

Chapter 4

Under-triage in the Manchester Triage System: an assessment of severity and suggestions for reduction

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ABSTRACT

Background The Manchester Triage System (MTS) determines an inappropriately low level of urgency (under-triage) to a minority of children. The aim of the study was to assess the clinical severity of under-triage and to determine predictors for under-triage in paediatric patients.

Methods Patients presenting at the ED were triaged using the MTS. Under-triage was defined as patients classified as high urgent (level 1 or 2) by the MTS and low urgent (level 3-5) by a fixed reference standard, based on abnormal vital signs (level 1), potentially life-threatening conditions (level 2) and a combination of diagnostic and therapeutic interventions and hospitalisation/follow up for the three lowest urgency levels. The clinical severity of under-triage was assessed by three experienced paediatricians for cases presented in a standardised format. We used logistic regression analysis to assess predictors for under-triage.

Results In total, 152/13,554 (1.1%) were under-triaged, of whom 70% could have been considered clinically severe (107/152). The reference standard was determined by abnormal vital signs, in 83 patients (78%).

Younger children (especially those below 3 months of age), and children assigned to the MTS flowchart 'unwell child' were more likely to be under-triaged than children assigned to other flowcharts, both in univariate and adjusted analyses.

Conclusion Under-triage occurs infrequently, but might have serious clinical consequences. The MTS may potentially be improved by adding abnormal vital signs as a discriminator for very young children and in the MTS flowchart 'unwell child'.

BACKGROUND

The Manchester Triage system (MTS) is commonly used in emergency departments (ED) to determine the clinical priority of patients.¹ The MTS is a consensus based system, which consists of 52 flowcharts containing discriminators. The selection of the discriminator leads to one of five urgency levels.¹

Earlier performed studies on the validity of the MTS calculated the sensitivity of detecting high urgent cases or patients with specific conditions.²⁻⁴

In a previous performed study we defined validity as sensitivity and specificity of the MTS in comparison to a reference standard for urgency.⁵ This study showed that the MTS errs on the safe side. The sensitivity was 63% and specificity 79%. Over- and under-triage are inevitable. More importantly, however, are the consequences of errors in triage and how these could be avoided in clinical practice.⁶

Under-triage is considered more severe for the individual patient than over-triage,^{7,8} since under-triage might increase morbidity and even mortality. We therefore focus here on under-triaged patients. This study aims to assess clinical severity of under-triage by experts and to determine predictors for under-triage in paediatric patients at the ED.

METHODS

Study design

We compared the MTS urgency classification (first edition) with an independent reference standard.⁵

Under-triage was defined when patients were triaged as low urgent according to the MTS and set as high urgent according to the reference standard urgency.

Experienced paediatricians discussed the possible impact of treatment delay in under-triaged cases to determine the clinical severity. The expert opinion was accomplished by standardized questionnaires. Subsequently, a logistic regression analysis was performed to determine predictors of under-triage. This study is part of an ongoing study.^{5,9} The same dataset was used before to assess the validity of the MTS in children.⁵ The study was approved by the institutional medical ethical committee; the requirement for informed consent was waived.

Patients

Patients, age range 0-16 years, who visited the ED of the Haga Hospital-Juliana Children's Hospital in The Hague between 1-1-2006 until 1-8-2006 and the Erasmus MC Sophia Children's hospital in Rotterdam between 1-1-2006 until 1-2-2007, were included. Nurses triaged the patients according to the MTS. The MTS applies five levels of urgency determined by standard discriminators in problem-specific flowcharts.¹ The clinical priority is categorized into five levels of urgency. The assigned urgency level decides the maximum possible waiting time for a patient to be seen by a physician, and the order in which the physician evaluates the patient. Urgency level "Immediate" (red) demands immediate medical evaluation, "very urgent" (orange) needs evaluation within 10 minutes, "urgent" (yellow) within 60 minutes, "standard" (green) within 120 minutes and "non-urgent" (blue) can wait for up to 240 minutes prior to clinical assessment.

The reference standard (see appendix, chapter 3) based on literature was used as an approximation of the patient's true urgency. The reference urgency levels were defined by abnormal vital signs (level 1), potential life-threatening conditions (level 2) and a combination of diagnostic and therapeutic interventions and hospitalisation/follow up (level 3, 4 and 5).^{5,10}

Under-triage

We defined under-triage as patients who were triaged as urgent, standard or non-urgent (level 3, 4 or 5) according to the MTS and set as immediate or high urgent (level 1 or 2) according to the reference standard. We included under-triaged patients with at least a difference of two urgency levels between the MTS level of urgency and the reference standard urgency level.

The patients were assigned to reference level 1 if they had abnormal vital signs according to the paediatric risk of mortality score (PRISM)^{5,11} and to level 2 if they had normal vital signs, but the presumed diagnosis at the end of the ED consultation was potentially life-threatening.⁵ In the event of similar under-triaged cases, one case was randomly selected as a representative case for the expert meeting.

Expert meeting

Three paediatricians evaluated the cases based on the anonymous ED forms at a meeting. The ED forms included information of the assigned MTS and reference urgency levels, the presenting symptom(s), history, physical examination, working diagnosis, therapy, diagnostics and follow-up.

First, the experts scored the expected clinical severity of under-triage on a scale from zero to ten. Zero represented 'the absolute minimum severity' and ten 'the maximum severity of under-triage'. Secondly, the experts evaluated the clinical severity of under-triage by using an eight-item questionnaire. The experts were asked to decide what the maximum waiting time for the discussed case might be. The maximum waiting time is the time the patient could wait safely before being seen by a physician. The assigned maximum waiting time can be seen as an indicator for patient's true urgency and varied from zero to 240 minutes.

Subsequently the experts assessed the risk of more interventions or diagnostics, a longer duration of hospitalization, complications, long-term morbidity and mortality for the cases. The answers for the questionnaire provided to ascertain their opinions was purely in a 'yes and no' format. The experts were paediatricians with a minimum of fifteen years of clinical experience with expertise in emergency medicine, working in large inner-city teaching or university hospitals.

Data analysis

Assumptions were made that the experts would have scored similar cases in an equal manner. Therefore, the results of the discussed case were multiplied to the number of similar cases. Under-triage was defined as severe if the severity score was high (≥ 7) or if the probability for one of the possible consequences of under-triage was high ($\geq 67\%$).

We performed a univariate and multivariable logistic regression analysis to determine predictors for under-triage.

Age, gender and the assigned MTS flowchart, specific for the patient's presenting problem were considered as possible predictors of under-triage. Since the relation between age and risk of under-triage was non-linear, age was categorized as younger than 3 months, 3 months to 11 months, 1 to 4 years, 4 to 8 years and older than 8 years. SPSS version 15.0 was used for statistical analysis.

RESULTS

Under-triage

Complete data of MTS triage and reference standard were available for 13,554 patients.⁵ 243 (1.8%) of patients triaged by the MTS as 'urgent' 'standard' or 'non-urgent' (N=10,445) were assigned to the reference urgency levels 'very urgent' or 'immediate'.

In 160/243 (66%) of under-triaged cases the difference between the MTS urgency and reference standard urgency was two or more urgency levels. In 8 cases the medical records were missing. In total 152 cases remained for analysis (figure 1).

With regards to cases featuring similar medical problems, one was randomly selected for evaluation in the expert meeting. This provided 23 cases for discussion by the panel of experts.

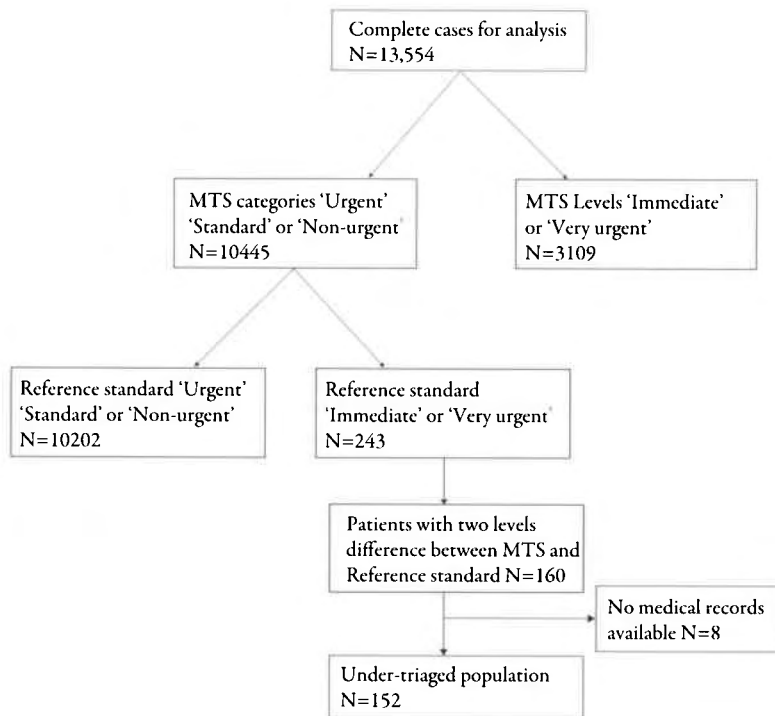


Figure 1 | Population

Clinical severity

The items discussed by the experts are shown in table 1.

In 70% (107/152) of the under-triaged patients, under-triage was considered severe and 78% (83/107) had a high urgency for the reference standard due to abnormal vital signs (heart rate, blood pressure, pulse oximetry, respiratory rate).

According to the experts, 65% (99/152) of the under-triaged patients could potentially experience at least one consequence of under-triage. In 58% (89/152) the consequences of under-triage might include more interventions and in 50% (77/152) more diagnostic

Table 1 | The clinical severity of undertriaged patients discussed by experts.

Under-triaged patients Vital sign or life-threatening condition	Under-triaged Patients	Items discussed by expert panel					Complications	Severity [†]	Maximum waiting time [‡]	Morbidity	Mortality
		EP**	More interventions	More diagnostics	Longer hospitalization	More					
Alte	37 (24%)	3	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (0-8)	120 (10-240)	0 (0%)	0 (0%)	
Sepsis	4 (3%)	2	2 (50%)	2 (50%)	0 (0%)	2 (50%)	5 (1-9)	65 (10-120)	2 (50%)	0 (0%)	
Near drowning	4 (3%)	2	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0-0)	120 (120-120)	0 (0%)	0 (0%)	
Intoxication	1 (1%)	1	0 (0%)	0 (0%)	0 (0%)	1 (100%)	10 (10-10)	0 (0-0)	1 (100%)	0 (0%)	
Abnormal Heart rate	34 (22%)	6	26 (76%)	20 (58%)	8 (25%)	23 (67%)	7 (6-10)	10 (10-10)	11 (33%)	8 (25%)	
Abnormal Blood pressure	7 (5%)	2	0 (0%)	0 (0%)	5 (71%)	5 (71%)	10 (3-10)	5 (5-10)	5 (71%)	0 (0%)	
Pulse oximetry deviated	18 (12%)	2	18 (100%)	11 (61%)	0 (0%)	7 (39%)	8 (8-8)	10 (10-30)	7 (39%)	0 (0%)	
Abnormal Respiratory rate	21 (14%)	3	21 (100%)	21 (100%)	7 (33%)	7 (33%)	4 (4-8)	10 (5-10)	0 (0%)	7 (33%)	
Hyperpyrexia	3 (2%)	1	0 (0%)	0 (0%)	0 (0%)	3 (100%)	7 (7-7)	30 (30-30)	0 (0%)	0 (0%)	
Unresponsiveness	23 (15%)	1	23 (100%)	23 (100%)	0 (0%)	23 (100%)	9 (9-9)	10 (10-10)	0 (0%)	0 (0%)	
Total	152 (100%)	23	90 (58%)	77 (50%)	20 (13%)	71 (46%)	7 (4-9)	10 (10-60)	26 (17%)	15 (10%)	

* Patients characteristic, which determines the reference standard;

** Number of cases as discussed by expert panel (EP);

† Clinical severity: median of the marks experts scored on a scale from 1-10. 10 is considered as highest severity (25th-75th percentiles);

‡ Median waiting time in minutes before the physician should see the patient and the subsequent priority level, on scale 0-240 minutes (25th-75th percentiles).

investigations. In 46% (70/152), complications were considered likely to occur and it was predicted that in 13% (20/152), under-triage could lead to an increased duration of hospitalization. Substantial risks of morbidity or mortality due to under-triage were estimated as 7% (26/152) and 10% (15/152) respectively by the experts.

Apparent life-threatening event (ALTE) was present in 37 of the under-triaged cases. All were considered as absolute non severe according to the experts. (Severity score 1 and no consequences due to under-triage).

Determinants of under-triage

Patients assigned to the flowchart 'unwell child' were more often under-triaged compared to patients assigned to the 'general' flowchart. (OR_{unwell child} 5.6, 95% CI 2.6-12). (Table 2)

Table 2 | Predictors for under-triage

Predictors	Low urgent patients* (N=10,445)	Under-triage N=152	OR, (95% C.I) univariate	Adjusted OR (95% C.I) **
Gender				
Male	5,982	79	0.8 (0.6-1.1)	-
Female	4,463	73	Reference	-
Age				
<3 months	773	42	7.2 (4.3-12.1)	3.3 (1.9-5.8)
3-11 months	1,321	27	2.6 (1.5-4.6)	1.3 (0.7-2.4)
1-4 years	3,220	46	1.8 (1.1-3.0)	1.3 (0.8-2.2)
4-8 years	2,208	14	0.8 (0.4-1.6)	0.8 (0.4-1.5)
8-16 years	2,923	23	Reference	Reference
Flowchart used				
Diarrhoea and vomiting	1,084	20	0.7 (0.4-1.2)	0.7 (0.4-1.2)
General	1,122	31	Reference	Reference
Headache	158	5	1.2 (0.4-3.0)	1.7 (0.6-4.6)
Shortness of breath	792	30	1.4 (0.8-2.3)	1.5 (0.9-2.5)
Unwell child	73	10	5.6 (2.6-11.9)	5.9 (2.7-12.8)
Worried parent	805	37	1.7 (1.0-2.8)	1.5 (0.9-2.5)
Other	6,411	19	-	-

* According to the MTS;

** Adjusted for age and flowchart, respectively

Younger patients (under 4 years, and especially under 3 months of age) had a higher risk of under-triage than children aged 8-16 years ($OR_{<3 \text{ months}}$ 7.2, 95% CI 4.3-12, $OR_{3-11 \text{ months}}$ 2.6, 95% CI 1.5-4.6, $OR_{1-4 \text{ years}}$ 1.8, 95% CI 1.1-3.0).

Younger patients (0-3 months) and patients assigned to the 'unwell' flowchart also had a higher risk of under-triage when adjusted in multivariable analyses ($aOR_{0-3 \text{ months}}$ 3.3, 95% CI 1.9-5.8 adjusted for flowchart, $aOR_{\text{unwell child}}$ 5.9, 95% CI 2.7-13 adjusted for age).

DISCUSSION

Our study aimed to assess the clinical severity of treatment delay as a result of under-triage using the Manchester triage system, compared to a reference standard.

70% (107/152) of the under-triaged patients highlighted by this study could be considered as clinically severe, and 65% (99/152) might experience at least one consequence due directly to under-triage.

78% (83/107) of the clinically severe under-triaged patients had abnormal vital signs. In the MTS vital signs are not measured; instead, abnormal vital signs were identified using the discriminators shock, inadequate breathing, compromised airway, and unresponsiveness. Not all patients with abnormal vital signs were assigned to one of these discriminators and therefore not always recognized as patients with high urgency.⁵ Cooke et al demonstrated misclassification in the MTS due to abnormal vital signs in adults.³ In this study, three patients with chest pain could have been assigned to the correct urgency level if pulse oximetry had been part of the triage assessment.

73% (37/51) of patients diagnosed with a potential life-threatening event (ALTE) were under-triaged according to our reference standard. The experts considered these cases as not severe. Thus, in these cases the experts agreed with the MTS urgency level and not with the reference standard. Therefore ALTE should not be considered a level 2 condition in the reference standard.

Although under-triage was infrequent in children assessed with the MTS, some specific predictors for under-triage were distinguished. Patients younger than 3 months (26.3% under-triaged cases) and patients assigned to the flowcharts 'unwell child' (6.3% of the under-triaged cases) were more likely to be under-triaged. Together these subgroups contained 31% (47/152) of all under-triaged patients.

In a triage system, a certain percentage of under-triage is considered inevitable, because patients presenting with the same symptoms could have different priorities. As a result, it is difficult to find discriminators, which embrace all presenting signs and symptoms. Modification of a triage system should decrease under-triage, while the number of over-triaged cases is reduced or remained constant.

Measuring vital signs in every patient increases the sensitivity of the MTS, but will increase the workload substantially. Therefore, only measuring vital signs in children younger than three months and in children assigned to the flowcharts 'unwell child' could be considered. Then 19% (20/107) of the clinically severe under-triaged could be prevented, while in 9% (1,157/13,554) vital signs should be measured.

Limitations

The value of expert opinion has been criticized. Nonetheless, expert opinion is the best available method to evaluate the consequences of under-triage for individual cases. Standardized questionnaires were used to improve validity of the judgment of the cases. The experts were all experienced paediatricians in emergency medicine.

We did not check all cases for errors on the assigned MTS. Earlier performed studies demonstrated adequate reliability and accuracy of the MTS as a predictive tool.^{9, 12-14}

Under-triage is a term used for patients who are assigned to a low urgency level, while the "true" urgency is high. To determine patient's true urgency a reference standard based on patient's characteristics during ED consultation was determined as best proxy for true urgency.⁹ The items on which the reference standard was based were extracted from the literature, but the final combinations of these items were defined by expert opinion, which is a low grade of evidence-based medicine. Despite these limitations, a reference standard is in our opinion a reasonable best approach to assess the urgency with which particular patients should be seen and assessed.¹⁵

CONCLUSION

Serious under-triage occurs in very small numbers of cases (approximately 1%), but could potentially have serious consequences. To reduce significant under-triage, some adjustments to the MTS are recommended. Adding abnormal vital signs as a discriminator in severity to the MTS, when applied to patients younger than three months, and for those assigned to the flowchart 'unwell child' could reduce the numbers considered under-triaged.

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