

The Validity of the Pediatric Assessment Triangle as the First Step in the Triage Process in a Pediatric Emergency Department

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Objective: This study aimed to assess the association between pediatric assessment triangle (PAT) findings during triage and markers of severity in a pediatric emergency department (PED).

Methods: During the study period, patients arriving to the PED were classified by trained nurses with the Pediatric Canadian Triage and Acuity Scale using a computer system, from which data were obtained and analyzed retrospectively. The primary outcome measure was the percentage of children hospitalized related with PAT findings. The secondary outcome measures were the admission to the intensive care unit (%), PED length of stay, and performance of blood tests (%).

Results: Among the 302,103 episodes included, there were abnormal PAT findings in 24,120 cases (7.9%). Multivariate analysis adjusted for age confirmed that PAT findings and triage level were independent risk factors for admission (odds ratio [OR], 2.21; 95% confidence interval [CI], 2.13–2.29; OR, 6.01; 95% CI, 5.79–6.24, respectively). Abnormal findings in appearance or in more than 1 PAT component were even more strongly associated with admission (3.99; 95% CI, 3.63–4.38; 14.99, 95% CI, 11.99–18.74, respectively). When adjusted for triage level and age, abnormal PAT findings were also an independent risk factor for intensive care unit admission (OR, 4.44; 95% CI, 3.77–5.24) and a longer stay in the PED (OR, 1.78; 95% CI, 1.72–1.84).

Conclusions: Abnormal findings in the PAT applied by trained nurses at triage identify patients with a higher risk of hospitalization. The PAT seems to be a valid tool for identifying the most severe patients as a first step in the triage process.

Key Words: triage, pediatric assessment triangle, quality

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In emergency departments (EDs), triage is a preliminary clinical assessment process that classifies patients, depending on how urgently they need to be attended and the risk to deteriorate. Several different systems are used for triage in EDs. Among them, those based on 5 triage levels are supported by sound scientific evidence, having all the following pediatric version: the Australasian Triage Scale (ATS), the Emergency Severity Index (ESI), the Canadian Triage and Acuity Scale (CTAS), and the Manchester Triage System (MTS). So far, however, there is a limited level of evidence for all of them, in terms of validity and reliability.^{1,2} To classify patients, these different scales generally consider a combination of the presenting complaint or main problem and different vital signs or triage modifiers.^{3–5} The Paediatric CTAS (PaedCTAS) includes the pediatric assessment triangle (PAT), as the first step to assess the physiologic status of the patients.⁵

The PAT is a rapid and easy-to-apply tool that allows trained health care professionals to identify patients with physiological

deterioration. This suggests that it could be the ideal tool to use in the first stage of triage in a pediatric ED (PED).

The PAT was developed by the American Academy of Pediatrics at the end of the 1990s as a tool for the initial assessment of pediatric patients in a prehospital environment.⁶ Since then, it has been taught to and used by health professionals in various different settings, although there have been very few validation studies. Mierek et al,⁷ in 2010, confirmed that many of the characteristics of the so-called “view from the door” approach used by experienced prehospital providers to make decisions regarding transfers fit in with the PAT and asserted that it is a rapid and efficient tool to classify patients.

Although some authors have analyzed the value of PAT in triage performed in different settings,^{8,9} to date, no studies have assessed the validity of PAT as a triage tool in a PED and related with markers of severity. The objective of this study was to assess the relationship between PAT performed by trained nurses at the point of triage in a hospital PED and a range of markers of severity in patients.

METHODS

Study Design and Setting

This was a single-center retrospective study in which we analyzed a cohort of children attended in 1 PED during a period of 5 years (January 2007 to December 2011), assessing the outcomes of applying PAT and the course of patients (destination tests and performed).

The study was performed in the PED of an urban tertiary university hospital providing care for patients between 0 and 14 years old. The PED team is composed of pediatric emergency physicians and residents in pediatrics and family medicine, and approximately 60,000 episodes are registered per year.

In our PED, we use a 5-level triage system based on the PaedCTAS since 2007, applying it with our own computer software. Patient classification is based on the following:

- The PAT: simple rapid and useful tool recommended by the American Academy of Pediatrics for health professionals to develop their first impression of the appearance of children. It assesses 3 aspects (appearance, work of breathing, and circulation to the skin) describing their physiological status and guiding the initial approach to their care, with no need to examine patients or measure their vital signs.
- Presenting complaint: we identify the main reason for the consultation using a brief interview with relatives or caregivers.
- Triage modifiers:
 - Pain
 - Trauma mechanism
 - Vital signs (respiratory rate, heart rate, and neurological status). Vital signs are only measured systematically at the point of triage in certain cases (in accordance with a protocol) and on an individual basis when it is judged that the information is essential for classifying patients.

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TABLE 1. Performance of Blood Tests, Hospitalization, and LOS Related With Triage Level

Triage Level	Blood Test Performed	Admitted to Hospital	Admitted to the PICU	LOS, Median (Interquartile Range), min
I	108 (65.8)	136 (82.92%)	55 (33.5%)	229.28 (543.97)
II	1,793 (41%)	2246 (51.49%)	143 (3.3%)	138.30 (355.38)
III	14,356 (12.8%)	13,577 (12.13%)	388 (0.3%)	77.13 (104.57)
IV	5,920 (3.37%)	3998 (2.27%)	17 (0.01%)	66.08 (62.32)
V	205 (2%)	373 (3.65%)	0	55.12 (57.04)

With the use of this assessment, patients are classified into 1 of 5 triage levels: I, resuscitation; II, emergent; III, urgent; IV, less urgent; and V, nonurgent. For each level, there is a maximum recommended waiting time until medical assessment.

Patients are received, assessed, and classified by PED nurses who must meet the following requirement to work at the triage setting: 6 months of uninterrupted experience working in PEDs and having received theoretical and practical training in initial pediatric assessment, basic concepts of triage, and the structure of the PaedCTAS. The triage setting has 2 rooms and is managed by 1 trained nurse together with a nursing assistant.

During the study period, all patients received in the PED were classified by trained nurses with the PaedCTAS using the aforementioned computer software. The tool has been updated in line with each revision of the PaedCTAS.

Outcomes, Methods, and Measurements

The primary outcome measure analyzed was the percentage of children hospitalized as a function of the PAT findings made by nurses at the time of triage. We defined hospitalization as patient admission to the PED observation unit or a hospital ward.

Secondary outcomes analyzed in relation to the PAT findings were the percentage of patients admitted to the pediatric intensive care unit (PICU), the length of stay (LOS) in the PED (<3 hours and ≥3 hours), and the percentage of patients from whom blood tests were obtained. Other variables recorded during the triage, specifically age and assigned triage level, were analyzed as markers of severity.

Information on the patients and the episode was obtained from the electronic health records of the PED and the Basque Health Service. Specifically, the following data were collected:

patient sociodemographic and triage data (PAT findings and assigned triage level), their LOS, blood tests performed, and their destination.

The study was approved by the ethics committee of Cruces University Hospital. Given that the data were collected and entered into a database for analysis on an anonymous basis and patients did not undergo any intervention, it was not considered necessary to request their written informed consent.

Statistical Analysis

Continuous variables were expressed as means and SDs or medians and interquartile ranges, depending on the distribution of the variables. Categorical variables were described using frequencies and percentages.

Univariate logistic regression analysis was performed with all the independent variables considered and hospitalization as the outcome measure. All variables with $P < 0.200$ were then included in multivariate logistic regression analysis (using a manual stepwise procedure). This model was run, the variable with the highest P value was eliminated, and the model was run again. The process was repeated until all remaining variables were statistically significant (with $P < 0.05$). This analysis was then performed for the other 3 outcome variables. The statistical analysis was performed using IBM SPSS software (version 19.0).

RESULTS

During the study period, 302,103 episodes were registered in the PED. Triage was completed in less than 10 minutes in 95.5% of cases. More than two thirds (66.7%) of patients were younger than 5 years, the median age was 35.89 months (interquartile range, 15.9–77.3 months).

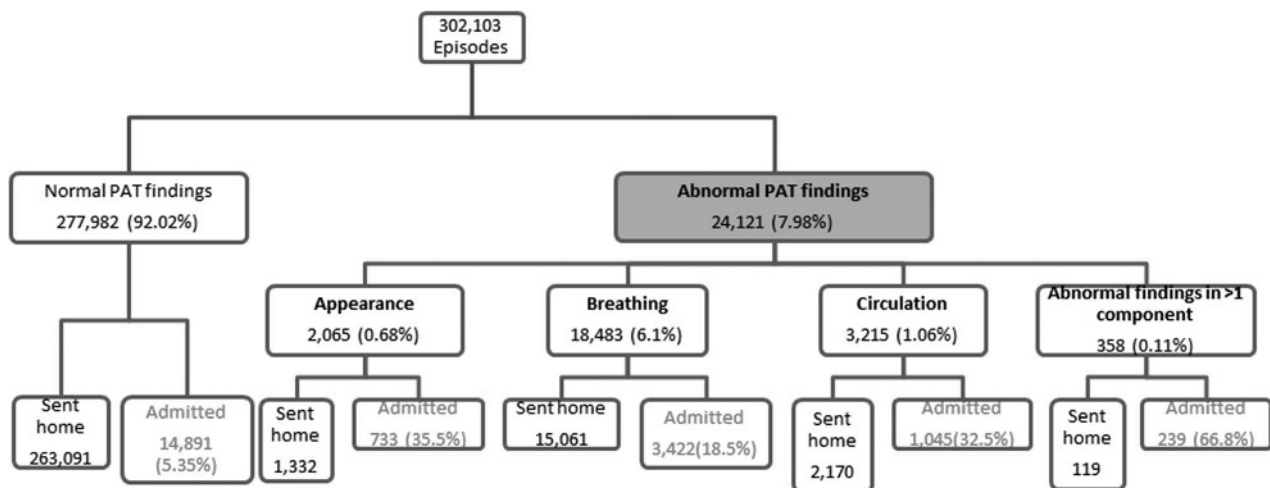
**FIGURE 1.** Destination of patients according to PAT findings on triage.

TABLE 2. Performance of Blood Tests, Hospitalization, and LOS Related With PAT Findings

PAT Findings	Blood Test Performed	Admitted to Hospital	Admitted to the PICU	LOS, Median (Interquartile Range), min
Normal	19,490 (7.01%)	14,891 (5.3%)	288 (0.1%)	66.9 (71.9)
Appearance	736 (35.6%)	733 (35.5%)	47 (2.3%)	142.0 (256.5)
Work of breathing	807 (4.4%)	3422 (18.5%)	129 (0.7%)	96.7 (118.3)
Circulation to the skin	1164 (36.2%)	1045 (32.5%)	68 (2.1%)	127.9 (172.1)
Abnormal findings in >1 component	185 (51.7%)	239 (66.7%)	71 (19.8%)	181.8 (578.1)

At the initial assessment performed on arrival at the PED, PAT findings were considered abnormal in 24,120 cases (7.98%). The component of the triangle most frequently affected was breathing, alone or in combination with other abnormal PAT findings (18,640, 6.17%).

The most common presenting complaints were related to the respiratory system (60,214, 19.93%), infection (52,018, 17.21%), the digestive system (46,586, 15.42%), the musculoskeletal system (36,920, 12.22%), the skin (30,985, 10.25%), and ear-nose-throat complaints (24,331, 8.05%). The overall distribution to triage levels, the fingerprint of our ED, was as follows: level I, 164 (0.05%); level II, 4362 (1.4%); level III, 111,847 (37.0%); level IV, 175,414 (58.1%); and level V, 10,316 (3.4%).

Blood tests were obtained in 22,382 cases (7.40%), and the patient was admitted in 20,330 cases (6.72%). Percentages of patients requiring blood tests or hospitalization as well as the LOSs by triage level can be seen in Table 1. On the other hand, 985 patients left the ED without being assessed by a pediatrician (0.32%).

Only 5.38% of the patients with normal PAT findings on arrival were admitted, compared with 22.5% of those with abnormal PAT findings ($P < 0.001$). The percentage of patients hospitalized varied, depending on the component of the PAT that was altered (appearance, 35.5%; breathing, 18.5%; and circulation to the skin, 32.5%), and when there were abnormal findings related to more than 1 of these 3 components, the percentage of hospitalization was 66.8%, the differences being statistically significant ($P < 0.001$) (Fig 1).

Table 2 shows the performance of blood tests, hospitalization, and LOS related with PAT findings.

In relation to the primary outcome measure analyzed in the univariate analysis, the presence of abnormal PAT findings at triage was associated with a higher probability of hospitalization (odds ratio [OR], 5.14; 95% CI, 4.97–5.32; $P < 0.01$). Analyzing each component of the PAT, an abnormal finding in any 1 component was associated with a greater probability of hospitalization, but this association was stronger in the cases of appearance and circulation to the skin (OR, 7.87; 95% CI, 7.18–8.62; $P < 0.01$; OR, 6.98; 95% CI, 6.47–7.52; $P < 0.01$, respectively) than for work of breathing (OR, 3.58; 95% CI, 3.44–3.73; $P < 0.01$). The OR for hospitalization when abnormal findings were found in more than 1 of the PAT components was 28.15 (95% CI, 22.58–35.09; $P < 0.01$). A triage level of between I and III was also associated with a greater probability of hospitalization (OR, 6.59; 95% CI, 6.37–6.82; $P < 0.01$).

In the multivariate analysis, abnormal PAT findings and more urgent triage level (I–III) were confirmed to be independent risk factors for hospitalization, after adjustment for age (≥ 5 years) (OR, 2.21; 95% CI, 2.13–2.29; $P < 0.01$) (triage level I–III: OR, 6.01; 95% CI, 5.79–6.24; $P < 0.01$). In the multivariate analysis of the different components of the PAT, all 3 components were confirmed to be independent risk factors for hospitalization, after adjusting for triage level (Table 3).

Regarding secondary outcome measures, abnormal PAT findings, mainly appearance, and combinations of more than 1 component were associated with longer stays in the PED (OR for abnormal PAT, 3.29; 95% CI, 3.19–3.39; OR for abnormal appearance, 5.28; 95% CI, 4.83–5.77; and OR for more than 1 abnormal component, 7.79; 95% CI, 6.33–9.59) and greater probability of admission to the PICU (OR for abnormal PAT, 12.75; 95% CI, 10.86–14.97; OR for abnormal appearance, 12.54; 95% CI, 9.28–16.95; and OR for more than one abnormal component, 140.06; 95% CI, 106.56–184.10).

The multivariate analysis confirmed that the presence of abnormal PAT findings was an independent risk factor for PICU admission and for a longer stay in the ED, after adjusting for age and triage level (Table 4). In contrast, laboratory tests were more commonly performed in the group with normal PAT findings.

DISCUSSION

The PAT is a useful tool for identifying severe cases at the time of triage when performed by trained nurses in a PED. Patients with abnormal PAT findings on admission were more likely to be hospitalized and stay longer in the PED.

The PAT was developed as a tool for identifying the physiological status of children and guiding the initial approach to their care. Initially designed for use in a prehospital setting, it has subsequently begun to be used in hospitals, at different stages of clinical assessment and by various types of health professionals.⁶ That it can be applied easily and quickly, stratifying stable and unstable patients to different care pathways, makes this a potentially ideal tool to guide triage decisions.

Horeczko et al⁸ demonstrated for the first time that a structured assessment based on PAT performed by nurses during patient triage does rapidly and reliably identify clinically urgent pediatric patients and their pathophysiological status. However, in this study, the sample was quite small, and the PAT performed at triage was validated with the PAT performed by the physicians, and not with surrogate markers of severity. Our study analyzes the

TABLE 3. Multivariate Logistic Regression Analysis for Abnormal Findings in Each Component of the PAT With Hospitalization as the Main Outcome

Variable	Multivariate OR (95% CI)	P
Appearance	3.99 (3.63–4.38)	<0.01
Work of breathing	1.78 (1.71–1.86)	<0.001
Circulation to the skin	3.27 (3.02–3.54)	<0.001
Abnormal findings in >1 component	14.99 (11.99–18.74)	<0.001
Triage level I–III	5.94 (5.72–6.17)	<0.001
Age ≥ 5 years	1.51 (1.46–1.56)	<0.001

TABLE 4. Multivariate Logistic Regression Analysis for Secondary Outcome Measures

Variable	Admission to the PICU	LOS	Blood Tests
	Multivariate OR (95% CI)	Multivariate OR (95% CI)	Multivariate OR (95% CI)
Abnormal PAT findings	4.44 (3.77–5.24) $P < 0.001$	1.78 (1.72–1.84) $P < 0.001$	0.76 (0.73–0.80) $P < 0.001$
Triage level I–III	34.85 (21.29–57.04) $P < 0.001$	3.10 (3.02–3.18) $P < 0.001$	5.67 (5.48–5.86) $P < 0.001$
Age ≥ 5 years	1.52 (1.27–1.82) $P < 0.001$	1.54 (1.50–1.58) $P < 0.001$	1.65 (1.60–1.70) $P < 0.001$

value of the PAT related directly with different surrogates of severity in a large sample in a clinical setting during several years. This discriminatory power of the PAT makes it possible to rapidly initiate efforts to stabilize severe cases. Our study provides a new perspective on the ability of PAT to select patients: this tool helps to identify not only patients with more urgent needs but also those who, after complete diagnosis and treatment, have more serious health problems and are eventually admitted to the hospital. This fact could lead to changes in diagnostic and treatment processes aiming to optimize admission decisions.

To date, various studies have been performed to assess the validity of the PaedCTAS, suggesting that it is a valuable tool for classifying pediatric patients.^{10,11} Previous studies to validate PaedCTAS have assessed the association between the final outcome of the process (triage level) and markers of severity. However, little attention has been paid to the individual weight of each of the components of the assessment process (PAT, presenting complaint, and vital signs). In this context, an interesting and original characteristic of our study was the analysis of PAT separately, one of the elements of the triage process performed in the PaedCTAS, it being confirmed to be an independent risk factor for hospitalization.

In addition, the use of vital signs to establish the triage level in pediatric patients has been questioned.^{12,13} There are various practical limitations on the taking of vital signs of pediatric patients in general and especially on arrival to a PED (fear and moodiness, among others), particularly at times of high demand for care, and these factors may decrease the quality of the information reported. In such cases, PAT can be used as tool for prioritizing patients within the same triage level, regardless of age and the taking of vital signs. This is a very important issue for determining patient flow within the ED, especially during overcrowding situations.

The usefulness of PAT during triage seems strong, but it should be underlined that with PAT, no objective measures are used (vital signs, age, etc), so this is a tool that is highly dependent on the observer. To decrease variability in the results of triage tools, such as the PAT, it is essential to maintain skills, through continuous professional training. Another factor that increases consistency is the use of computer systems to support health professionals through the various steps in the process of triage.^{14–16}

Not surprisingly, laboratory tests were more commonly practiced in the group of patients with normal PAT findings. The largest group of patients included in the altered PAT group has altered only the breathing, and in this group, it is more unusual to practice blood tests or get a venous access. These patients being excluded, the performance of laboratory tests is higher in altered PAT patients.

This study has several limitations. It is a retrospective study performed in a single center. In this way, some patients, those more critical, may have been attended before the triage is registered, and in these, the value of the data registered may be limited. However, we are confident that the data analyzed are of very high

quality, given that they were obtained through a computer system in which all the variables analyzed were recorded at the time of patient triage, rather than by review and assessment of individual medical records. In addition, the large sample size increases the likelihood that the results of our study are applicable to other health care settings. Moreover, being a retrospective study, it avoids the Hawthorne effect. Finally, another potential limitation on the applicability of the results of this study is the fact that the distribution of severity in our population, its fingerprint, differs from that of most studies performed in tertiary hospitals, other researchers finding higher percentages of children classified in triage levels I and II. This may be explained by the fact that patients with minor problems have easy access to hospital EDs in our health system, increasing the percentage of cases classified as low severity. However, we believe that this distinctive feature is not likely to interfere with the results concerning the PAT.

To conclude, the association between the PAT findings and several markers of severity suggest that PAT is a valid tool as the first step in the triage process performed by nurses in the PED.

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