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Triaging of acutely ill children transported by ambulance

ORIGINAL ARTICLE

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Main findings

Out of 303 children transported by ambulance to the accident and emergency department (A&E) at Haukeland University Hospital for emergency medical assistance, 88 were treated as outpatients, 185 were admitted to a regular ward and 30 to a high dependency unit.

A total of 270 (89 %) children were triaged using SATS-N in the ambulance and 243 (80 %) in A&E.

The proportion with the same SATS-N triage category in the pre-hospital and A&E settings was 103/216 (48 %).

The sensitivity of SATS-N was 96 % and 88 % in the pre-hospital and A&E settings respectively, and specificity was 46 % and 60 %.

Various triage tools have been developed to ensure effective prioritisation of patients with an urgent need for health care. These tools must be easy to use and must be able to discriminate between patients in a time-critical medical emergency and patients who can wait. Several triage tools are used in Norwegian hospitals, such as the Rapid Emergency Triage and Treatment System and the Manchester Triage Scale (1, 2). The Norwegian Board of Health Supervision has sought standardisation, but no national model has been proposed (3, 4). Although triage tools are widely used, their validity is not always well documented (1, 5–7).

In pre-hospital and A&E settings, Western Norway Regional Health Authority uses SATS Norge (SATS-N), a modified version of the South African Triage Scale that has been adapted to Norwegian conditions. In SATS-N, patients are categorised in five triage levels: red, orange, yellow, green or blue (8). SATS-N is based on three components: a *clinical discriminator list* for symptoms, a *triage early warning score* (TEWS), which is calculated based on observed vital parameters, and *clinical judgement*, where healthcare personnel can upgrade the triage level. The highest rating out of all three components determines the patient's final triage category. In A&E settings, the red category requires immediate medical assistance, orange within ten minutes, yellow within 60 minutes, and green and blue within two hours. The blue category is used for minor issues or administrative enquiries without the need to observe vital parameters. In the paediatric component of SATS-N, which applies to patients aged 0–14 years, the TEWS is age-appropriate and there is a separate clinical discriminator list of symptoms.

There are few validation studies of SATS-N (9, 10). The main purpose of our study was therefore to examine the validity of the paediatric component of SATS-N version 4.0 used in pre-hospital and A&E settings for children transported to hospital by ambulance for emergency medical assistance. The secondary goal was to compare the triage levels given in the pre-hospital and A&E settings.

Material and method

Design and study population

Our retrospective observational study included all patients in the age group 0–14 years who were transported to Haukeland University Hospital by ambulance for emergency medical assistance for somatic problems in the period January–June 2020.

Pre-hospital data

Call-outs for emergency medical assistance where patients aged 0–14 years were transported to Haukeland University Hospital during the study period were identified in the Acute Medical Information System (AMIS) (CSAM Health Group AS, Oslo, Norway). The transport time for each call-out was obtained from the same source. Information regarding triage using SATS-N version 4.0 by paramedics in the pre-hospital setting was primarily obtained from ambulance records, which consist of paper forms that are scanned and stored in the electronic patient record system DIPS (Distribuert Informasjons- og Pasientsystem i Sykehus AS, Bodø, Norway). Additionally, the pre-hospital SATS-N triage category is also recorded in AMIS and can be noted on the SATS-N triage form used in A&E. We collected data on pre-hospital triage categories from all these sources. Where there were discrepancies between the sources, we used the triage category indicated in the ambulance record.

Data from A&E

At Haukeland University Hospital, the Children and Youth Clinic's A&E accepts children with medical problems. A&E in the main hospital building accepts adult patients as well as children with surgical requirements (orthopaedics, gastric surgery, neurosurgery, plastic surgery and ear, nose and throat surgery) and critically ill children with an assumed need for direct transfer to the intensive care unit. The problem identified by the referring doctor or operator in the Emergency Medical Communication Centre (AMK) in consultation with paramedics determines which A&E the child is transported to.

Triage using SATS-N version 4.0 is performed by nurses in both A&Es. Ideally, the nurse should triage the patient within ten minutes of their arrival and this will normally be done before the patient has been seen by a doctor. Triage data were retrieved from the electronic SATS form in Meona, an electronic chart system (Mesalvo Freiburg GmbH, Freiburg, Germany), or from the scanned paper version used at the Children and Youth Clinic.

In the absence of a fully completed triage record, the final triage category was extrapolated if both the clinical discriminator list and the TEWS were correctly indicated. Patients assessed by the trauma team were assigned to the red triage category even if the SATS-N form had not been completed, as trauma with potential serious injury is defined under the red triage category in the SATS-N form.

Data on hospital stay

Information on sex, age, admission date, medical or surgical department, treatment level and diagnosis was retrieved from electronic patient records. Treatment level was classified as outpatient (i.e. patient discharged home from the A&E), admission to a regular ward or, as an indication of a genuinely high triage level, direct transfer from A&E to a high dependency unit (paediatric high dependency unit, surgical department/post-operative unit or intensive care unit). All patients with a discharge report were categorised as either admitted to a regular ward or transferred to a high dependency unit, and the duration of the stay was specified as the number of days. One ICD-10 diagnostic code from the discharge report was entered per patient, and the primary diagnosis was chosen unless another code was clearly more relevant. The diagnoses were grouped into categories.

Analyses

Descriptive variables were entered as absolute numbers and percentages, or as a mean with standard deviation (SD). The five possible triage categories assigned in the ambulance and in A&E were dichotomised into high triage level (red and orange) and low triage level (yellow, green and blue) for further analysis of sensitivity and specificity, as well as positive predictive value and negative predictive value. Sensitivity was calculated as the proportion of patients with a high triage level among those transferred directly from A&E to a high dependency unit. Specificity was calculated as the proportion of patients with low triage level among those not transferred directly to a high dependency unit. The positive predictive value was the proportion of patients transferred to a high dependency unit among those with a high triage level, while the negative predictive value was the proportion of patients who were not transferred to a high dependency unit among those with a low triage level.

Overtriage was calculated as the proportion of outpatient contacts who were assigned a high triage level, and undertriage was defined as 1 minus sensitivity. Using the Wilson score, a 95 % confidence interval in a binomial model was calculated for sensitivity, specificity, positive predictive value, negative predictive value and overtriage. Comparisons of triaging in pre-hospital and A&E settings were evaluated based on the percentage of similar triage categories (colour codes) and levels (high/low). Statistical analyses were performed in SPSS version 29 (IBM SPPS Statistics, Armonk, NY, IBM Corp.).

Ethics

The study was approved by the Regional Committee for Medical and Health Research Ethics (REK) West Norway (reference number 2021/219082) and endorsed by the data protection officer at Haukeland University Hospital. REK did not require written consent for participation. Potential study participants received written information about the purpose of the study in the post. Both they and their legal guardians were given the opportunity to decline the invitation to participate by contacting the project manager by email or telephone.

Results

Twelve patients were excluded from the study either because they declined or because their information letter was returned. Overall, 303 ambulance journeys involving a total of 290 patients aged 0–14 years were included in the study. More boys than girls were transported, with 194/303 (64 %) and 109/303 (36 %), respectively. The average (SD) age of the children at the time of transport was 5.5 (4.7) years, and the average (SD) transport time was 25 (26) minutes. Approximately one-third (88/303) of the patients received outpatient treatment and were able to go home upon discharge from A&E (Table 1).

Table 1

Patients aged 0–14 years who were transported by ambulance for emergency medical assistance at Haukeland University Hospital, January–June 2020 (*N* = 303).

		Total number (%)	Admitted to hospital, incl. high dependency unit (*n* = 215) Number (%)	Outpatient treatment (*n* = 88) Number (%)
Sex				
	Male	194 (64)	137 (64)	57 (65)
	Female	109 (36)	78 (36)	31 (35)
Age				
	< 1 year	47 (16)	37 (17)	10 11)
	> 1 year	256 (84)	178 (83)	78 (89)
Medical issue				
	Paediatric	197 (65)	141 (66)	56 (64)

		Total number (%)	Admitted to hospital, incl. high dependency unit (n = 215) Number (%)	Outpatient treatment (n = 88) Number (%)
	Surgical	106 (35)	74 (34)	32 (36)
Transport time in ambulance				
	0–14 minutes	117 (39)	84 (39)	33 (38)
	≥ 15 minutes	173 (57)	121(56)	52 (59)
	Not known	13 (4)	10 (5)	3 (3)
Diagnostic category				
	Trauma incl. burns and concussion	75 (25)	55 (26)	20 (23)
	Upper respiratory tract infection	67 (22)	43 (20)	24 (27)
	Neurological and endocrinological conditions	39 (13)	34 (16)	5 (6)
	Gastrointestinal disease and testicular torsion	33 (11)	22 (10)	11 (13)
	Lower respiratory tract infection and asthma	23 (8)	21 (10)	2 (2)
	Compromised airway or dyspnoea	19 (6)	14 (7)	5 (6)
	Other infections	18 (6)	12 (6)	6 (7)
	Allergic reaction	11 (4)	6 (3)	5 (6)
	Poisoning	6 (2)	4 (2)	2 (2)
	Cardiovascular diseases	4 (1)	3 (1)	1 (1)
	Other, incl. congenital conditions	8 (3)	1 (0.5)	7 (8)

A total of 270/303 (89 %) ambulance journeys included had a documented pre-hospital SATS-N triage. Five patients were transported to hospital by air ambulance, which uses separate transport records. The SATS-N triage category for two of these five was obtained from AMIS.

Triage was documented for 243/303 (80 %) of the patients who were taken to A&E. Of these, 22 were directly classified in the red triage category and assessed by the trauma team. See Table 2 for an overview of the triage level given in the pre-hospital and A&E settings according to treatment level.

Table 2

Triage categories according to SATS-N version 4.0 and level of treatment for patients aged 0–14 years who were transported by ambulance for emergency medical assistance to A&E at Haukeland University Hospital, January–June 2020.

		Total (*N* = 303) n (%)	Outpatient contact (*n* = 88) n (%)	Admitted to hospital (*n* = 215)	
Triage category[1]				Regular ward (*n* = 185) Number (%)	High dependency unit[2] (*n* = 30) Number (%)
Pre-hospital					
	Red	114 (38)	22 (25)	71 (38)	21 (70)
	Orange	43 (14)	8 (9)	30 (16)	5 (17)
	Yellow	96 (32)	45 (51)	50 (27)	1 (3)
	Green	17 (6)	6 (7)	11 (6)	0 (0)
	Blue	0 (0)	0 (0)	0 (0)	0 (0)
	Not specified	33 (11)	7 (8)	26 (14)	3 (10)
A&E					
	Red	63 (21)	6 (7)	40 (22)	17 (57)
	Orange	46 (15)	14 (16)	27 (15)	4 (13)
	Yellow	97 (32)	37 (42)	58 (31)	2 (7)
	Green	36 (12)	15 (17)	20 (11)	1 (3)
	Blue	1 (0)	1 (1)	0 (0)	0 (0)
	Not specified	60 (20)	15 (17)	40 (22)	5 (17)

[1]In A&E, a red triage category requires immediate medical assistance, orange requires medical assistance within 10 minutes, yellow within 60 minutes and green and blue within two hours.

[2]Includes intensive care unit, paediatric high dependency unit and surgical department/post-operative unit.

Among the 303 patient transports included, 216 (71 %) were given a triage category in both the pre-hospital and A&E settings. Table 3 gives a breakdown of and compares triage categories in both settings. The proportion with the same SATS-N triage category in both settings was 48 % (103/216). Furthermore, 148/216 (69 %) retained the same triage level (high or low) after triage in A&E. The proportion that changed from high in the pre-hospital setting to low in A&E was 45/216 (21 %), while the proportion who changed from low to high was 23/216 (11 %). Table 1 gives an overview of the patient distribution according to the medical issue and treatment level.

Table 3

Distribution of SATS-N triage categories in the pre-hospital and A&E settings for patients aged 0–14 years who were transported to Haukeland University Hospital by ambulance for emergency medical assistance in the period January–June 2020.

	Triage category in A&E[1]	High triage level (number)		Low triage level (number)			Not specified (number)	Total (number)
Pre-hospital triage category[1]		Red	Orange	Yellow	Green	Blue		
High triage level	Red	48	17	21	7	0	21	114
	Orange	6	8	13	4	0	12	43
Low triage level	Yellow	3	16	45	14	0	18	96
	Green	2	2	8	2	0	3	17
	Blue	0	0	0	0	0	0	0
Not specified		4	3	10	9	1	6	33
Total		63	46	97	36	1	60	303

[1]In A&E, a red triage category requires immediate medical assistance, orange requires medical assistance within 10 minutes, yellow within 60 minutes and green and blue within two hours.

Table 4 shows sensitivity, specificity, positive predictive value, negative predictive value and overtriage for SATS-N used in pre-hospital and A&E settings, as well as results for medical and surgical patient groups. For all patients, sensitivity was 96 % for pre-hospital triage and 88 % for triage in A&E. This resulted in undertriage of 4 % and 12 %, respectively. Sensitivity was somewhat higher for surgical issues than medical issues in both settings. Specificity was 46 % and 60 % in the pre-hospital and A&E setting, respectively, and overtriage was 19 % and 18 %, respectively. The positive predictive value was low (17 % and 20 %) and the negative predictive value was high (99 % and 98 %) in both settings.

Table 4

Sensitivity, specificity, positive and negative predictive values for the paediatric version of SATS-N version 4.0 used in pre-hospital and A&E settings on patients aged 0–14 years who were transported to hospital by ambulance. CI = confidence interval.

Triage		Sensitivity[1] Percentage (95 % CI)	Specificity[2] Percentage (95 % CI)	Positive predictive value[3] Percentage (95 % CI)	Negative predictive value[4] Percentage (95 % CI)	Overtriage[5] Percentage (95 % CI)
Pre-hospital						
	Total	96 (82 to 99)	46 (40 to 52)	17 (12 to 23)	99 (95 to 100)	19 (14 to 26)
	Paediatric medical issue	92 (65 to 99)	49 (41 to 56)	12 (7 to 20)	99 (93 to 100)	21 (13 to 33)
	Surgical issue	100 (80 to 100)	41 (31 to 52)	24 (15 to 36)	100 (90 to 100)	15 (7 to 27)
A&E						
	Total	88 (70 to 96)	60 (54 to 66)	20 (14 to 29)	98 (94 to 99)	18 (12 to 26)
	Paediatric medical issue	82 (52 to 95)	62 (54 to 70)	15 (8 to 26)	98 (92 to 99)	21 (14 to 30)
	Surgical issue	93 (69 to 99)	57 (46 to 67)	27 (17 to 41)	98 (89 to 100)	16 (9 to 26)

[1]Sensitivity: the proportion of patients with a high triage level (red and orange) among those transferred directly from A&E to a high dependency unit (intensive care unit, surgical department/post-operative unit and paediatric high dependency unit).

[2]Specificity: the proportion of patients with a low triage level (yellow, green and blue) among those not transferred directly to a high dependency unit.

[3]Positive predictive value: the proportion of patients transferred directly to a high dependency unit among those given a high triage level.

[4]Negative predictive value: the proportion of patients who were not admitted to a high dependency unit among those given a low triage level.

[5]Overtriage: the proportion of patients given a high triage level among those with outpatient contact.

Discussion

In this study, we examined the validity of the paediatric component of SATS-N version 4.0 used on patients aged 0–14 years who were transported by ambulance to hospital for emergency medical assistance. We found that only half of the patients were assigned the same triage category in the pre-hospital and A&E settings. The SATS-N form used in both settings had high sensitivity

(96 % and 88 %), low specificity (46 % and 60 %) and a very high negative predictive value (99 % and 98 %) for identifying children who needed to be transferred directly from A&E to a high dependency unit. The overtriage rate was low (below 20 %).

In a busy A&E, the need for further triage in addition to that in the pre-hospital setting could be questioned. Being mistakenly assigned a low triage category will have the most serious repercussions for the patient. Although only half (48 %) of the patients retained the same triage category (colour code), we found that the majority (69 %) retained the same triage level (high or low) following triage in A&E, while a small proportion (11 %) were upgraded from low to high. The change in triage level may be due to a change in clinical status or effect of initiated treatment. The difference may also depend on the healthcare personnel's clinical experience in assessing children. The results of this study suggest that children should be triaged in A&E even if this has been done in the pre-hospital setting.

The sensitivity and specificity in the SATS-N form in this study were similar to those observed for other triage tools, although direct comparisons are difficult due to the different nature of health services and methods for measuring validity (11–13). In a systematic review from 2019, two widely used triage tools were examined: the Manchester Triage Scale and the Canadian Triage and Acuity Scale. Sensitivity was defined as a high triage level in A&E and subsequent admission to the intensive care unit, while specificity was defined as a low triage level in A&E and subsequent outpatient treatment. The sensitivity in paediatric triage tools ranged from 71 % to 93 % and specificity from 69 % to 96 %. The study also showed that triage tools yielded different outcomes across studies, depending on the study population and design, and how the true triage level was defined (11).

A systematic review of paediatric triage tools found that the validity of various tools was higher in studies conducted in or near the country where the triage tool was originally developed (12). The paediatric version of SATS used in South Africa has previously proven to be a robust tool, with sensitivity of 91 %, specificity of 54 % and a negative predictive value of 95 % for identifying children who need to be admitted to hospital (14). In our study of SATS-N, we found roughly the same values, but specificity in SATS-N was slightly lower and the negative predictive value was slightly higher. The varying definitions of a true high triage level and the differences in patient population in terms of the range of medical problems and economic conditions both make direct comparisons challenging.

An ideal triage tool should have low overtriage and undertriage rates. A high overtriage rate can lead to fatigue among healthcare personnel and misuse of resources (9, 15), and at worst could compromise the care of the most urgent patients (12). However, it is generally acceptable to have a slightly higher overtriage rate and higher resource utilisation than a high undertriage rate, which can delay the treatment of serious illness. The study from South Africa found that the paediatric version of SATS resulted in an overtriage rate of 45.5 % (14). There is no consensus on what constitutes an acceptable level of overtriage or undertriage for triage tools. The international trauma community recommends an overtriage limit of around 20–25 % and an undertriage limit of around 5 % (16, 17). Based on these criteria, SATS-N showed a low overtriage rate (19 % and 18 %) for children transported to hospital by ambulance, an excessive undertriage rate in A&E (12 %), and a satisfactory undertriage rate in the pre-hospital setting (4 %).

The negative predictive value is an important measure of validity in the evaluation of triage tools. In this study, we found that SATS-N had a very high negative predictive value (98–99 %), meaning that patients given a low triage level were highly unlikely to be transferred from A&E to a high dependency unit. This is reassuring in a clinical context. One of the weaknesses of SATS-N was the low specificity, of just 46–60 %. Consequently, a substantial number of patients can be assigned a high triage level that, according to the definition criteria, is incorrect. However, positive and negative predictive values depend on the prevalence of the variable to be identified in a population, and the result can therefore vary across different patient populations.

Strengths and weaknesses

This study of the use of SATS-N in a pre-hospital setting aims to expand the knowledge base for the triage system used in the Western Norway Regional Health Authority. The study spans several seasons to encompass the heightened influx of paediatric patients during the winter, which is the peak season for respiratory infections.

A weakness of the study was the inclusion of patients during the ongoing COVID-19 pandemic. During the period with extensive infection control measures in spring 2020, there were fewer acute hospital admissions than usual for somatic conditions for both children and adults (18). However, several countries reported delayed access to emergency medical assistance for children (19, 20). The range of illnesses and their severity in patients transported to the hospital during the inclusion period may have been different from that normally observed. Another weakness is that pre-hospital triage levels were not documented for around 10 % of the ambulance patients. This may be related to the prioritisation of infection control measures over documentation of urgency. It could also be associated with the relatively high proportion of short journeys (less than 15 minutes). At the start of the COVID-19 pandemic, the threshold for admission to an intensive care unit may have been higher than usual to avoid overcrowding. However, in our experience, children were given a very high priority by the intensive care unit at Haukeland University Hospital, and we do not believe that this has impacted on the results in this study.

Other weaknesses of the study were the inclusion of patients from only one hospital and one geographical area, and the fact that A&E nurses were not blinded to pre-hospital triage levels and may have been influenced by this information. There is no consensus on which method should be used to validate triage tools or on the definitions of overtriage and undertriage (7, 21). Our benchmark for a true high triage level, involving direct transfer from A&E to a high dependency unit, may be inaccurate, as healthcare personnel may assign this to a patient as a precaution, even if the patient is not necessarily critically ill. Definitions also do not encompass all conditions with a high urgency level.

For example, children with a reduced level of consciousness in connection with a febrile seizure or hypoglycaemia often recover quickly and may not necessarily need to be transferred to a high dependency unit.

Conclusion

For children transported by ambulance to the hospital, the SATS-N form proved to be an effective tool for assessing the need for direct transfer from A&E to a high dependency unit. It showed high sensitivity (96 % pre-hospital and 88 % in A&E) and a high negative predictive value (99 % pre-hospital and 98 % in A&E). The overtriage rate was low, at less than 20 %. Only half of the patients were assigned the same triage category in the pre-hospital and A&E settings, and we therefore recommend further triage upon arrival at A&E.

The article has been peer-reviewed.

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