Safety of the Manchester Triage System to Detect Critically Ill Children at the Emergency Department

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Objective To assess the safety of the Manchester Triage System in pediatric emergency care for children who require admission to the intensive care unit (ICU).

Study Design Between 2006 and 2013, 50 062 consecutive emergency department visits of children younger than the age of 16 years were included. We determined the percentage of undertriage, defined as the proportion of children admitted to ICU triaged as low urgent according to the Manchester Triage System, and diagnostic performance measures, including sensitivity, specificity, and diagnostic OR. Characteristics of undertriaged patients were compared with correctly triaged patients. In a logistic regression model, risk factors for undertriage were determined.

Results In total, 238 (28.7%) of the 830 children admitted to ICU during the study period were undertriaged. Sensitivity of high Manchester Triage System urgency levels to detect ICU admission was 71% (95% CI 68%-74%) and specificity 85% (95% CI 85%-85%). Severity of illness was lower in undertriaged children than correctly triaged children admitted to ICU. Risk factors for undertriage were age <3 months, medical presenting problem, comorbidity, referral by a medical specialist or emergency medical services, and presentation during the evening or night shift.

Conclusion The Manchester Triage System misclassifies a substantial number of children who require ICU admission. Modifications targeted at young children and children with a comorbid condition could possibly improve safety of the Manchester Triage System in pediatric emergency care. *(J Pediatr 2016;177:232-7).*

Triage systems are used in emergency departments (EDs) to prioritize patients and to ensure that they are seen in order of clinical need when demand exceeds capacity. In Europe, the Manchester Triage System (MTS) is the most frequently used emergency medical triage system.[1] The MTS is a flowchart-based algorithm that classifies patients into 1 of 5 urgency categories, each corresponding to a predetermined maximum waiting time.

Although the MTS is used widely, research evaluating its safety for the triage of children is limited. The safety of a triage system refers to its ability to identify high-urgent patients. Misclassification of high-urgent patients to a low-urgency level, so-called "undertriage," causes delay in the care of severely ill patients and potentially leads to morbidity or even mortality. Children, accounting for more than 25% of the workload of EDs, are at increased risk of undertriage: they suffer from a different spectrum of disease than adults, they frequently present with nonspecific complaints, and characteristic changes in vital signs that signal deterioration in adults often occur late in the disease course.[2,3] Two previous studies assessed the diagnostic accuracy of the MTS in children and concluded that validity of the MTS for the triage of children was moderate[4,5]; however, these studies did not specifically address safety of the MTS for high-urgent children, nor did these studies determine predictors of undertriage.

Admission to the intensive care unit (ICU) is a specific and clinically relevant outcome to study the safety of triage systems.[6] Patients admitted to the ICU are by definition either critically ill or at risk of developing life-threatening conditions. Moreover, delays in admission to the ICU have been shown to negatively impact health outcomes in adults.[7] We propose as minimum requirement for a triage system that it accurately identifies patients in need of admission to the ICU. Therefore, we performed a large observational study to determine the safety of the MTS in pediatric emergency care for children who required admission to the ICU. Moreover, we aimed to describe the group of undertriaged children and identify risk factors for undertriage.

ED	Emergency department
ICU	Intensive care unit
MTS	Manchester Triage System
PIM	Pediatric Index of Mortality
PRISM	Pediatric Risk of Mortality Score

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Supported by the Netherlands Organization for Health Research and Development (945-06-211). The authors declare no conflicts of interest.

http://dx.doi.org10.1016/j.jpeds.2016.06.068

Methods

We evaluated the safety of the MTS as part of an ongoing study on the validity of the MTS in children.[5,8-10] The Medical Ethics Committee of the Erasmus MC approved the study, and the requirement for informed consent was waived.

Erasmus MC-Sophia Children's Hospital is an urban university hospital in the city of Rotterdam, the Netherlands. The pediatric ED serves the inner-city population but also holds a regional function for patients with significant comorbidity. Approximately 7000 children are seen yearly. Major trauma cases are diverted to the adult Erasmus MC ED. The pediatric ICU is a tertiary medical and surgical unit with approximately 1500 planned and unplanned admissions yearly. In addition to the patients who are admitted from the Erasmus ED, the ICU receives a large proportion of its patients from regional hospitals.

We included all consecutive ED visits of children younger than the age of 16 years at the Erasmus MC-Sophia Children's Hospital between January 1, 2006, and December 31, 2012. We excluded patients with a tracheal cannula or home care ventilation because these patients cannot be admitted to the general wards of the hospital for logistic reasons and therefore may have other reasons for admission to the ICU than severity of illness.

Admission to the ICU was defined as admission to the ICU immediately after a visit to the ED. Children who were admitted to the ICU after first being admitted to the general ward, for example, due to clinical deterioration, were not classified as ICU admissions in the study. Indications for admission to the ICU conform to national standards and include acute or threatening failure of 2 or more organ systems; requirement of advanced respiratory support, expected to last >24 hours or in a child younger than 1 year of age; or need for intensive monitoring because of the acute or threatening failure of 1 or more organ systems.[11] Comorbidity alone is no indication for admission to our ICU.

Triage at the Erasmus MC-Sophia Children's Hospital was performed by ED nurses trained in the MTS. A computerized version of the official Dutch translation of the MTS was used, with validated modifications for febrile children implemented from April 2007 onwards.[10,12] Nurses routinely recorded data of all ED visits on structured electronic forms, during or shortly after the ED visit. These forms contain items regarding patient characteristics, vital signs, working diagnosis, and follow-up.

Data on admission to the ICU, including length of stay, mortality, and severity-of-illness scores, were retrieved from electronic medical ICU records. These data were collected routinely as part of the pediatric intensive care evaluation, a national pediatric ICU registry for benchmarking and research purposes.[13] We quantified severity of illness with the Pediatric Risk of Mortality Score (PRISM) 3, for which the greater scores indicate greater risk of mortality (maximum score 74) and the Pediatric Index of Mortality (PIM) 2, for which the score (percentage) indicates the predicted death rate.[14,15]

To assess comorbidity, one investigator reviewed all undertriaged (low-urgent, ICU-admitted) patients and a random sample of correctly triaged low-urgent non-ICU-admitted patients and recorded all underlying chronic conditions based on the written information available in the patients' medical records, blinded to information on MTS urgency classification. Chronic diseases were classified according to the Pediatric Medical Complexity Algorithm into complex chronic disease, noncomplex chronic disease, and no chronic disease.[16] Children are defined as having a complex chronic condition if 2 or more body systems are affected, if they suffer from a progressive condition or a malignancy, or if they are continuously dependent on technological support.

Data Analyses

Because we had little missing information on triage classification or outcome (5%), we used a complete case analysis. Demographic and clinical characteristics of included patients were presented as proportions or medians and IQRs.

We dichotomized MTS urgency categories into high urgent (MTS urgency 1 and 2) and low urgent (MTS urgency 3, 4, and 5). The MTS defines a maximum waiting time before first contact with a physician: 0 and 10 minutes waiting time for urgency levels 1 and 2 and 60, 120, and 240 minutes waiting time for the urgency levels 3, 4, and 5. We set our cut-off between urgency level 2 and 3, because we consider 10 minutes before first contact with a physician a safe time window for patients who require admission to the ICU. MTS urgency 3 has a maximum waiting time of 60 minutes, which can lead to delays in care for critically ill patients. Safety of the MTS was assessed by the percentage of undertriage, defined as the proportion of patients admitted to the ICU who were triaged initially as low urgent. Moreover, we calculated the sensitivity, specificity, predictive values, likelihood ratios, and the diagnostic OR of MTS high-urgency classification for the detection of admission to the ICU.

To evaluate whether undertriaged patients were clinically different from correctly triaged patients admitted to ICU, we compared several measures of severity of illness between these 2 groups: PIM2 and PRISM3 score, length of stay, need of ventilatory support, and mortality. Groups were compared by use of the Pearson χ^2 test for categorical or the Mann-Whitney U test for continuous variables.

To identify risk factors for undertriage, multivariable logistic regression analysis was performed to compare the undertriaged patients with the low-urgent patients who were not admitted to the ICU. Predictor variables were selected on the basis of previous research[9,16] and clinical knowledge. We included all candidate predictor variables in the model, independent of their statistical contribution. Age was converted into an ordinal variable with clinically relevant categories (0-<3 months; 3-<12 months; 1-<4 years; 4-<8 years; 8-<16 years). Comorbidity was only available in a sample of patients and therefore the OR was calculated independently. SPSS version 20.0 (SPSS Inc, Chicago, Illinois) and the VassarStats Web site (www.vassarstats.net) were used for the statistical analysis.