Can urgency classification of the Manchester triage system predict serious bacterial infections in febrile children?

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ABSTRACT

Objective To evaluate the discriminative ability of the Manchester triage system (MTS) to identify serious bacterial infections (SBIs) in children with fever in the emergency department (ED) and to study the association between predictors of SBI and discriminators of MTS urgency of care.

Methods This prospective observational study included 1255 children with fever (1 month–16 years) attending the ED of the Erasmus MC – Sophia Children's Hospital, Rotterdam, The Netherlands in 2008–9. Triage urgency was determined with the MTS (urgency (U) level 1–5). The relationship between triage urgency and SBI was assessed with multivariable logistic regression, including effects of age, sex and temperature. Discriminative ability was assessed by receiver operating characteristic curve analysis.

Results SBI prevalence was 11% (n=131, 95% CI 9% to 12%). The discriminative value of the MTS for predicting SBI was 0.57 (95% CI 0.52 to 0.62), and the MTS did not contribute to a model including age, sex and temperature. The sensitivity of the MTS (U1–2 vs U3–5) to detect SBI was 0.42 (95% CI 0.33 to 0.51) and specificity was 0.69 (95% CI 0.66 to 0.72). MTS high urgency discriminators include several known predictors of SBI, such as fever, work of breathing, meningism and oxygen saturation, but apply to non-SBI children as well.

Conclusion The MTS has poor discriminative ability to predict the presence of SBIs in children presenting with fever to the paediatric ED. Important predictors of SBI are represented within the MTS, but are used in a different way to classify urgency.

What is already known on this topic

- Triage systems are useful for assessing the ill child's appearance and defining the urgency of care at initial presentation.
- Prediction rules for serious bacterial infections (SBIs) have identified predictors that are easily recognised at first assessment.

What this study adds

- Although important predictors of SBIs are represented within the Manchester triage system, a different role is assigned to them in the urgency classification.
- At first assessment of a febrile child in the emergency department, a triage system and clinical prediction rules should be used in parallel to guide clinical decisions.

INTRODUCTION

Children with fever are at risk for serious bacterial infections (SBIs) and present with a wide range of clinical signs and symptoms.[1–3] Early identification of SBIs, especially invasive bacterial infections such as meningitis and septicaemia, allows for immediate medical care, thereby improving patient outcome.[4] Prediction rules have been developed to identify SBIs and several studies have identified predictors of SBI that are readily recognised at first assessment.[5–11] As patient triage is used to assess urgency of care at first presentation, it might be a useful tool for identifying SBIs early in the diagnostic pathway.

Several triage systems have been developed in recent years.[12 13] The Royal College of Nursing Accident and Emergency Association and the British Association for Accident and Emergency Medicine developed the Manchester triage system (MTS) in 1997.[14 15] With the MTS, patients are classified into one of five urgency categories, determined by a positive discriminator in a flowchart which best describes the patient's presenting problem.[14] Study results have proven the reliability, reproducibility and validity of the MTS and have led to its widespread implementation in emergency departments (EDs).[12 16 17]

This study aims to evaluate the discriminative ability of the MTS to identify SBIs in children with fever in the ED and to study the association between predictors of SBI and discriminators of MTS urgency of care.

METHODS

Study population

This study was conducted as part of a prospective observational study to validate the MTS. Patient characteristics, presenting signs and symptoms and the triage data of all patients visiting the ED of the Erasmus MC – Sophia Children's Hospital are registered routinely in an electronic patient record.[18] For this particular study, all children with fever (ie, a temperature ≥38.5°C, a recent high fever or fever as a reason for referral), aged 1 month to 16 years, who attended the ED of the Erasmus MC – Sophia Children's Hospital, Rotterdam, The Netherlands, from January 2008

until July 2009, were eligible. The Erasmus MC – Sophia Children's Hospital is an inner city university hospital and its ED is visited by approximately 9000 patients annually, 90% of whom receive basic paediatric emergency care, with the remaining 10% receiving specialised tertiary centre care.[19] Patients with chronic comorbidity, who have an increased risk of acquiring SBIs or developing severe complications and who visited a (subspecialist) paediatrician at least twice in the preceding year, were excluded from the study. Children who visited the ED for the same reason and with the same symptoms within 5 days of their first presentation were only once considered in the analysis; final diagnoses were based on available data from all consecutive visits. The institutional medical ethics committee approved the study; the requirement for informed consent was waived.

Manchester triage system

The MTS is used for patient triage in the ED of the Erasmus MC – Sophia Children's Hospital.[18] The MTS is a five-level triage system used to allocate clinical priority to adult and children, as assessed by emergency care nurses.[14 15] It was introduced in the United Kingdom in 1996 and its translated versions have been adapted around the world. The MTS uses 52 flowcharts which represent the presenting complaints such as 'worried parent', 'limping child' and 'shortness of breath in children'. Each flowchart contains general as well as problem-specific signs and symptoms (discriminators) that differentiate between the different urgency categories. The discriminators for urgency level mainly depend on six general discriminators: life threat, pain, haemorrhage, level of consciousness, temperature and acuteness of onset. Selection of a discriminator allocates the patient to one of five urgency levels, each indicating the maximum time a patient should wait before being seen by a physician and the order in which the physician should evaluate the patient.[14 15] Urgency level 'immediate' (red) demands immediate medical evaluation, 'very urgent' (orange) requires evaluation within 10 min, 'urgent' (yellow) within 60 min, 'standard' (green) within 120 min and 'non-urgent' (blue) can wait for up to 240 min before clinical assessment. Trained paediatric emergency care nurses triaged the patients with the official Dutch translation of the first edition of the MTS.[14] During the study period we used a modified version of the first edition of the MTS, with several adjustments for the triage of febrile children.[20] The MTS has been validated in children recently and showed good inter-rater agreement.[18 21]

Outcome measures

Final diagnoses were classified as either SBI or non-SBI. Within SBI, we distinguished pneumonia, meningitis, septicaemia, urinary tract infections and other less frequently occurring diagnoses such as erysipelas, cellulitis, bacterial gastroenteritis, cellulitis orbitae, bacterial upper airway infection, ethmoiditis, arthritis and osteomyelitis. Final diagnoses were determined by positive bacteriological cultures of blood, urine, stool and ear, nose or throat, or radiological findings according to a reference standard.[10] The reference standard included a follow-up period for all discharged patients to rule out the possibility of missed SBI and to avoid verification bias. Follow-up consisted of checking for consecutive ED visits and hospital admissions in a 1-week period after the first visit. If the final diagnosis was inconclusive, a consensus diagnosis was reached by the investigators (RN, RO, HM).

Data analysis

In univariate analysis we compared patient characteristics, referral pattern, height of fever and MTS discriminators for the presence of SBI using the Kruskall–Wallis test (continuous non-parametric variables) and Pearson's χ^2 test (dichotomous and categorical variables; Fisher's exact test was used when cells contained less than five cases). Diagnostic performance measures of the MTS to predict SBI included sensitivity, specificity, positive predicted value (PPV) and negative predictive value (NPV), and positive and negative likelihood ratios (LR+, LR–). We dichotomised MTS categories into urgent (U1–2) and non-urgent (U3–5). This cut-off point reflects children needing 'immediate' or 'very urgent' care within 10 min after presentation (U1–2) and children in less urgent need of medical care who can wait for 60 min or more (U3–5) according to MTS triage.

We assessed the discriminative ability of the MTS (categorical variable, U1–U5) for the presence of SBI with multivariate logistic regression analysis and receiver operating characteristic (ROC) curve analysis. A ROC area can range from 0.50 (non-informative test) to 1.0 (optimal test).[22] As age and temperature are important predictors of SBI and are integrated into the MTS urgency classification,[2–4 11 14 18 23–26] we added these variables to the model and examined the incremental value of discriminative ability. Next, we tested the interaction terms for statistically significant model improvement ($p<0.05$). Data were analysed using SPSS v 15.0. The diagnostic performance measures (sensitivity, specificity, PPV, NPV, LR+, LR–) of the MTS were calculated using the VassarStats website.[27] We tested the linearity of age and temperature with restricted cubic splines (RCS) with R statistical software package v 2.8.1, using the Hmisc and Design library (http://www.r-project.org).[28] Both temperature and age showed linearity on the log odds scale and were included as such in the analysis.

RESULTS

A total of 1911 children with fever were eligible for inclusion. We excluded consecutive visits of children within 5 days of the first presentation with the same reason for consultation (n=121), children with missing data (n=1) and children with chronic co-morbidity (n=534), leaving 1255 children for inclusion. These children had a median age of 1.8 years (IQR 0.9–3.9) and 743 (59%) were boys. The prevalence of SBI was 11% (95% CI 9% to 12%). Table 1 shows the patient characteristics of children with and without SBI in our study population. Children with SBI are older, more often referred by a general practitioner, more frequently triaged in urgency categories 1–2, and have a higher body temperature at presentation. The most commonly used MTS flowcharts are listed in table 1.

Table 2 shows MTS urgency distribution for different SBIs. Four cases were diagnosed with sepsis/meningitis, three of which were classified as 'very urgent' and one of which was classified as 'urgent'. Other SBIs, such as pneumonia and urinary tract infections, were distributed among the urgency classification more heterogeneously, but none in the immediate/red or standard/blue category. In four cases triage data was missing.

Table 3 describes the frequency of positive discriminators as documented in our patients with SBI. The positive discriminators 'meningeal signs', 'increased work of breathing' and 'very low SaO_2' classify patients to high urgency (U1–2), while 'chest infection', 'recent problem' (ie, defined as a problem

arising in the last 7 days), 'vomiting' and 'child with fever' (aged >3 months) indicate lower urgency in children with SBI. 'Fever' and 'pain', however, occurred among all MTS urgency classes. Table 4 shows the distribution of positive discriminators indicating 'immediate' or 'very urgent' as observed among children with and without SBI. Discriminators of 'immediate' urgency were only documented in children without SBI. The most commonly used positive discriminators to allocate high urgency (U1–2) were 'child with fever' and 'increased work of breathing'. The discriminators 'increased work of breathing' and 'very low $PaSO_2$' classified children with SBI as 'very urgent' significantly more often compared to children without SBI. Two high urgency discriminators were observed in children with SBI only (both n=1): 'purpura' and 'facial oedema'. In our population most discriminators are only used sporadically to define the urgency of the presenting problem.

Table 5 describes the diagnostic performance of a dichotomised MTS (U1–2 vs U3–5). In our population with an SBI prevalence of 11%, a positive likelihood ratio of 1.34 increased the risk of SBI to 16% in children triaged with high urgency levels (U1–2), while a negative likelihood ratio of 0.85 decreased the risk of SBI to 10%. The discriminative value of the MTS (ROC area) to identify SBI was 0.57 (95% CI 0.52 to 0.62). The MTS, however, hardly contributed to a model including age, sex and temperature (ROC area 0.62; 95% CI 0.57 to 0.67). Tests for interaction between MTS urgency and temperature and MTS urgency and age were not significant.

To better understand the limited diagnostic value of the MTS to discriminate children with SBI, we matched known predictors of SBI, as identified in a systematic review by Van den Bruel *et al*[11], with discriminators of urgency of care as used in the MTS (table 6). Important predictors of SBI, such

Table 1 Characteristics of children with fever diagnosed with SBI (n=131) and without SBI (n=1124)[†‡]

Characteristic	Children with SBI	Children without SBI	p Value
Age (years)[§]	2.16 (0.93–4.65)	1.79 (0.86–3.76)	0.113
1 month–1 year	36 (28%)	325 (29%)	
1 year–2 years	26 (20%)	280 (25%)	
2–5 years	38 (29%)	335 (30%)	
5–16 years	31 (24%)	184 (16%)	
Gender (male)	72 (55%)	671 (60%)	0.297
Referral from primary care	54 (42%)	287 (26%)	0.000*
MTS classification: high urgency (U1–2)	53 (42%)	337 (31%)	0.009*
MTS flowcharts			
General	24 (19%)	314 (29%)	
Worried parent	11 (9%)	177 (16%)	
Shortness of breath in children	36 (28%)	138 (13%)	
Fits	5 (4%)	116 (11%)	
Diarrhoea and vomiting	8 (6%)	106 (10%)	
Abdominal pain in children	6 (5%)	39 (4%)	
Rashes	4 (3%)	30 (3%)	
Unwell child	2 (2%)	29 (3%)	
Ear problems	5 (4%)	24 (2%)	
Urinary problems	11 (9%)	16 (1%)	
Other[¶]	15 (12%)	105 (10%)	
Temperature in the ED (°C)[§]	39.3 (38.6–39.8)	38.9 (38.1–39.6)	0.000*

*Indicates a significant difference ($p<0.05$)
[†]Values are number (percentage) unless otherwise stated.
[‡]Valid data available for all patients, except for the variables GP referral, MTS classification, temperature and duration of ED visit (data available for >97% of cases).
[§]Median (IQR).
[¶]Other flowcharts (with n<25): asthma (n=7), corpus alienum (n=1), limb problems (n=4), haematological disease (n=6), headache (n=24), crying baby (n=20), abscesses or local infections (n=7), sore throat (n=23), GI bleeding (n=1), limping child (n=5), neck pain (n=7), facial problems (n=2), eye problems (n=3), chest pain (n=3), irritable child (n=2), back pain (n=3), apparently drunk (n=2).
ED, emergency department; GI, gastro-intestinal; GP, general practitioner; MTS, Manchester triage system; SBI, serious bacterial infection.

Table 2 Distribution of different serious bacterial infections among MTS urgency classifications (n=131)*

	MTS urgency classification						
SBI	Immediate	Very urgent	Urgent	Standard	Non-urgent	Urgency not known	Total
Pneumonia	0	29	24	16	0	1	70 (53%)
Urinary tract infection	0	10	15	3	0	0	28 (21%)
Meningitis/septicaemia	0	3	1	0	0	1	5 (4%)
SBI other[†]	0	11	10	5	0	2	28 (21%)
Total	0	53 (40%)	50 (38%)	24 (18%)	0	4 (3%)	131 (100%)

*Values are number (percentage).
[†]Other SBI: bacterial gastro-enteritis (n=6), osteomyelitis (n=1), arthritis (n=1), abscess (n=2), bacterial upper airway infection (n=5), other (n=13).
MTS, Manchester triage system; SBI, serious bacterial infection.

Table 3 Positive discriminators for children with serious bacterial infection (n=131)

	MTS urgency classification of SBI					
Positive discriminator*	**Immediate**	**Very urgent**	**Urgent**	**Standard**	**Non-urgent**	**Total**
General						
Significant medical history		0	5	0		5
Medical history other		0	0	1		1
Significant respiratory history		0	3	0		3
Recent problem		0	0	7		7
Fever†		27	25	4		56
Pain						
Pain‡		2	7	5		14
Pain on joint movement		0	1	0		1
Respiratory						
Wheeze		0	1	0		1
Chest infection		0	0	5		5
Unable to talk in sentences		0	1	0		1
Very low SaO_2		3	0	0		3
Low SaO_2		0	3	0		3
Low PEFR		0	1	0		1
Increased work of breathing		16	0	0		16
Gastro-intestinal						
Signs of dehydration		0	2	0		2
Vomiting		0	0	2		2
Passing fresh or altered blood (in stool)		1	0	0		1
Neurological						
Signs of meningism		1	0	0		1
Altered level of consciousness		1	0	0		1
Recent reduced visual acuity		0	1	0		1
Cutaneous						
Purpura		1	0	0		1
Facial oedema		1	0	0		1
Missing						4 (3%)
Total§	0	53 (40%)	50 (38%)	24 (18%)	0	131 (100%)

* Discriminators as used in the modified first edition of the MTS.[18]
‡Urgency distribution of children with the discriminator 'pain' depends on the severity of pain and/or the presence of itch in specific flowcharts in the modified first edition of the MTS.[18]
†Urgency distribution of children with the discriminator 'fever' depends on age in specific flowcharts in the modified first edition of the MTS.[18]
MTS, Manchester triage system; PEFR, peak expiratory flow rate; SaO_2, oxygen saturation; SBI, serious bacterial infection.

as cyanosis, petechial rash, meningeal irritation and unconsciousness, are represented in the MTS by the discriminators '(very) low $PaSO_2$' (U2–3), 'non-blanching rash' (U2), 'signs of meningism' (U2) and 'altered level of consciousness' (U2) or 'unresponsive child' (U1), respectively. We could not match positive discriminators for a number of predictors but they match with flowcharts that include all levels of urgency. Parental concern, for example, matches the flowchart 'worried parent', changed crying pattern matches 'crying child', child appears ill matches 'unwell child' and child is irritable matches 'irritable child'. Although the predictor 'age' is not a specific feature of the MTS, it is incorporated in a modified MTS to differentiate urgency classification in febrile children in several commonly used flowcharts.[18]

DISCUSSION

The MTS has poor discriminative ability to identify SBI in children with fever. Comparison of high urgency (U1–2) with lower urgency (U3–5) categories shows poor sensitivity and moderate specificity and only a marginal increase in predicted risk with a low positive likelihood ratio. MTS urgency, adjusted for age, sex and body temperature, has no value in discriminating children with SBI from those without SBI. Some important predictors of SBI[11] are included in the MTS by urgency discriminators, as shown in table 6. Other important predictors of SBI, however, are only represented with flowcharts that do not indicate a specific urgency level.

Triage systems may be a promising tool to identify children with SBIs, as they asses the child's ill appearance at initial presentation in the ED. However, based on our observations, we conclude that the MTS cannot be used to identify SBIs in children with fever. This has not been proven before. The limited diagnostic value of the MTS for SBI in general can be explained by the fact that triage systems predict urgency of disease, which differs substantially from predicting severity of disease or assessment of diagnosis.[29] Both SBIs and viral and self-limiting diseases may disturb vital functions requiring immediate intervention and are therefore classified as highly urgent (eg, bronchiolitis with respiratory insufficiency, febrile convulsion, shock from viraemia or dehydration complicating viral gastroenteritis).[30–34] Some SBIs, in contrast, may have a more benign clinical course and do not require immediate medical care.[35] Next, signs of bacterial sepsis and meningitis often occur late in the course of disease[35 36] and may not be present at first evaluation, as illustrated by one case of septicaemia not being classified as high urgency. The poor discriminative

Table 4 Positive discriminators for children with MTS high urgency (U1–2) (n=390)

Urgency level	Positive discriminator†	SBI	Non-SBI	OR (95% CI)‡
Urgency 'immediate' (U1)	Currently fitting	0	8	NC
	Inadequate breathing	0	7	NC
	Airway compromise	0	6	NC
	Shock	0	2	NC
	Unresponsive	0	2	NC
	Stridor	0	1	NC
	Total U1	0	26	NC
Urgency 'very urgent' (U2)	High fever	27	207	1.16 (0.74 to 1.82)
	Increased work of breathing	16*	58	2.56 (1.42 to 4.59)
	Altered conscious level	1	13	NC
	Very low SaO_2	3*	4	NC
	Non-blanching rash	0	7	NC
	Cold (temperature)	0	5	NC
	Significant haematological history	0	3	NC
	Cardiac pain	0	3	NC
	Abnormal pulse	0	2	NC
	Severe pain	1	1	NC
	Signs of severe pain	1	1	NC
	Responds to voice or pain only	0	2	NC
	Exhaustion	0	2	NC
	Passing fresh or altered blood (in stool)	1	1	NC
	Signs of meningism	1	1	NC
	Facial oedema	1*	0	NC
	Purpura	1*	0	NC
	Abrupt onset	0	1	NC
	Total U2	53*	311	1.80 (1.24 to 2.63)
Total U1 and U2		53 (14%)*	337 (86%)	1.61 (1.11 to 2.34)

*Indicates a significant difference ($p<0.05$).
†Discriminators as used in the modified MTS first edition.[18]
‡NC, ORs not calculated with <5 cases in a cell (Fisher's exact test for significance was used when cells contained less than five cases); when cells contained zero cases, 0.5 was added to each cell.
MTS, Manchester triage system; SaO_2, oxygen saturation; SBI, serious bacterial infection.

Table 5 Diagnostic performance measures of MTS urgency (U1–2 vs U3–5) to identify serious bacterial infections

	MTS urgency U1–2 vs U3–5 (95% CI)
Sensitivity	0.42 (0.33 to 0.51)
Specificity	0.69 (0.66 to 0.72)
PPV	0.14 (0.10 to 0.17)
NPV	0.91 (0.89 to 0.93)
LR+	1.35 (1.08 to 1.69)
LR−	0.84 (0.73 to 0.98)

LR, likelihood ratio; MTS, Manchester triage system; NPV, negative predictive value; PPV, positive predictive value.

ability of the MTS illustrates the need for parallel use of clinical prediction rules for SBI at first evaluation.

Presenting signs and symptoms are diverse in febrile children: positive discriminators as documented in children with SBI are distributed equally among the three intermediate urgency classifications (U2–4), as shown in table 3. The presence of some frequently encountered discriminators for high urgency (such as (high) fever in young children and increased work of breathing) are rather aspecific and do not discriminate between children with and without SBI (table 4). Therefore, a different role is assigned to predictors of SBI as regards urgency classification compared to severity of disease classification. Our results do show, however, that most children with invasive SBIs such as meningitis or pneumonia are classified to high urgency by the discriminators associated with 'meningeal signs' and 'severe dyspnoea'.

Only one previous study by Thompson *et al* examined the predictive ability of triage urgency to identify SBI in febrile children by dichotomising the MTS into an urgent (U1–3) and a non-urgent group (U4–5). The authors observed a sensitivity of 84% and a specificity of 38%.[37] Using similar cut-offs, we observed a sensitivity of 81% (95% CI 0.73% to 0.87%) with a low specificity of 25% (95% CI 0.22% to 0.28%), corresponding with the findings of Thompson *et al*. However, they did not examine different MTS cut-off points and did not adjust for other relevant predictors.

In our and previous studies, temperature and age are important predictors of SBI in children with fever.[2–4 11 23–26] In an earlier study we observed that performance of the MTS improved with age-specific adjustments, which led to the implementation of modifications for children with fever.[18] These modifications proved to be safe with an increase in specificity and unchanged sensitivity[20].

The MTS was recently validated for children and was shown to have good inter-rater agreement, which enhances the validity of our results.[18 21] In addition, compliance with the MTS at our ED is high, with data missing for only four children with SBI (3%) and 34 children in our total study population (3%). Our study population included both self-referrals and patients referred by general practitioner (n=341, 27%), with a higher prevalence of SBIs in the latter. The reported association between referral status and the severity of illness and triage level[38] reflects a difference in population selection (self-referred patients present with other clinical

Table 6 Identified predictors of serious bacterial infections and characteristics of the MTS (first edition)*[11 14]

Predictor of SBI identified by Van den Bruel *et al*[11]		Positive discriminator of MTS
Global assessment		
Strong predictors†	Height of fever	Fever (U2–4)‡
	Parental concern§	
	Clinician instinct that something is wrong	
	Clinical impression	
	Child appears ill§	
Intermediate predictors†	No obvious source of fever	
Child behaviour		
Strong predictors†	Changed crying behaviour§	Inconsolable by parents (U3), prolonged or uninterrupted crying (U3), not distractable (U3)
	Child inconsolable§	Inconsolable by parents (U3), prolonged or uninterrupted crying (U3), not distractable (U3)
	Child moaning	
	Child drowsy	Fails to react to parents (U2)
Intermediate predictors†	Child no longer smiles	
	Child is irritable§	
	Child is somnolent	Altered level of consciousness (U2), fails to react to parents (U2)
	Child is reactive	
Circulatory and respiratory features		
Strong predictors†	Cyanosis	Very low SaO_2 (U2), low SaO_2 (U3)
	Crackles	
	Decreased breathing sounds	
	Short of breath§	Inadequate breathing (U1), increased work of breathing (U2), unable to talk in sentences (U2–3)¶
	Rapid breathing	Increased work of breathing (U2)
	Poor peripheral circulation**	(Abnormal capillary refill), shock (U1)
Intermediate predictors†	Changed breathing pattern	
	Cough	
	Signs of URTI	
Miscellaneous		
Strong predictors†	Meningeal irritation	Signs of meningism (U2)
	Petechial rash§	Non-blanching rash (U2), purpura (U2)
	Seizures§	Currently having a fit (U1)
	Unconsciousness	Altered level of consciousness (U2), unresponsive child (U1)
Intermediate predictors†	Age	Fever (U2–4)‡, persistent vomiting (U3–4)¶
	Underlying condition	Significant medical history (U3), significant cardiac history (U3)
	Duration of fever or illness	
	Abnormal skin colour	
	Tummy ache§	
	Headache§	
	Tachycardia	Abnormal pulse (U2)
Specific predictors of meningitis		
	Child is irritable§	
	Vomiting	Persistent vomiting (U3–4)¶
	Duration of fever or illness	
	Sought care in previous 48 h	
	Paresis or paralysis	Acute neurological deficit (U2)
Specific predictors of meningococcal disease		
	Cough	
	Vomiting	Persistent vomiting (U3–4)¶
Specific predictors of pneumonia		
	Grunting	

Continued

Table 6 Continued

Predictor of SBI identified by Van den Bruel *et al*[11]		Positive discriminator of MTS
	Wheezing	Wheeze (U3–4)[¶]
	Duration	
Specific predictors of bacteraemia		
	Child is irritable[§]	
	Child is lethargic	Unresponsive (U1), floppy (U2), altered level of consciousness (U2)
	Functional status	
	Age	Fever (U2–4)[‡], persistent vomiting (U3–4)[¶]
	Referral status	

*Predictors of dehydration as a result of gastro-enteritis are excluded from the table. Flowcharts not considered (as being irrelevant for febrile children at risk of SBI): burns and scalds, assault, abdominal pain in adults, collapsed adult, exposure to chemicals, falls, foreign body, GI bleeding, head injury, major trauma, mental illness, overdose and poisoning, pregnancy, PV bleeding, self-harm, sexually acquired infection, shortness of breath in adults, torso injury, unwell adult, wounds, major incidents.
[†]Strong predictors are defined as LR+ >5.0 or LR– <0.2 in at least one of the studies considered in meta-analysis; intermediate predictors are defined as less helpful predictors in ruling in or ruling out the presence of SBI.[11]
[‡]Discriminators of fever: in the original MTS (first edition), the urgency of children with fever could be assessed with the positive discriminator 'hot child' (U2 in all relevant flowcharts); in the modified MTS (first edition), 'hot child' was altered to describe different urgency categories for different age groups in several commonly used flowcharts.[18]
[§]Predictor with flowchart describing the presenting problem (no specific urgency classification).
[¶]Urgency distribution of children with the discriminator 'persisting vomiting' depends on age in specific flowcharts in the modified first edition of the MTS[18]; the discriminators 'unable to talk in sentences' and 'wheeze' depend on the flowchart.
**Positive discriminator only used in the special flowchart 'major incidents' and is not used in regular flowcharts.
GI, gastrointestinal; LR, likelihood ratio; MTS, Manchester triage system; PV, per vaginam; SBI, serious bacterial infection; URTI, upper respiratory tract infection.

characteristics as they are in a different phase of illness) rather than a different approach during triage. We did not observe effect modification between the MTS and referral. Referral status is not included as a determinant in the MTS.[14] A limitation of our study is that the data are obtained from a single centre. Also, we observe a number of discriminators that are used to determine urgency of care only sporadically: more data are needed to assess the diagnostic value of these specific discriminators to predict SBI in febrile children. Next, results may need confirmation in a population with more SBIs. Although invasive bacterial infections are only a very small proportion of all SBIs, they are of great clinical importance, and a high predictive value for these SBIs would be useful. Finally, children with comorbidity, who may be at higher risk of SBIs or their complicated course, are excluded from this study. Comorbidity is included as a discriminator in the MTS so confirming our results in a population with comorbidity may be worthwhile.

CONCLUSION

The MTS has poor discriminative ability for predicting the presence of SBIs in children presenting with fever at the paediatric ED. Adjusting for age and temperature does not improve the diagnostic performance of the MTS to identify children with SBI. Although important predictors of SBI are represented within the MTS, a different role is assigned to them in the urgency classification. In the first assessment of a febrile child at the ED, a triage system and clinical prediction rules should be used in parallel to guide clinical decisions.

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