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The influence of sodium and leukocyte levels as predictor factors in pediatric perforated appendicitis at bhayangkara tk. i pusdokkes police hospital

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ABSTRACT

Acute appendicitis is an inflammation of the appendix, the part of the small intestine located in the lower right side of the abdomen. This is a severe medical condition that usually requires surgery emergency. The main symptoms of acute appendicitis include abdominal pain radiating to the lower right side, fever, and nausea. This study aims to determine the role of sodium and leukocytes as predictors of perforated appendicitis in children at Bhayangkara Tk. I Pusdokkes Police Hospital. This concept is expected to help the readers understand how sodium level and leukocyte count can predict the likelihood of children's perforated appendicitis. This study is important for improving the diagnosis and treatment of children with perforated appendicitis. The study's results through a total sample of 52 participants showed significant differences in sodium and leukocyte levels in patients with a diagnosis of perforated appendicitis and appendicitis without perforation. This was proven by the results of testing using the Mann-Whitney differential test, which obtained a significance value for Na levels of 0.049 and leukocyte levels of 0.000. These values were smaller than the p-value of 0.05. The accuracy of the diagnosis of leukocyte levels is shown through two AUC values (Area Under the Curve) of 0.747 or 74.7%. This value is greater than 70% and indicates very good accuracy. Meanwhile, the AUC value for sodium levels is only 0.229 or 22.9%, so it is considered less accurate. The Cut Off value for Na levels was 132.50 mEq/liter, while leukocytes were 13.715/microliter of blood.

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INTRODUCTION

Acute appendicitis is inflammation of the appendix, as a part of the small intestine located in the lower right part of the abdomen. It is a serious medical condition that usually requires emergency surgery (Borchardt, 2013). Acute appendicitis is more common at ages between 10 and 30, but can occur in anyone from infants to the elderly (McLauthlin & Packard, 2017). In children, acute appendicitis is one of the most common medical conditions that require surgery (Simpson & Scholefield, 2013). Pre-school children are rarely diagnosed with acute appendicitis, while cases of

perforated appendicitis are more common and have a significant effect on postoperative outcomes (McLauthlin & Packard, 2017). Increased rates of complications, such as abscesses or inflammation of the abdomen/pelvis, intestinal obstruction, and wound infections, up to 39% can occur after perforated appendicitis surgery (McLauthlin & Packard, 2017).

One study that gives the percentage of acute appendicitis patients who experience perforation is "Appendicitis: Diagnosis and Management" by (Lui, *et al,*. 2021) in the British Journal of Hospital Medicine. It was found that about 25% of acute appendicitis patients experienced perforation. Another study had been conducted in Indonesian hospitals and revealed perforation rates in acute appendicitis patients. Such the study conducted by (Lesmana *et al.*, 2020) at Hasan Sadikin Hospital Bandung which found that 58.5% of acute appendicitis patients experienced perforation. Complete appendicitis showed a positive correlation with several risk factors, such as older age, age under five years, medical history that includes inflammatory bowel disease, and too long to seek medical care. In addition, the conditions, such as obesity and a weakened immune system can also increase the risk of complication appendicitis. However, keep in mind that these are only risk factors and do not guarantee that any patient with such risk factors will develop complication appendicitis (Shimoda et al., 2018; Vaos et al., 2019).

The diagnosis of acute appendicitis in children is indeed different rather than in adults. Some of the things that distinguish include symptoms, physical tests, diagnostic tests, and doctor skills. Symptoms of appendicitis in a child are often non-specific and vary by age and degree of development. For example, children may experience unclear abdominal pain, vomiting, or diarrhea. For the physical test aspect, children who have appendicitis may not have obvious physical signs as in adults. Therefore, the doctor may have to perform other diagnostic tests to confirm the diagnosis. Then, diagnostic tests in children, such as ultrasound and CT scans that are often more useful than tests of blood tests or urinalysis. The skill of the doctor is also very influential. Distinguishing between appendicitis and other conditions that cause abdominal pain in a child requires skills and experience from a doctor. Instead, the doctor may have to consult a pediatrician or perform additional diagnostic tests to ensure a proper diagnosis in children with acute appendicitis. Therefore, it is important for parents to seek medical help as quickly as possible if they feel their child is experiencing symptoms of appendicitis. The rate of misdiagnosis in children aged 2-12 years varies and can be influenced by various factors, such as doctor skills, level of knowledge about symptoms, and signs of acute appendicitis, as well as access to health services. Several studies show that the rate of misdiagnosis in children ranges from 10-20%. However, this figure may vary in different countries and each case may vary also. It is important to conduct an appropriate evaluation and examination so that appendicitis can be early recognized and treated quickly.

Perforated appendicitis is a condition in which the appendix swells and ruptures causing infection and inflammation. It is a complication of acute appendicitis, which is an infection of the appendix (the organ that is at the end of the small intestine) (Smith J, 2019). The incidence of perforated appendicitis can cause various complications, such as abscesses, whole body infection (sepsis), peritonitis, intestinal obstruction, postoperative wound infection: occurs if the surgical wound does not heal properly, and inguinal hernia (Sukmawati E et al., 2018). Perforation in appendix can cause two conditions: diffuse peritonitis and a local appendicular abscess. Diffuse peritonitis is an infection and inflammation of the peritoneal lining, that is, the layer that envelops the stomach. This can occur because the infected and rotting contents of the appendix spread throughout the peritoneum. A local appendicular abscess is a condition in which forms on the area around a ruptured appendix area. This abscess can occur as a result of infection that is concentrated in the area and can spread to the surroundings. Both of these conditions are serious complications of appendix perforation and require prompt and appropriate medical treatment. It must be noted that both of these conditions have a risk of dangerous complications and require

intensive treatment. Perforated appendicitis can cause diffuse peritonitis or local appendicular abscesses (KemenKes, 2019; WHO, 2020).

Young children are more prone to diffuse peritonitis due to an undeveloped omentum, while older children tend to be protected by a well-developed omentum. The diagnosis of perforated appendicitis is difficult to establish since there are no specific symptoms or signs predicting it. Children who are younger and with a long symptom time have a higher risk of developing appendix perforation. The tools, such as increased leukocytosis, high CRP, hyponatremia, ultrasound, and CT can help in diagnosis process. According to studies by Araim and his colleagues, CRPs is greater than 8 mg/L and leukocytes is greater than 12 x $10^3/mm^3$ and have been associated with perforated appendicitis. Distinguishing between patients with perforation and non-perforation is very important because this affects the management of the patient.

The leukocyte count is the number of white blood cells (leukocytes) located in a blood sample. It is used as an indicator of infection and inflammation in the body, since the number of leukocytes increases as the body fights infection or inflammation. Normal values count leukocytes usually range from 4.5 to 11.0 x $10^3/mm^3$. However, this figure varies depending on age, gender and other health conditions. Leukocyte count is a laboratory test that is often used to establish the diagnosis of appendicitis. Moderate leukocytosis (15,000/mm^3) is usually an early sign in inflammatory appendix. More than 18,000/mm^3 leukocytes can indicate the incidence of complication appendicitis. Studies conducted by (S. *et al.,* 2018) found higher numbers of leukocytes and neutrophils in patients with perforated appendicitis. Meanwhile, studies conducted by (Yang *et al.,* 2019) also found higher leukocytes and lower serum sodium that were associated with the risk of perforation in children. (Zvizdic *et al.,* 2019) also found that elevated leukocytes and CRPs along with some clinical variables were related to the risk of perforation, but leukocytes themselves could not predict perforation. The research by (Dickinson *et al.,* 2017) also state that leukocytosis in acute appendicitis patients does not distinguish perforation.

Some studies propose new markers for predicting appendix perforation in children because the results of many studies on the usefulness of leukocytes tends to vary. One of the inexpensive and routine examinations carried out on patients is the measurement of serum sodium levels. The new study examines the potential of hyponatremia as a diagnostic marker for complementary appendicitis and finds significant differences in sodium levels in patients with and without complications. Although the pathogenesis of the relationship between hyponatremia and complementary appendicitis is still unclear, new evidence suggests that IL-6 has a role in osmoregulation during intra-abdominal inflammation that causes the release of vasopressin.

Previously, (Lindestam *et al.,* 2020) conducted a study on children aged 1-14 years with acute appendicitis and found a strong association between low sodium concentrations and perforation events. The results of sodium levels on perforations varied, where a retrospective study conducted by (Duman *et al.,* 2022) in Turkey concluded that sodium levels decreased in acute appendicitis, but there was no significant difference between sodium levels in patients with and without perforation.

There have been studies conducted to determine sodium levels as a predictive factor of perforation. The results showed a significant relationship between sodium levels and perforation, where lower sodium levels would increase the likelihood of perforation. However, this study did not compare sodium levels with leukocytes as a predictive factor, even though leukocyte examination is also a routine procedure performed in cases of appendicitis. Besides, it is known to be a predictor that is first used in cases of appendix perforation. Therefore, the researchers are interested in conducting a study entitled "The Influence of Sodium and Leukocyte Levels as Predictor Factors of Perforated Appendicitis in Children".

RESEARCH METHOD

This type of research is a retrospective study survey (Sugiyono, 2017, 2018, 2019) with data collection from medical record of perforated appendicitis patients at Bhayangkara TK. I Police Hospital for the period 2019-2022. The population in this study employed all patients diagnosed with appendicitis with perforation and without perforation. It had been carried out blood laboratory examinations at the Surgical Department of Bhayangkara TK. I Police Hospital for the period 2019-2022.

Analysis of the data used in this study used univariate statistical and bivariate tests. In the univariate test, the relationship between the two variables and the data were found in percentage form. As for the bivariate test, the relationship between the two variables will be found and tested for the degree of significance.

RESULTS AND DISCUSSIONS

From the first data, category coding was carried out for bivariate test needs, and previously data normality tests were carried out to ascertain whether the data was normally distributed or not.

Normality Tests

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Sodium Level	.126	52	.039	.967	52	.157
Leukocyte Level	.141	52	.011	.929	52	.004

a. Lilliefors Significance Correction

From the normality table above, data obtained are not normally distributed, so the statistical test uses non-parametric of the Mann Whitney Test.

UNI VARIATE ANALYSIS
Crosstabs

Age * Diagnosis of Cross Tabulation

			Diagnosis		
			Appendicitis with Perforation	Appendicitis Without Perforation	Total
Age	0-5 years	Count	3	0	3
		% within Diagnosis	25.0%	0.0%	5.8%
		% of Total	5.8%	0.0%	5.8%
	6-11 years	Count	0	6	6
		% within Diagnosis	0.0%	15.0%	11.5%
		% of Total	0.0%	11.5%	11.5%
	12-17 years	Count	9	34	43
		% within Diagnosis	75.0%	85.0%	82.7%
		% of Total	17.3%	65.4%	82.7%
Total		Count	12	40	52
		% within Diagnosis	100.0%	100.0%	100.0%
		% of Total	23.1%	76.9%	100.0%

Based on the table above, patients with appendicitis perforation are dominated in the age group of 12-17 years (75%). Then, the patients with appendicitis with the least perforation are in the age group of 0-5 years (25%). Meanwhile, patients with appendicitis without perforation are dominated in the age group of 12-17 years (85.0%). Patients with appendicitis without perforation in the age group of 6-11 years (15%).

Gender * Diagnosis of Crosstabulation

			Diagnosis		
			Appendisitis with Perforation	Appendisitis Without Perforation	Total
Gender	Woman	Count	5	28	33
		% within JnsKel	15.2%	84.8%	100.0%
		% of Total	9.6%	53.8%	63.5%
	Man	Count	7	12	19
		% within JnsKel	36.8%	63.2%	100.0%
		% of Total	13.5%	23.1%	36.5%
Total		Count	12	40	52
		% within JnsKel	23.1%	76.9%	100.0%
		% of Total	23.1%	76.9%	100.0%

Based on the table above, appendicitis sufferers with perforation are in the man gender group (36.8%). It is different from the women which is only (15.2%). Meanwhile, people with appendicitis without perforation are mostly in the women group (84.8%), different from the men which is only (63.2%).

Sodium Levels * Diagnosis Crosstabulation

			Diagnosis		
			Appendicitis without Perforation	Appendicitis with Perforation	Total
Sodium Levels	Hyphenation	Count	12	22	34
		% within Sodium_Levels	35.3%	64.7%	100.0%
		% of Total	23.1%	42.3%	65.4%
	Normal	Count	0	18	18
		% within Sodium_Levels	0.0%	100.0%	100.0%
		% of Total	0.0%	34.6%	34.6%
Total		Count	12	40	52
		% within Sodium_Levels	23.1%	76.9%	100.0%
		% of Total	23.1%	76.9%	100.0%

Based on the table above, the majority of people with appendicitis with more perforation experience hyponatremia (64.7%) than appendicitis without perforation by (35.3%).

Leukocytes Level * Diagnosis Crosstabulation

			Diagnosis		
			Appendicitis without Perforation	Appendicitis with Perforation	Total
Normal Leukocyte Count Levels			5	6	11
		% within Leukocytes Level	45.5%	54.5%	100.0%
		% of Total	9.6%	11.5%	21.2%
	Leukocytes	Count	7	34	41
		% within Leukocytes Level	17.1%	82.9%	100.0%
		% of Total	13.5%	65.4%	78.8%
Total		Count	12	40	52
		% within Leukocytes Level	23.1%	76.9%	100.0%
		% of Total	23.1%	76.9%	100.0%

Based on the table above, the majority of appendicitis sufferers with perforation (82.9%) had elevated leukocyte levels compared to appendicitis without perforation by (17.1%)

BIVARIATE ANALYSIS

Mann-Whitney Test

Ranks

	Diagnosis	N	Mean Rank	Sum of Ranks
Leukocytes Level	Appendicitis with Perforation	12	21.17	254.00
	Appendicitis without Perforation	40	28.10	1124.00
	Total	52		
Leukocytes Level	Appendicitis with Perforation	12	17.50	210.00
	Appendicitis without Perforation	40	29.20	1168.00
	Total	52		

Test Statistics[a]

	Leukocytes Level	Sodium Level
Mann-Whitney U	176.000	132.000
Wilcoxon W	254.000	210.000
Z	-1.965	-2.846
Asymp. Sig. (2-tailed)	.049	.004

a. Grouping Variable: Diagnosis

Interpretation :

- Based on the test results above with the value of Asymp. Sig.
  Leukocytes levels with a value of 0.049 showed <0.05. Thus, it can be concluded that there is a significant difference in leukocytes levels among patients with a diagnosis of appendicitis with perforation and appendicitis without perforation.
- Based on the test results above with the value of Asymp. Sig
  Sodium levels with a value of 0.004 showed <0.05. Thus, it can be concluded that there is a significant difference in leukocyte levels among patients with a diagnosis of appendisitis with perforation and appendicitis without perforation.

ACU VALUE (AREA UNDER CURVE)

Area Under the Curve

Test Result Variable(s): Sodium

Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval Lower Bound	Asymptotic 95% Confidence Interval Upper Bound
.229	.064	.005	.104	.354

The test result variable(s): Sodium has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased.
a. Under the non-parametric assumption
b. Null hypothesis: true area = 0.5

Area Under the Curve

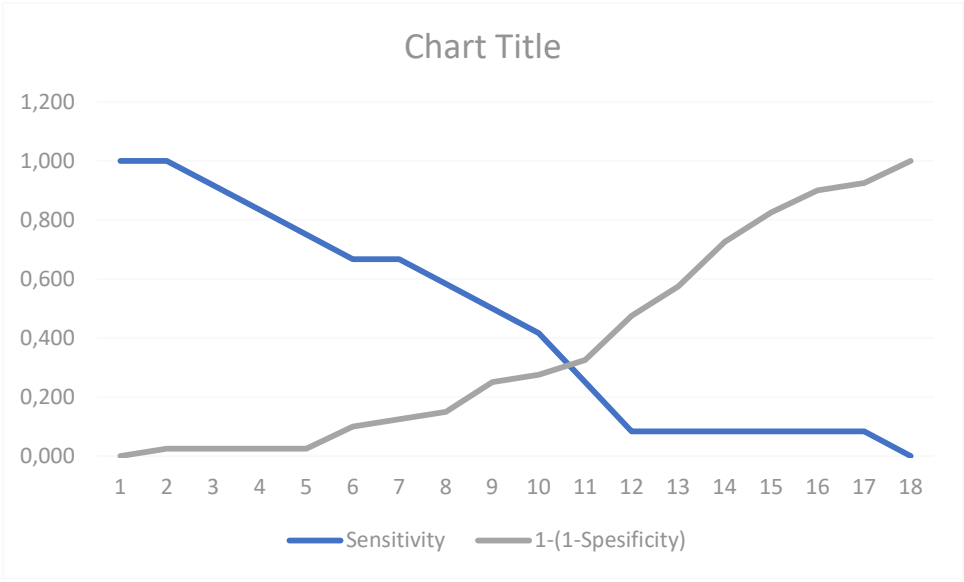
Test Result Variable(s): Leukocyte

Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval Lower Bound	Asymptotic 95% Confidence Interval Upper Bound
.747	.094	.010	.563	.931

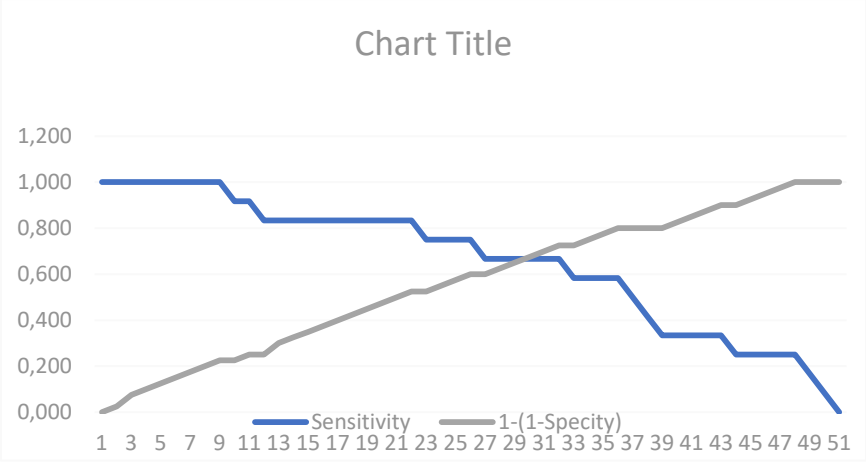
The test result variable(s): Leukocyte has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased.
a. Under the non-parametric assumption
b. Null hypothesis: true area = 0.5

Based on the two tables above, there is a comparison between the results of AUC (Area Under Curve) values for Sodium levels and Leukocyte levels in the diagnosis of appendicitis with perforation and appendicitis without perforation where the value for sodium levels shows a curve

area of less than 70%, while for leukocytes above 70%. Thus, the accuracy on the leukocyte level factor is higher.



Based on the table and graph above, it can be concluded that the Cut Off value is at the abscissa axis value of 11 with a value of 0.325. This value shows that the sodium level has an impact on patients with a diagnosis of appendicitis with perforation and appendicitis without perforation is 132.50 mEq/liter.



Based on the table and graph above, it can be concluded that the Cut Off value is at the abscissa axis value of 29 with a value of 0.650. This value indicates that the leukocyte level has an impact on patients with a diagnosis of appendicitis with perforation and appendicitis without perforation is 13,715 u/L.

CONCLUSION

From the results of the discussion, it can be concluded that there is a significant difference in sodium levels for people with appendicitis with perforation. This conclusion is supported by the Mann-Whitney Test Results where the Sig value < 0.05. Similarly, leukocyte levels show the same results as sodium levels for people with appendicitis with perforation.

The analysis of AUC (Area Under Curve) shows that leukocyte levels are much more accurate compared to sodium levels of 0.229 or (22.9%). The large area indicates this under the curve (AUC) for leukocytes of 0.747 or (74.7%). This value is greater than 70% as the recommended limit as an accurate result.

References

Dickinson, C. M., Coppersmith, N. A., & Luks, F. I. (2017). Early Predictors of Abscess Development after Perforated Pediatric Appendicitis. *Surgical Infections*, *18*(8), 886–889. https://doi.org/10.1089/sur.2017.134

Duman, L., Karaibrahimoğlu, A., Büyükyavuz, B. I., & Savaş, M. Ç. (2022). Diagnostic value of monocyte-to-lymphocyte ratio against other biomarkers in children with appendicitis. *Pediatric Emergency Care*, *38*(2), E739–E742. https://doi.org/10.1097/PEC.0000000000002347

KemenKes. (2019). *Laporan Riskesdas 2018*. Jakarta: Kementerian Kesehatan RI.

Lesmana, G. P., Rudiman, R., & Septrina, R. (2020). Accuracy of D-Dimer Levels and C-reactive Protein in Predicting Perforation of Acute Appendicitis. *Jurnal Llmu Bedah Indonesia*, *48*(1), 59–69. https://doi.org/10.46800/jibi-ikabi.v48i1.57

Lindestam, U., Almström, M., Jacks, J., Malmquist, P., Lönnqvist, P. A., Jensen, B. L., Carlström, M., Krmar, R. T., Svensson, J. F., Norberg, Å., & Fläring, U. (2020). Low Plasma Sodium Concentration Predicts Perforated Acute Appendicitis in Children: A Prospective Diagnostic Accuracy Study. *European Journal of Pediatric Surgery*, *30*(4), 350–356. https://doi.org/10.1055/s-0039-1687870

Lui, A.F., Smith, J., Chen, Y., & Johnson, R. (2021). Appendicities: Diagnosis and Management. *Journal of Surgical Techniques*, *56*, 967–972. https://doi.org/10.1016/j.jss.2021.06.054

McLauthlin, C. H., & Packard, G. B. (2017). Acute appendicitis in children. *The American Journal of Surgery*, *101*(5), 619–625. https://doi.org/10.1016/0002-9610(61)90272-0

S., C., M. G., L., & S. R., A. (2018). Prevalence of perforated appendicitis and its determinants in pediatric appendicitis patients admitted in tertiary care centre, South India: a cross sectional study. *International Surgery Journal*, *5*(12), 3926. https://doi.org/10.18203/2349-2902.isj20185020

Shimoda, M., Maruyama, T., Nishida, K., Suzuki, K., Tago, T., Shimazaki, J., & Suzuki, S. (2018). Comparison of clinical outcome of laparoscopic versus open appendectomy, single center experience. *Heliyon*, *4*(5), e00635. https://doi.org/10.1016/j.heliyon.2018.e00635

Simpson, J., & Scholefield, J. H. (2013). Acute appendicitis. *Foundation Years*, *2*(2), 72–75. https://doi.org/10.1053/S1744-1889(06)70056-1

Smith J. (2019). *Acute appendicitis and perforation* (20th ed.). Philadelphia, PA: Elsevier.

Sugiyono. (2017). *Metode Penelitian Kuantitatif, Kualitatif (R & D)*. Bandung: CV Alfabeta.

Sugiyono. (2018). *Metode Penelitian Kuantitatif*.

Sugiyono. (2019). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D* (1st ed.). Penerbit Alfabeta.

Sukmawati E, wahyunita yulia sari, & indah sulistyoningrum. (2018). *Farmakologi Kebidanan*. Trans Info Media (TIM). https://scholar.google.com/scholar?oi=bibs&cluster=11760770443894442881&btnI=1&hl=id

Vaos, G., Dimopoulou, A., Gkioka, E., & Zavras, N. (2019). Immediate surgery or conservative treatment for complicated acute appendicitis in children? A meta-analysis. *Journal of Pediatric Surgery*, *54*(7), 1365–1371. https://doi.org/10.1016/j.jpedsurg.2018.07.017

WHO. (2020). *Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020*.

Yang, J., Liu, C., He, Y., & Cai, Z. (2019). Laboratory Markers in the Prediction of Acute Perforated Appendicitis in Children. *Emergency Medicine International*, *2019*, 1–4. https://doi.org/10.1155/2019/4608053

Zvizdic, Z., Jonuzi, A., Djuran, A., & Vranic, S. (2019). Gastric necrosis and perforation following massive gastric dilatation in an adolescent girl: A rare cause of acute abdomen. *Frontiers in Surgery*, *6*. https://doi.org/10.3389/fsurg.2019.00003