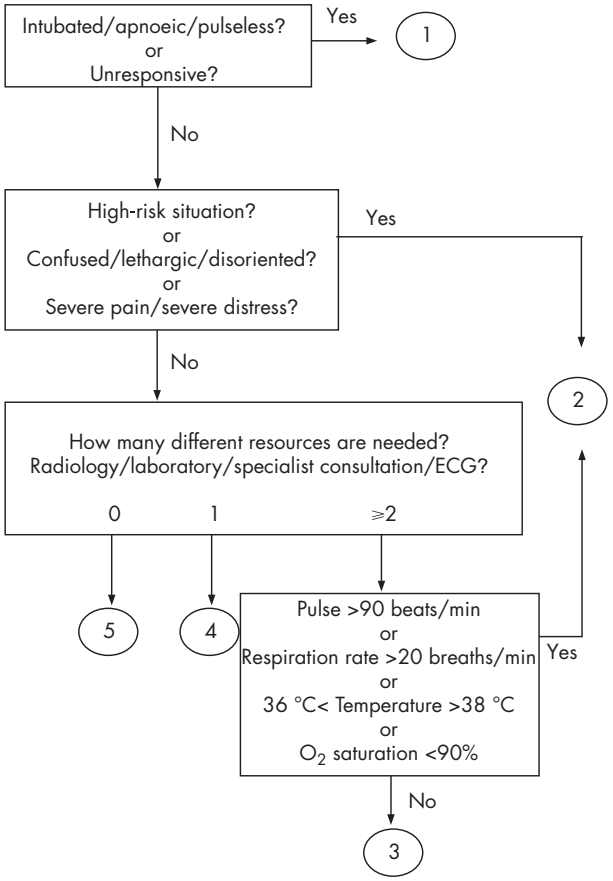

Figure 1 Emergency Severity Index triage algorithm.[1] ECG, electrocardiogram. Adapted from **Gilboy N**, Travers D, Wuerz RC. Re-evaluating triage in the new millennium: a comprehensive look at the need for standardization and quality. *J Emerg Nurs* 1999; **25**: 468–73.

were called frequently (85%) for ESI-2 patients who also required blood tests (76%) and ECGs (50%), but rarely (5%) for ESI-5 patients who almost never had blood tests (2%) or an ECG (1%) performed. *x* Rays were the most common resource used in ESI-4 and ESI-5. Thus, this population could easily be treated in a fast-track/minor emergency department area, or possibly even by physician extenders or nurse practitioners.

None of the studies to date have looked at consultations or discharge referrals as an indicator of severity. There is a clear relationship with consultations and increasing severity or complexity of disease and injury. Consultation is also generally required for admission. However, even on discharge, those assigned critical ESI levels were more likely to be referred to a specialist and much less likely to a general practitioner. As the severity decreased, this relationship changed, and referrals were more likely to a general practitioner or not at all.

Many countries struggle with the need for a good emergency department triage system, and different algorithms have been developed in Canada (Canadian Triage Assessment Scale),[9–11] Australia (Australian Triage Scale),[12 13] the UK (Manchester Triage Scale)[14–16] and in the US. The Netherlands has also recognised the need for a triage system, and the Dutch Society for Emergency Nurses in collaboration with the Quality Institute for Health (CBO) has developed national guidelines for emergency department triage and actually advised the implementation of the ''Manchester Triage Model'' for Dutch emergency departments.[17] The Manchester Triage Model also stratifies patients into five categories using fixed flowcharts depending on the patient's complaint.[14] However, the ESI uses only one flowchart for all patients. Thus, it may be easier to implement. More importantly, it predicts resource utilisation, which may identify patients for a fast-track/minor emergency department route in the emergency department, allowing the limited space in the emergency department to be used more efficiently and waiting times to be reduced.[18] This has been shown clearly in our study, which has had the largest numbers of ESI-5 patients and second highest numbers of ESI-4 patients of any study to date. Despite its recommendation, the Manchester system has not yet been validated in The Netherlands and there is only one published study about its introduction, outside England, in Ireland.[16] A Belgian group has been studying the Australian triage system.[19] Certainly, any meaningful discussion about the relative merits of the different triage systems await their individual validation in different countries and possibly direct comparison in single centres.

Table 3 Predicted versus actual total resource consumption, consultations, admissions and discharge referrals by Emergency Severity Index category

	ESI-1	ESI-2	ESI-3	ESI-4	ESI-5
Patients, n (%)	2 (<1)	34 (2)	128 (7)	685 (37)	983 (54)
Use of resources					
Predicted by ESI	⩾2	⩾2	⩾2	1	0
Patients needing resources, n (%; 95% CI)	2 (100)	33 (97; 91 to 100)	115 (90; 85 to 95)	427 (62; 59 to 66)	143 (15; 12 to 17)
Resources used, n					
>2	2 (100)	29 (85)	92 (72)	152 (22)	27 (3)
1		4 (12)	23 (18)	275 (40)	116 (12)
None		1 (3)	13 (10)	258 (38)	840 (85)
% Correct predicted	100	85	72	40	86
Specialist consultation, n (%; 95% CI)		29 (85; 73 to 98)	68 (53; 44 to 62)	158 (23; 20 to 26)	53 (5; 4 to 7)
Admissions, n (%; 95% CI)		19 (56; 38 to 73)	16 (13; 7 to 18)	23 (3; 2 to 5)	7 (<1; 0 to 1)
Discharge referral					
Specialist's clinic, n (%; 95% CI)		13 (38; 21 to 55)	52 (41; 32 to 49)	140 (20; 17 to 23)	83 (8; 7 to 10)
GP, n (%; 95% CI)		2 (6; 2 to 14)	25 (20; 13 to 26)	171 (25; 22 to 28)	222 (23; 20 to 25)

ESI, Emergency Severity Index; GP, general practitioner.

Table 4 Use of specified resources per Emergency Severity Index category

	Patients seen, n (%)	Consultations, n (%)	Blood tests, n (%)	ECG, n (%)	*x* –Ray, n (%)	Urine analysis, n (%)
ESI-2	34 (2)	29 (85)	26 (76)	17(50)	16(47)	3(9)
ESI-3	128 (7)	68 (53)	75 (59)	43(34)	54(42)	16(13)
ESI-4	685 (37)	158 (23)	67 (10)	32(5)	302(44)	66(10)
ESI-5	983 (54)	53 (5)	15 (2)	14(1)	50(5)	39(4)

ECG, electrocardiogram; ESI, Emergency Severity Index.

LIMITATIONS

Our study has several limitations. It did not include all self-referred patients and was performed during a limited (39-day) period. Other studies, however, have also relied on convenience samples and recruited patients over a limited time.[2–5 7] The participating doctors worked all shifts and all days of the week, so we believe that the sample is representative of the self-referred patients presenting to the emergency department during that time. This is supported by table 2, which illustrates that there was no significant difference in the patient characteristics among the self-referred patients who were triaged (study participants) and those who were not.

This study does not include the referred patients who arrived at the emergency department to be seen directly by the specialist. This group is composed mostly of patients with chronic illnesses and those who have already been evaluated by a doctor, thus presumably sicker, and more likely to fall into the higher triage category.[8] However, their emergency department course was already somewhat predetermined and could not easily be influenced by emergency department staff. Nonetheless, this group is now subject to the same triage and is being included in ongoing studies.

This lack of access to the sicker referred patients meant that we ended up with only two patients in ESI-1 and 34 in ESI-2. However, there were 128 patients in ESI-3, a category of patients considered sick and in need of considerable resources. Furthermore, no other published studies to date include as many ESI-5 patients, and only one with more ESI-4 patients, than ours. The largest published study to date has only 739 ESI-5 patients compared with our 983, and although they had 2502 ESI-4 patients compared with our 685, no other studies come close.[3] In addition, two other validation studies had as few or fewer, sick ESI-3 patients as ours.[3 5]

A relevant criticism could be that doctors applied the triage score, a function usually relegated to specially trained nurses, as it was in other validation studies.[2 4–7] At the time our study was conducted, there were no triage nurses nor a formal triage system, and for practical reasons, doctors were used to apply the ESI algorithm. The ESI has been shown to have high inter-rater reliability when applied by nurses, and at least one study found a strong concordance between the doctors and nurse investigator's triages.[5–7]

Another potential issue is that the treating doctors assigned the ESI score themselves. However, they were not aware that the items recorded were actually being used for validation in the study, as they thought the purpose of the exercise was simply to describe the self-referred emergency department population while trialling the ESI system. As previously noted (table 2), overall the number of resources consumed and disposition seem to be similar in the triaged and self-referred (not triaged) patients. Finally, although the study reflects data collected a number of years ago and was based on ESI version 1, to date, there have been no published studies reporting on the validity of the ESI triage algorithm outside the US, and in fact only two that have been performed outside the original research centres in the US, one of which was in a paediatric population. Furthermore, this is the first study to describe in detail the resources consumed rather than the total number of resources used.[5 7]

CONCLUSIONS

Despite some apparent differences in healthcare, the ESI triage algorithm, originally designed for use in US emergency departments, seems to be valid in a busy European urban teaching hospital's emergency department, at least in the self-referred population who make up most of the patients seen. It identifies those who require minimal resources, or at most an *x* ray, and who can safely wait or be directed towards a fast-track/minor emergency department or even potentially be seen by physician extenders. At the same time, it identifies sicker patients requiring more, and immediate, testing and admission in a population of patients (the self-referred) perceived to be less ill. By giving a reliable estimation of resource consumption and hospital admission, it should allow for better planning of limited resources, space and staff, and serve both as a triage tool and a management tool. Further work is currently being carried out at our institute with the newer version of the ESI applied by nurses in triage to all patients, irrespective of referral status. We hope to determine whether the algorithm is valid when applied to all emergency department patients. This should also be carried out at other institutes and with other triage schemes. A meaningful discussion about the relative merits of the different triage systems for use in The Netherlands and elsewhere in Europe cannot ensue until the different triage systems have been both validated and compared.

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Competing interests: None declared.

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