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Pediatric Appendicitis Score (PAS)

The pediatric appendicitis score predicts the likelihood of a diagnosis of appendicitis in pediatric patients with abdominal pain.

Points & Pearls

- The pediatric appendicitis score (PAS) predicts the likelihood of appendicitis in patients aged 3 to 18 years who present with abdominal pain with a duration of ≤ 4 days.
- The PAS stratifies patients as low risk, high risk, or equivocal for appendicitis.
- The score includes findings from the history, physical examination, and laboratory testing.
- The PAS should not be used in patients who have known gastrointestinal disease, are pregnant, or have had abdominal surgery previously.

Advice

Patients who are identified as not low risk (eg, equivocal or high risk) for appendicitis by the PAS should receive nothing by mouth, and the next steps should include administration of intravenous fluids and analgesia, ordering imaging, and/or surgical consultation.

Critical Action

Patients in the low risk group according to the PAS do not have *no* risk for appendicitis. Emergency clinicians should use clinical discretion to determine if imaging or surgical consultation would help with diagnosis for these patients.

Evidence Appraisal

The PAS was developed in 2002 by Dr. Madan Samuel in a prospective cohort study of 1170 patients

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aged 4 to 15 years who presented with abdominal pain. Clinical history, physical examination, and laboratory data for these patients were analyzed to identify 8 variables that showed statistical significance for acute appendicitis. A 10-point scoring system was created using these variables.

The PAS has been validated in multiple prospective studies. Bhatt et al (2009) studied 246 children aged 4 to 18 years and found a sensitivity of 97.6%, with a negative predictive value of 97.7%, at a cutoff PAS of ≤ 4 points. When a PAS of ≥ 8 points was used to determine that appendectomy was needed, the specificity was 95.1% and the positive predictive value was 85.2%. In this cohort, 41% of computed tomography scans would have been avoided using the PAS. Goldman et al (2008) evaluated the PAS in 849 children aged 1 to 17 years; the area under the receiver operating characteristic curve was 0.95, although the study used more conservative cutoffs of ≤ 2 points and ≥ 7 points.

Schneider et al (2007) evaluated both the PAS and the Alvarado score and found that they had similar sensitivity and specificity, but concluded that neither score was sufficient to be relied on as the only method to determine whether appendectomy is needed. Shah et al (2016) developed a diagnostic algorithm and used it prospectively in 840 patients, 267 of whom were ultimately diagnosed with appendicitis. The algorithm was found to have a sensitivity of 98.6% and specificity of 94.4%, with a decrease in utilization of computed tomography from 75.4% to 24.2%.

Use the Calculator Now

[Click here to access the PAS on MDCalc.](#)

Calculator Creator

Madan Samuel, MD

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Why to Use

The PAS has been validated in multicenter studies and may be as good as clinician gestalt at identifying patients who are at low risk for appendicitis versus patients with appendicitis.

When to Use

Use the PAS for children and adolescents who present with acute abdominal pain in whom appendicitis is suspected, especially if the pain is localized to the right lower quadrant.

Next Steps

Low Risk PAS (< 4 points)

- Patients with low-risk PAS scores have a low likelihood of acute appendicitis. Imaging is usually not warranted in these patients.
- There is a higher negative predictive value (95%) with the absence of right lower quadrant pain, the absence of pain with walking, jumping, or coughing, and an ANC of < 6750 cells/mcL.
- Other causes of acute abdominal pain should be considered in patients with low-risk scores.

Equivocal PAS (4-6 points)

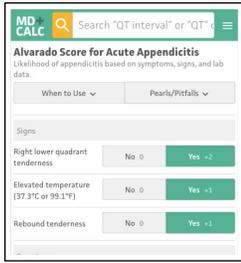
- Imaging can be helpful in this group of patients. Ultrasound or MRI are preferred for pediatric patients.
- Surgical consultation is warranted for patients with equivocal scores.

High Risk PAS (≥ 7 points)

- Surgical consultation is warranted for patients with high-risk scores.
- Imaging may be pursued for this group of patients, but patients should undergo only ultrasound prior to a surgical consultation.

Abbreviations: ANC, absolute neutrophil count; MRI, magnetic resonance imaging; PAS, pediatric appendicitis score.

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Alvarado Score for Acute Appendicitis

The Alvarado score for acute appendicitis predicts the likelihood of a diagnosis of appendicitis.

Points & Pearls

- The Alvarado score is more accurate at the extremes than for equivocal scores, so it is unclear whether the score is better than clinical gestalt.
- Symptoms of appendicitis may overlap with other diseases (ie, higher scores can be found in patients with nonappendiceal inflammatory conditions, such as diverticulitis or acute pelvic inflammatory disease). Therefore, it is important to consider the whole clinical picture in making the diagnosis of appendicitis.
- There are several modifications of the Alvarado score in use; these modifications may be appropriate in specific settings, such as for children, pregnant patients, or in low-resource facilities with limited or no laboratory testing capability, but the original score remains the best studied and validated in a general population.

Critical Actions

Clinicians should use clinical judgment in nonclassic presentations of appendicitis.

Evidence Appraisal

The Alvarado score was initially described in 1986 by Dr. Alfredo Alvarado in a retrospective study at a single center in Philadelphia. For 305 patients aged 4 to 80 years, 8 predictive factors were identified to stratify the risk of acute appendicitis. Increasing scores were found to correlate with increasing risk for appendicitis, as determined by final surgical pathology.

In 2007, McKay et al studied a retrospective cohort of 150 patients (aged ≥ 7 years) presenting with abdominal pain, with the aim of stratifying risk specifically for the use of computed tomography

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Why to Use

Acute appendicitis is a common surgical emergency in the United States. Diagnostic accuracy for appendicitis is increased with the use of CT scanning; however, there are risks and disadvantages associated with CT scans, including radiation exposure, contrast-related complications, and cost. The Alvarado score is a well-established and widely used clinical decision tool that may help reduce the need for CT scans when diagnosing appendicitis.

When to Use

The Alvarado score can be used for patients with suspected acute appendicitis (typically, patients presenting with right lower quadrant pain).

Next Steps

- Cutoffs differ by study, but one validated stratification assigns the highest risk to Alvarado scores ≥ 9 in men and a score of 10 in women; the lowest-risk scores were ≤ 1 in men and ≤ 2 in women (Coleman 2018).
- In patients whose score indicates high risk, treatment without obtaining CT imaging should be considered. Alternative diagnoses should be considered in patients whose score indicates low risk. In patients with equivocal scores, CT scanning should be considered to help clarify the diagnosis.

Abbreviation: CT, computed tomography.

(CT) scanning for diagnosis. They found 35.6% sensitivity for appendicitis based on equivocal Alvarado scores (defined as scores of 4-6) compared with 90.4% sensitivity based on CT scan in this group. They concluded that patients with equivocal scores would benefit from CT scanning.

Similarly, Coleman et al (2018) conducted a retrospective review in which the Alvarado score was applied to a cohort of 492 patients (median age, 33 years), and found that 20% of the patients

were in either the high-risk group (defined as scores ≥ 9 in men or a score of 10 in women) or the low-risk group (scores ≤ 1 in men and ≤ 2 in women). These patients spent a cumulative total of > 170 hours awaiting CT scanning that was ultimately unnecessary. The authors found that scores of 0 or 1 had 0% incidence of acute appendicitis and that 100% of men with a score ≥ 9 and 100% of women with a score of 10 had acute appendicitis confirmed on surgical pathology.

Pogorelić et al (2015) prospectively studied 311 pediatric patients and applied both the Alvarado score and the pediatric appendicitis score (Samuel 2002). Receiver operating characteristic analysis showed similar accuracy between the scores, with area under the receiver operating characteristics of 0.74 (95% confidence interval, 0.66-0.82) for the Alvarado score and 0.73 (95% confidence interval, 0.65-0.81) for the pediatric appendicitis score. The authors concluded that the scores may be useful in emergency settings, but neither score is superior to the clinical gestalt of a pediatric surgeon.

Use the Calculator Now

[Click here to access the Alvarado score on MDCalc.](#)

Calculator Creator

Alfredo Alvarado, MD

[Click here to read more about Dr. Alvarado.](#)

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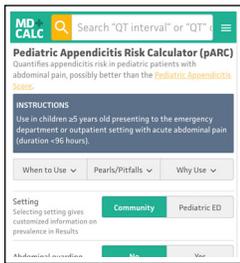
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Pediatric Appendicitis Risk Calculator (pARC)

The pediatric appendicitis risk calculator quantifies appendicitis risk in pediatric patients with abdominal pain, possibly better than the pediatric appendicitis score.

Points & Pearls

- The patients in the pediatric appendicitis risk calculator (pARC) study were aged 5 to 18 years. Appendicitis is relatively rare in children aged < 5 years and when it does occur in that age group, it is more likely to present with atypical features not captured by the pARC.
- Cases of appendicitis among patients in the lowest-risk groups (< 5% or 5%-14% risk as determined by the pARC) were missed only 0.4% of the time in each group. The sensitivity of the pARC was 100% in patients with < 5% risk of appendicitis; the sensitivity was 97.2% in patients determined to have a 5% to 14% risk.
- The specificity of the pARC was 99.7% for patients determined to be at highest risk of appendicitis (> 85% risk) and the specificity was 97.5% for patients in the high-intermediate risk group (75%-84%).

Critical Actions

Critically ill patients or patients with emergent “surgical abdomens” (rigidity, visible ecchymosis or hematoma, etc) should not be considered for delayed surgical consultation or imaging. These patients will likely benefit from early consultation with pediatric surgeons and from imaging, if they are able to be transported to radiology.

Evidence Appraisal

The pARC formula was derived from a dataset of 2423 patients with an interquartile age range of 8 to 14 years. Candidate predictors with > 10% missing data were not included. Patients with certain comorbid conditions were also excluded (Kharbanda 2018).

While absolute neutrophil count (ANC) was used in the pARC formula, ANC values were missing for

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Why to Use

The pARC may help determine the need for advanced imaging such as formal ultrasound or CT scan. It can identify low-risk patients who can be observed in the ED or discharged from the ED with follow-up or return precautions. In a validation study, the pARC formula performed better than the PAS by placing fewer patients into equivocal risk categories, making the pARC potentially more useful than the PAS for aiding clinical decision-making.

When to Use

Use the pARC in children aged ≥ 5 years who present to the ED or outpatient setting with acute abdominal pain with a duration < 96 hours. Patients with the following conditions were excluded from the pARC study:

- Pregnancy
- Previous abdominal surgery
- Inflammatory bowel disease
- Chronic pancreatitis
- Sickle cell anemia
- Cystic fibrosis
- Any medical condition affecting the ability to obtain an accurate history
- History of abdominal trauma within the previous 7 days

Next Steps

Patients determined by the pARC to be at low risk for appendicitis can be considered candidates for safe discharge or observation in the ED without advanced imaging such as ultrasound or CT scan, based on the discretion of the emergency clinician and the comfort level of the patient’s family.

Given the specificity of the pARC, patients who are classified as high or high-intermediate risk for appendicitis may not need advanced imaging. In the high-risk group, 1.2% of appendectomy specimens were negative for appendicitis on pathology analysis and in the high-intermediate risk group, 2.6% of the specimens were negative.

Abbreviations: CT, computed tomography; ED, emergency department; pARC, pediatric appendicitis risk calculator; PAS, pediatric appendicitis score.

216 (9%) of the patients in the derivation data set. For patients missing the ANC value, it was imputed as $ANC = (-0.8783 + 1.1008 \times \sqrt{WBC})^2$. For patients missing both ANC and white blood cell count values, the ANC value was imputed as $7 \times 10^3/\text{mL}$, which was the mean ANC value in the derivation cohort. The proportion of missing values was less than the 10% cutoff point chosen by the study authors; however, imputation of missing values has the potential to introduce bias into the equation.

An independent validation study was conducted at different centers and demonstrated the ability of the pARC to outperform the pediatric appendicitis score (Cotton 2019). This study demonstrated a superior area under the receiver operating characteristic curve with nonoverlapping 95% confidence intervals as compared to the pediatric appendicitis score.

Use the Calculator Now

[Click here to access the pARC rule on MDCalc.](#)

Calculator Creator

[Click here to read more about Dr. Kharbanda.](#)

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