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Predictors of Perforated Appendix among Children

Kamlesh Kumar Jha*, Shilpa Singh, Shruti Trehan, Gregory E Gilbert, Aisha Mohammed, Moon Hee Hur, Joseph Uricchio, Shama Shirazi, Pragya Jha and Romeen Lavani

Department of Pediatrics, Saint Anthony Hospital, USA

***Corresponding author:** Kamlesh Kumar Jha, Department of Pediatrics, Division of Neonatology, Saint Anthony Hospital, 2875 W 19th Street, Chicago, Illinois 60623, USA, Tel: 3128509256; E-mail: drjha02@gmail.com

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Abstract

Objective: This study explores whether nominal demographics, symptoms, signs and laboratory predictors can determine a perforated appendix in pediatric population at an urban community hospital.

Methods: A retrospective analysis was performed including variables such as demographics, clinical signs, symptoms and laboratory predictors. The patient population consisted of all children between the ages of 0 and 18 years who were treated for acute appendicitis between January 2014-December 2014. Patients with perforated appendicitis were identified using coding data.

Results: During the 1-year period, 74 patients were treated for appendicitis. Using correlation and logistic regression, nineteen variables were assessed for any relationship to a ruptured appendix in these patients. No substantial correlations were detected.

Conclusions: There have been reports of racial and socioeconomic disparities with regards to perforated appendicitis in children. However, there is not enough evidence in the literature that supports the prediction of perforated appendix based on clinical and laboratory values. This study, at Saint Anthony Hospital, found no correlation between socioeconomic status, clinical presentation, laboratory values and ruptured appendix.

Keywords: Acute abdomen; Abdominal emergency; Markers

Introduction

A common reason for emergency department visits is an acute abdominal pain, which is defined as severe pain that requires immediate attention [1]. A most commonly performed surgical procedure in children is an appendectomy.

Appendicitis is not a preventable disease, and its treatment is time sensitive. Making a diagnosis is hard because of overlapping of symptoms with other conditions and atypical clinical presentation [2]. A higher rate of appendix perforation has been noted in children compared to adults [3]. Up to 35% of patients with acute appendicitis have a perforation of the appendix before surgical intervention [4]. Despite being so common, the markers for acute vs. perforated appendicitis remain debatable. In a suspected appendicitis case, white blood cell counts and CRP levels are commonly checked. White blood cell count is used as an early indication of appendiceal inflammation, but it does not help distinguish between acute vs. perforated appendix. However, CRP levels have been noted to show a significant increase in case of appendix perforation or abscess formation. A diagnosis is always made with a combination of physical exam, image findings and clinical history [3]. The treatment plan is significantly affected by the preoperative diagnosis of acute vs. perforated appendicitis. Urgent appendectomy is the treatment of choice for acute appendicitis. Intravenous antibiotics for a certain amount of time after interval appendectomy are the treatment of choice for complicated perforated appendicitis [3]. A rise in mortality, morbidity, and economic cost ratio is correlated to the amount of time a patient remains untreated.

Materials and Methods

A retrospective chart audit was performed on all patients, after obtaining a waiver of consent, diagnosed with acute appendicitis and treated at Saint Anthony Hospital between January 2014-December 2014. Statistical significance of $P<0.05$ was assigned to this study.

Study design

The study was reviewed and approved by the Institutional Review Board with a waiver of consent. A retrospective chart audit was performed on all patients diagnosed and treated with acute appendicitis at Saint Anthony Hospital from January 2014-December 2014. Statistical significance was assigned at $P<0.05$. Demographic data included age, weight, insurance, season during the time of visit and gender. Symptom variables included fever, vomiting, diarrhea, dysuria, cough, constipation and pain migration. Clinical data included a presence of right lower quadrant tenderness, rebound tenderness, Rovsing sign, Psoas sign and Obturator sign. Laboratory value variables included WBC count, PMN count, and ANC.

Statistical analysis

Biserial and Craver's V correlations were calculated between variables of interest and a ruptured appendix (1=yes/0=no) for this pediatric population. Significance testing was not done for correlations because correlations are notoriously sensitive to sample size resulting in meaningless significant results (e.g. a correlation of 0.05 being significant. Such a correlation would explain less than 0.5% of the variation in the dependent variable). For variables having more than

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one category reference categories were chosen based on greatest frequency or logical selection (For example, for age it made more sense to choose age greater than 15-year-old age as the reference group than the 10 to 15 age group even though there were more 10 to 15-year-olds than age more than 15). Unadjusted odds ratios were calculated using logistic regression for each variable. Where more than one category existed for a variable, a range of odds ratios is presented. An experiment-wise a priori alpha level of 0.05 was established for significance testing and Bonferroni correction [5] applied to control for multiple comparisons yielding an a priori comparison wise error rate of 0.05/19=0.0026. Had this correction not been applied and a comparison-wise alpha level of 0.05 been used the experiment-wise error rate would have been inflated to 1-(1-) c; where the comparison-wise error rate and c=the number of comparisons; =1-(1-.05) 19=1-0.9519=0.6226.

Results

Using correlation and logistic regression, nineteen variables were observed for a relationship to a perforated appendix (Tables 1-4). No significant correlations were detected in this study. Rebound tenderness, and the perforated appendix has the highest correlation; (0.33). This can be interpreted as in explaining/predicting a ruptured appendix rebound tenderness explains approximately 11% of the variation. There were only three patients without insurance explaining the hugely inflated odds ratio for that group (>4.8 M). There was good triangulation in terms of results. No association was found using correlational procedures and these results were confirmed using logistic regression methodology.

Variable	Reference	Correlation	Odds Ratio	P value
Age	>15	-0.06[c]	1.0-1.8[d]	0.8638[e]
Weight	Normal	0.13[f]	0.5-1.1[g]	0.5853[e]
Insurance	PA	0.17[f]	0.6 & 4, 815, 803[h]	0.3875[e]
Season	Spring	0.15[f]	0.5-.7[i]	0.8953[e]
Female	Male	0.20[f]	2.7	0.0904[j]

[c]: Rank biserial correlation appropriate for ranked data and nominal data;

[d]: Age categories: age 0-5, age >5 to 10, and age >10 to 15;

[e]: Likelihood ratio test against the null model;

[f]: Cramer's V correlation appropriate for two nominal variables;

[g]: Weight categories: overweight and obese;

[h]: Insurance categories: private insurance and no insurance. Unstable estimate due to only three observations with no insurance;

[i]: Season categories: Summer, Fall, and Winter;

[j]: P value from z-test for significance of variable in the model.

Table 1: Demographic variable, reference group correlation, odds ratio, and p value for significance in predicting a ruptured appendix in a pediatric population.

Variable	Reference	Correlation	Odds Ratio	P value
Fever	Absence	0.19[f]	0.4	0.1120[j]
Vomiting	Absence	0.17[f]	0.4	0.1436[j]
Diarrhea	Absence	0.26[f]	0.2	0.0393[j]
Dysuria	Absence	0.13[f]	0.4	0.2850[j]
Cough	Absence	0.04[f]	1.4	0.7645[j]
Constipation	Absence	0.03[f]	1.2	0.8005[j]
Pain Migration	Absence	0.07[f]	0.7	0.5559[j]

[f]: Cramer's V correlation appropriate for two nominal variables;

[j]: P value from z-test for significance of variable in the model.

Table 2: Symptom variable, reference group correlation, odds ratio and p value for significance in predicting a ruptured appendix in a pediatric population.

Variable	Reference	Correlation	Odds Ratio[a]	P value[b]
Tenderness RLQ	Absence	0.004[f]	1.0	0.9750[j]
Rebound-Tenderness	Absence	0.33[f]	0.2	0.0070[j]
Rovsing Sign	Absence	0.12[f]	0.7	0.3528[j]
Psoas Sign	Absence	0.08[f]	0.6	0.5094[j]
Obturator Sign	Absence	0.08[f]	0.6	0.5094[j]

[a]: Odds ratio for a range of variables comprising construct;

[b]: Alpha level for significance corrected for multiple comparisons using Bonferroni correction [5] Comparison wise Error Rate (αc)=[Experiment wise Error Rate (αe)/ Number of Comparisons]=[0.05/19]=.0026;

[f]: Cramer's V correlation appropriate for two nominal variables;

[j]: P value from z-test for significance of variable in the model.

Table 3: Clinical signs variable, reference group correlation, odds ratio and p value for significance in predicting a ruptured appendix in a pediatric population.

Variable	Reference	Correlation	Odds Ratio	P value[b]
WBC	6K-7.5K	-0.10[c]	1.0 to 4.3[e7]	0.0727[e]
Poly	<50%	-0.21[c]	0 to 1.0	0.6220[e]
ANC	1501-4999	-0.06[c]	0.0	0.3875[e]

b: Alpha level for significance corrected for multiple comparisons using Bonferroni correction [5] Comparison wise Error Rate (αc)=[Experimentwise Error Rate (αe)/ Number of Comparisons]=[0.05/19]=.0026;

c: Rank biserial correlation appropriate for ranked data and nominal data;

e: Likelihood ratio test against the null model.

Table 4: Laboratory values variable, reference group correlation, odds ratio, and p value for significance in predicting a ruptured appendix in a pediatric population.

Discussion

With this analysis of ED visits and direct admission of children diagnosed as having appendicitis, no correlation was found between the socioeconomic status, the clinical presentation, the laboratory values and ruptured appendix. Similar to the Guagliardo et al. [6], we found no evidence of an increase in appendiceal rupture with Hispanic patients who had Public Aid as their primary insurance (Correlation: 0.13; Odds Ratio: 0.5-1.1g; P value: 0.5853e). However, studies by Jablonski and Guagliardo [7] and Levas et al. [8] indicate that there exists such an association which can be attributed to limited English proficiency, Hispanic ethnicity, lacking private insurance, referred from somewhere other than the ED, discharged from a teaching hospital, from poorer ZIP codes and discharged from a high-volume hospital. As suggested in a study Levas et al. [8], equal access to care is the key to preventing any disparities in pediatric appendicitis outcome [9].

Conclusion

In conclusion, appendectomy remains one of the most commonly performed surgical procedures in children today. Identifying variables that can predict ruptured appendix remains crucial to ensure that the patient receives optimal care promptly. Many large databases, multicenter reviews have shown disparities in acute appendicitis and ruptured appendix based on variables such as ethnicity and socioeconomic status [6,7]. We attempted to study these variables, in addition to many others, in cases of appendicitis found in an urban community hospital setting. Our study did not show any correlation between race, ethnicity, socioeconomic status, clinical presentation, lab values and ruptured appendix. It is usually one or more of the following factors that can lead to an increased chance of ruptured appendix: not seeking medical attention on time, young age and delayed treatment when the patient does reach a facility on time. Weaknesses of this study are: retrospective study and small sample size.

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