JMS 2023; Vol6 (2):120-132
UDC:616.346.2-002.1-089.819
DOI: 10.55302/JMS2362120m

THE UTILIZATION OF ALVARADO, AIR AND RIPASA SCORING SYSTEMS IN ADULTS WITH ACUTE APPENDICITIS TREATED WITH LAPAROSCOPIC APPENDECTOMY

Ilija Milev[1], Vesna Velikj Stefanovska[2], Ognen Kostovski[3], Aleksandar Mitevski[4], Panche Karagjozov[3], Stefan Petrovski[1]

[1]Department of Surgery, Clinical Hospital-Stip, Faculty of Medical Sciences, Goce Delcev University, Stip, North Macedonia

[2]Department of Epidemiology and Biostatistics, Faculty of Medicine, Ss Cyril and Methodius University in Skopje, North Macedonia

[3]Clinic for Digestive Surgery, Faculty of Medicine, Ss Cyril and Methodius University in Skopje, North Macedonia

[4]Department of Surgery, Re-Medica General Hospital, Faculty of Medical Sciences, Goce Delcev University, Stip, North Macedonia

Abstract

The purpose of this study is to evaluate the applicability of Alvarado, Appendicitis Inflammatory Response (AIR) and "Raja Isteri Pengiran Anak Saleha Appendicitis" (RIPASA) score in diagnosing acute appendicitis (AA) in our population, as well as the possibility for a connection between certain values and the emergence of "adverse events" in relation to laparoscopic appendectomy (LA).

We conducted a multicentric, prospective, cohort, clinical study on 75 patients with AA treated with LA. For all the patients, the values and the corresponding group of the three scoring systems (Alvarado, AIR and RIPASA) were determined preoperatively.

We registered the emergence of intraoperative complications and difficulties, the reason for conversion and the presence of complications postoperatively. All the patients with some form of an intraoperative complication or difficulties, patients on whom conversion to open approach was performed or patients with any kind of postoperative complications were placed in the group "with adverse events" and the rest in the group "without adverse events".

The RIPASA score had an insignificantly higher sensitivity (sens.=96% at a cut-off >7 and sens.=68% at a cut-off >12) than the Alvarado score (sens.=90.7% at a cut-off ≥7 and sens.=62.7% at a cut-off ≥9) and both had significantly higher sensitivity than the AIR score (sens.=40% at a cut-off ≥9).

Further analysis showed that there was no association between the emergence of adverse events and the corresponding group of the scoring system.

The RIPASA scoring system had the highest sensitivity in our population, The investigated scoring systems Alvarado, AIR and RIPASA could not be used for predicting a possible unwanted course in patients with AA treated with LA.

Keywords: scoring systems, sensitivity, laparoscopic appendectomy, adverse events.

Introduction

The diagnosis of acute appendicitis (AA) can be a real challenge sometimes. Traditionally, for a long period the clinical symptoms and signs as well as the clinical skills of the surgeon had a central role in establishing the preoperative diagnosis of AA and indication for operative treatment.

This approach had led to a substantial percentage (10-30%) of negative appendectomies referring to the condition where intraoperatively the appendix is not inflamed, but it must be removed to eliminate the chance for diagnostic mistakes in the future. In searching for ways to improve the accuracy of preoperative diagnosis at first, several laboratory markers for inflammation (leukocytosis, neutrophilia, C-reactive protein) were included in the routine preoperative investigation. Soon it was realized that all the

characteristic symptoms, signs, and laboratory parameters that indicated the presence of AA had limited diagnostic efficacy as individual parameters and the efficacy was far greater when combining them.

From that conclusion emerged the necessity of combining the exact specific diagnostic parameters into so-called scoring systems.

The first such system was constructed by Alfredo Alvarado in 1986 and to this day this is the most widely used scoring system in the adult population.

The system was constructed on the base of a retrospective clinical study that was conducted on 305 participants admitted in hospital under the assumption of having AA. Several symptoms, signs, and laboratory parameters were investigated for sensitivity (sens.), specificity (spec.), positive predictive value (PPV), and negative predictive value (NPV) in diagnosing AA.

At the end, for eight of those parameters (migration of pain in the right lower quadrant, anorexia, nausea/vomiting, tenderness in the right lower quadrant, rebound tenderness in the right lower quadrant, elevated body temperature, leukocytosis and neutrophils left shift) significant influence in establishing the diagnosis for AA was concluded and, according to the level of that influence, exact points were assigned to each of them [1].

The term MANTRELS that is constructed of the starting letters of the used parameters is occasionally used as an eponym for the Alvarado scoring system. In the so-called modified Alvarado score (MAS), the neutrophil left shift is extracted from the score because many laboratories from that time did not investigate this parameter [2].

The efficacy of this system is close to the original but with a diminished capacity for diagnosing the early forms of AA.

In 2008, Anderson and Anderson published a new scoring system known as "Appendicitis inflammatory response" (AIR) – score. It was constructed upon the assumption that the Alvarado score had been made on the base of a retrospective study on patients who were operated under suspicion for AA and the score system itself had been used on patients who were investigated for possible presence of AA.

The AIR score was made based on prospectively collected data from 545 patients who were hospitalized under suspicion of having AA. Exactly eight clinical and laboratory parameters were pointed out, with highly discriminating force to suggest the presence of advanced AA.

The clinical sign – rebound tenderness or muscle defense in the right lower quadrant (RLQ) was graded and the laboratory parameters were presented at intervals that were supposed to lead to losing less diagnostic information. The subjective parameters like nausea, anorexia, and migration of pain were eliminated and replaced by more concrete parameters such as vomiting, C-reactive protein (CRP), and "guarding". In this study, the diagnostic accuracy of the AIR score was presented as far higher than that of the Alvarado score [3].

Opposite to that conclusion, the author of the Alvarado score, Alfredo Alvarado widely criticized the new scoring system mainly for the possibility of subjective interpretation of the variable, rebound tenderness that was graduated into light, medium and strong, as well as the absence of variable, migration of pain that in fact is one of the most characteristic symptoms of AA.

In 2010, Chong et al. created a new score system, especially prepared for the Asian and Middle East population after noticing that Alvarado and MAS score were giving poor results for that population. This system was constructed on the base of retrospective study conducted on 312 patients who were operated under suspicion for AA on the surgical ward at "Raja Isteri Pengiran Anak Saleha" (RIPAS) hospital in Brunei, Darusalem. The score contains 15 parameters carefully chosen on a panel discussion by consensus of all general surgeons at RIPAS hospital.

According to the level of the impact established by logistic regression analysis, 0.5, 1 or 2 points were assigned to each variable with special emphasis on the guarding and Rovsing sign as the strongest indicators for early AA as well as rebound tenderness as the strongest indicator for advance AA. The newly designed scoring system was called "„Raja Isteri Pengiran Anak Saleha Appendicitis" (RIPASA) score, after the mentioned hospital with a minimum of 2 and a maximum score of 16 points. For a cut-off ≥ 7.5 the authors calculated sens.=88%, spec.=67% and accuracy of 81% that corresponded to the performance of the Alvarado score in Western population and it was way better than Alvarado (sens.=50,6%-59,0% and

spec.=23,0%-94,5%) and MAS (sens.=53,8% и spec.=80%) regarding the Asian and Middle East population [4]. In 2011, Chong et al. published a prospective study with 192 participants where the results of the RIPASA score in diagnosing AA were: sens.=98% and spec.=81.3% opposite sens.=67% and spec.=87.9% for the Alvarado score. Along with the previous study, the creators of the RIPASA scoring system showed its remarkable superiority in diagnosing AA over the Alvarado score for the population for which it was created [5].

The experience in practice is showing that, while the usage of various scoring systems will not influence much the decision of the experienced surgeon when to operate on the patient with suspected AA, it can very much help the young surgeon in the same circumstances.

These scoring systems can also help in the decision which patients should be observed in hospital or at home or maybe when to indicate additional investigations like ultrasonography or computed tomography for example.

The purpose of this study is to evaluate the applicability of the three basic scoring (Alvarado, AIR and RIPASA) system in diagnosing AA in our population, as well as the possibility for a connection between certain values of the three scoring systems and the emergence of "adverse events" represented as various kinds of intra and postoperative difficulties and complications in relation to the laparoscopic appendectomy.

Materials and Methods

We conducted a multicentric, prospective, cohort, clinical study on patients with AA treated with laparoscopic appendectomy or with conversion from laparoscopic to open approach in some of the cases. The study was conducted in the Clinical Hospital Stip and in the University Clinic for Digestive Surgery Skopje in a two-year period.

The participants were selected by exact inclusion and exclusion criteria. The inclusion criteria were: age from 15-60 years, suspicion for AA that demanded emergency operation or in- hospital observation, regarding to gender, religion, education, socioeconomic status, and other demographic characteristics, willingness for participation and signed informed consent. The exclusion criteria were: inadequate age, presence of contraindications for laparoscopic surgery, clinical signs of diffuse peritonitis, presence of peri-appendicular infiltration or abscess, previous laparotomies, pregnancy, and lack of willingness for participation. At the and 75 participants on whom LA or conversion was performed remained in the study. Acute appendicitis was confirmed in each of them on histopathological postoperative analysis.

For all the patients, the values and the corresponding group of the three scoring systems (Alvarado, AIR and RIPASA) were determined. The Alvarado score ranges from 0 to 10. According to the values of the Alvarado score, the patients can be grouped into four groups: group I (0-4) – the presence of AA is unlikely, group II (5-6) – the presence of AA is possible, group III (7-8) - the presence of AA is probable and group IV (9-10) – the presence of AA is very probable. The AIR score ranges from 0 to 12. The probability for AA rises with bigger values. The patients can be grouped into three groups according to the values of the AIR score: group I (0-4) - low probability for AA, group II (5-8) - intermediate group and group III (9-12) high probability for AA. The RIPASA score ranges from 0 to 17.5. The patients can be grouped in four groups according to the possibility for AA regarding the values of the RIPASA score: group I (<5) – probability for AA is unlikely, group II (5-7) – low probability for AA, group III (7.5-12) – high probability for AA and group IV (>12) – the presence of AA is certain.

LA was performed by using one 10 mm supraumbilical port and two 5 mm ports, one in the suprapubic region and one in the lower left abdominal quadrant. Conversion to open approach when needed was performed by Mac Burney incision or infraumbilical median laparotomy.

We registered the emergence of intraoperative complications and difficulties, as well as the reason for conversion to open appendectomy in corresponding cases. The presence of abdominal and extra abdominal complications was registered on the 7-th and 30-th postoperative day. All the patients with some form of intraoperative complication or difficulties, patients on whom conversion was performed or patients with any kind of postoperative complications were placed in the group "with adverse events" and the rest in the group "without adverse events".

Results

Our analysis showed that by accepting the results from groups III and IV as positive results for presence of AA, the Alvarado score has a sensitivity of 90.7% CI (81%-96%), whereas if we accept only group IV as positive, the sensitivity drops substantially to 62.7% CI (81%-96%). The situation was similar with the RIPASA score where the sensitivity drops from 96% CI (88%-99%) when accepting the results of groups III and IV as a positive finding for AA to 68% CI (56.1%-78%) when only the results from group IV are accepted as a positive finding. The AIR score had the lowest sensitivity for our patients and, when accepting the results of group III as a positive finding for AA, the sensitivity was only 40% CI (29.1-51.9).

We made a comparison between the sensitivity of the Alvarado and the RIPASA scoring system when accepting groups III and IV as a positive finding for the presence of AA (Table 1). The difference between the sensitivity of the two scoring systems as shown was not statistically significant for $p>0.05$ (Difference test: Difference 5% [(-3.49-14.01) CI 95%]; Chi-square=1.532; df=1 p=0.2158). The RIPASA scoring system had an insignificantly higher sensitivity for establishing the diagnosis of AA than that of the Alvarado scoring system.

Table 1. Comparison of the Alvarado and RIPASA scoring systems when accepting group III and IV as a positive finding.

Scoring system	Sensitivity Estimated Value	95% Confidence Interval		p
		Lower Limit	Upper Limit	
Alvarado	91%	81.1%	95.8%	p=0.2158
RIPASA	96%	87.9%	98.9%	

*significant for $p<0.05$

Further, we compared the difference between the sensitivity of the AIR scoring system with that of the Alvarado and RIPASA scoring systems when accepting only group IV as a positive finding for AA (Table 2). For $p<0.05$ (Difference test: Difference 22.7% [(6.70-37.12) CI 95%]; Chi-square=7.683; def=1 p=0.0056), the Alvarado scoring system had a significantly higher sensitivity for establishing the diagnosis of AA than the AIR scoring system. The sensitivity of the RIPASA scoring system was also significantly higher than that of the AIR scoring system (Difference test: Difference 28% [12.7-42.01) CI 95%]; Chi-square=11.757; df=1 p=0.006).

At the end we made a comparison between the results for sensitivity of the Alvarado and RIPASA scoring systems when accepting only the results from group IV as a positive finding for the presence of AA (Table 3). For $p>0.05$, the difference was not statistically significant (Difference test: Difference 5.3% [(-9.77-20.4) CI 95%]; Chi-square=0.462; df=1 p=0.4966). The RIPASA scoring systems (when accepting the results only of group IV as a positive finding) had an insignificantly higher sensitivity than the Alvarado scoring system.

Table 2. Comparison of the sensitivity of the AIR scoring system and Alvarado and RIPASA scoring systems

Scoring system	Sensitivity Estimated Value	95% Confidence Interval		p
		Lower Limit	Upper Limit	
AIR	40%	29.1%	51,9%	p=0.0056*
Alvarado	62.7%	50.7%	73.3%	
AIR	40%	29.1%	51.9%	p=0.0006*
RIPASA	68%	56.1%	78.1%	

*significant for p<0.05

Table 3. Comparison of the sensitivity of the Alvarado and RIPASA scoring systems when accepting only group IV as a positive finding

Scoring system	Sensitivity Estimated Value	95% Confidence Interval		p
		Lower Limit	Upper Limit	
Alvarado	62.7%	50.7%	73.3%	p=0.4966
RIPASA	68%	56.1%	78.1%	

*significant for p<0.05

An additional analysis was made regarding the possible connection between the value of the Alvarado score and the emergence of adverse events in relation to the LA.

According to the analysis, there was an insignificant, weak positive correlation between the value of the Alvarado score and the emergence of adverse events - Sperman Rank Order Correlation: R=0,1218; p>0,05 (Figure 1). With higher values of the Alvarado score, the probability for the emergence of adverse events was insignificantly higher.

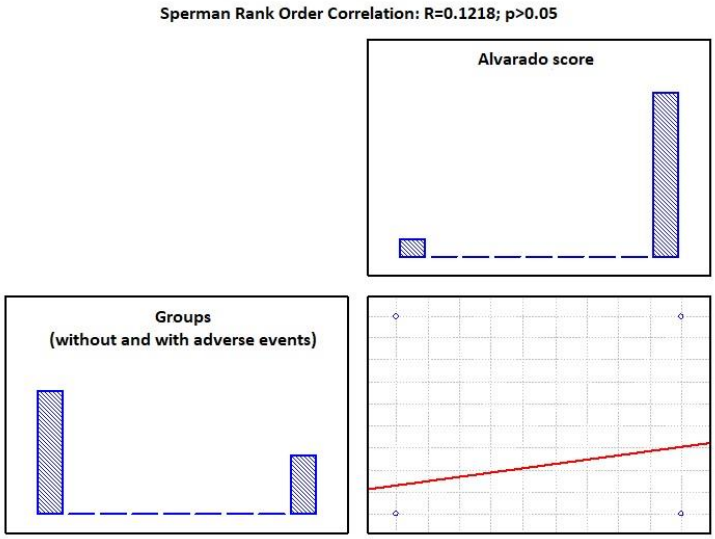

Figure 1. Correlation between the Alvarado score and the emergence of adverse events

The most represented group of the Alvarado scoring system in the entire sample was group IV (the presence of AA is very probable) in 47 (62.7%) participants. In the group without adverse events and with adverse events, consequently group I (the presence of AA is unlikely) of the Alvarado scoring system was represented in 1 (1.9%) vs. 0 (0%) participants; group II (the presence of AA is possible) was represented in 5 (9.8%) vs. 1 (4.2%); e group III (the presence of AA is probable) in 13 (25%) vs. 8 (33%) and group IV (the presence of AA is very probable) was represented in 32 (63.7%) vs. 15 (62.5%). For p>0.05, there was not a significant association between the group of the Alvarado scoring system and the group without and with adverse events of the patients (Fisher-Freeman-Halton exact test: p=0.8205), (Table 4, Figure 2).

Table 4. Analysis according to groups of Alvarado score and groups without and with adverse events

Alvarado scoring system - groups		**Groups**		**Summary**
		Without "adverse events"	**With "adverse events"**	
Group I	**Number**	1	0	1
	%	1.96%	0%	1.33%
Group II	**Number**	5	1	6
	%	9.80%	4.17%	8%
Group III	**Number**	13	8	21
	%	25.49%	33.33%	28%
Group IV	**Number**	32	15	47
	%	62.75%	62.50%	62.67%
Summary	**Number**	51	24	75
	%	68%	32%	100%

Fisher-Freeman-Halton exact test: p=0,8205 *significant for p<0.05

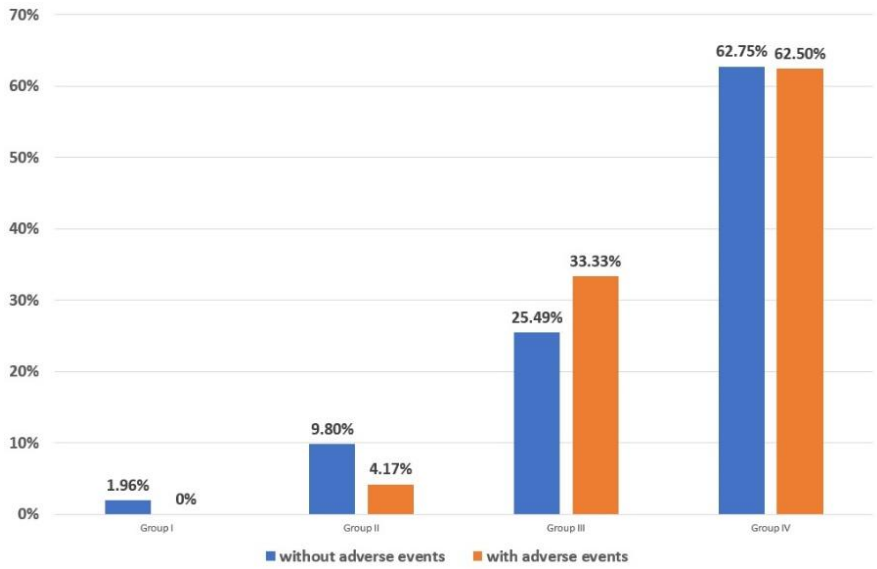

Figure 2. Analysis according to groups of the Alvarado score and groups without and with adverse events

Further, we analyzed the possible connection between the value of the RIPASA score and the emergence of adverse events. It showed the presence of a week, negative correlation between higher values of the RIPASA score and the emergence of adverse events (Sperman Rank Order Correlation: R=-0.0703; p>0.05), (Figure 3). According to this analysis, the probability of the emergence of adverse events was insignificantly reduced with higher values for the RIPASA score.

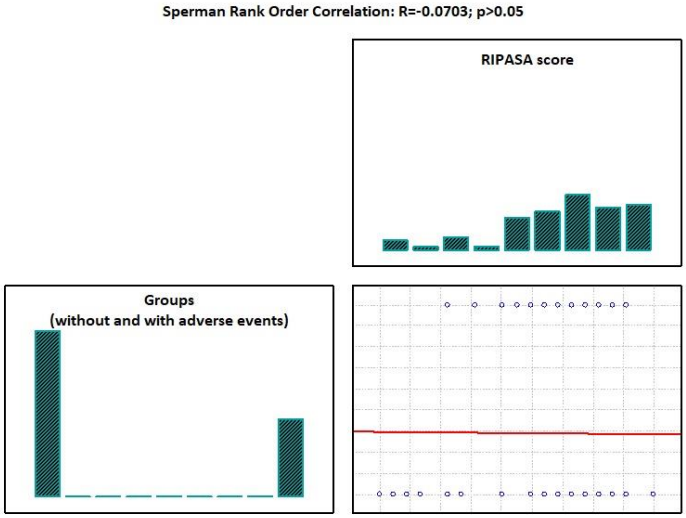

Figure 3. Correlation between the RIPASA score and emergence of adverse events

The most represented group of the RIPASA score in the entire sample was group IV (the presence of AA is certain) in 51 (68%) of the participants. In the group without adverse events and with adverse events consequently there were 3 (5.9%) vs. 0 (0%) participants classified in group I (the presence of AA is unlikely) of the RIPASA scoring system; none from group II (the presence of AA is possible); 12 (23.5%) vs. 9 (37.9%) classified in group III (the presence of AA is probable) and 36 (70.6%) vs. 15 (62.5%) from

group IV (the presence of AA is very probable). For p>0.05 there was not a significant association between the group of the RIPASA score and the group without or with adverse events (Fisher-Freeman-Halton exact test: p=0.3151) (table 5, Figure 4).

Table 5. Analysis according to groups of the RIPASA score and groups without and with adverse events

RIPASA scoring system - Groups		Groups		Summery
		Without "adverse events"	With "adverse events"	
Group I	**Number**	3	0	3
	%	5.88%	0%	4%
Group III	**Number**	12	9	21
	%	23.53%	37.50%	28%
Group IV	**Number**	36	15	51
	%	70.59%	62.50%	68%
Summery	**Number**	51	24	75
	%	68%	32%	100%

Fisher-Freeman-Halton exact test: p=0.3151 *significant for p<0.05

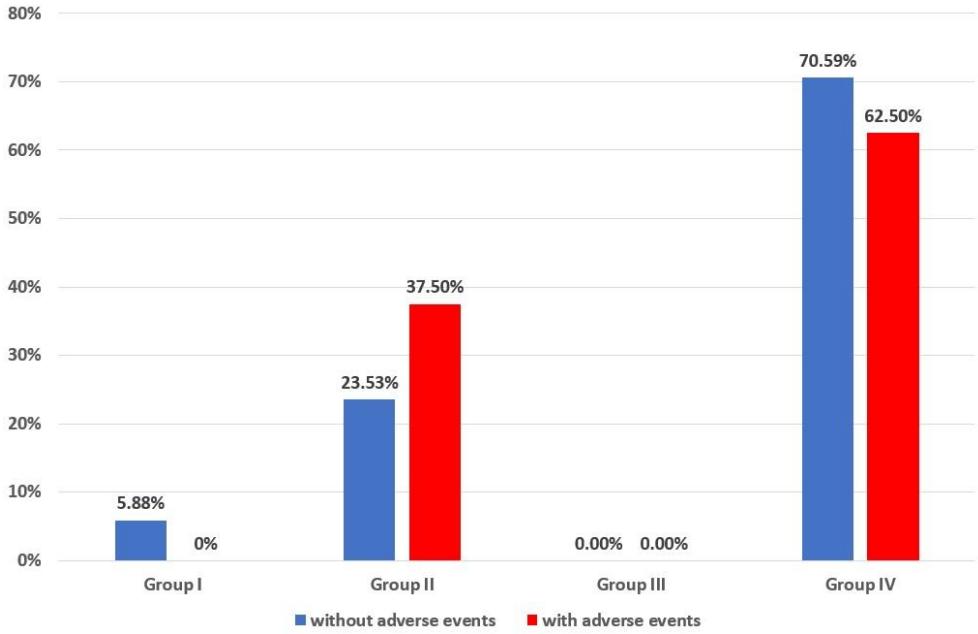

Figure 4. Analysis according to groups of the RIPASA score and groups without and with adverse events

An analysis was also made for the possible correlation between the value of the AIR score and the emergence of adverse events in relation to LA. This analysis showed a presence of an insignificant, week positive correlation between the value of the AIR score and the emergence of adverse events in a way that there was a presence of an insignificantly higher probability for emergence of adverse events with higher values of the AIR score (Sperman Rank Order Correlation: R=0.151; p>0.05) (Figure 5)

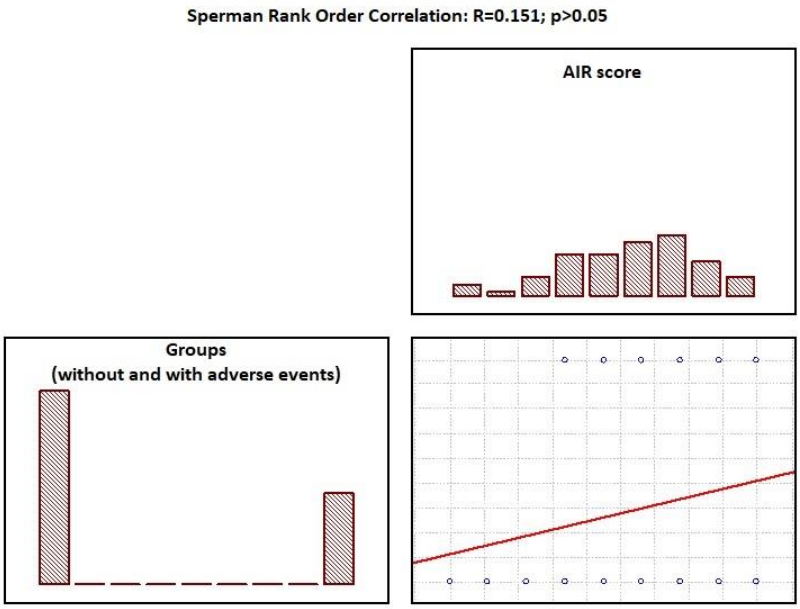

Figure 5. Correlation between the AIR score and the emergence of adverse events

The most represented group of the AIR score system in the whole sample was group II (intermediate probability for AA) in 41 (54.7%) participants. In the group without adverse events and with adverse events consequently group I (low probability for AA) was represented in 4 (7.8%) vs. 0 (0%), group II (intermediate probability for AA) in 27 (52.9%) vs. 14 (58.3%) and group III (high probability for AA) in 20 (39.2%) vs. 10 (41.7%). For p>0.05 there was not a significant association between the group of the AIR score and the groups without and with adverse events of the participants (Fisher-Freeman-Halton exact test: p=0.5107) (table 6, Figure 6).

Table 9. Analysis according to groups of the AIR score and groups without and with adverse events

AIR scoring system - Groups		Groups		Summary
		Without "adverse events"	With "adverse events"	
Group I	**Number**	4	0	4
	%	7,84%	0%	5,33%
Group II	**Number**	27	14	41
	%	52,94%	58,33%	54,67%
Group III	**Number**	20	10	30
	%	39,22%	41,67%	40%
Summary	**Number**	51	24	75
	%	68%	32%	100%

Fisher-Freeman-Halton exact test: p=0,5107 *significant for p<0,05

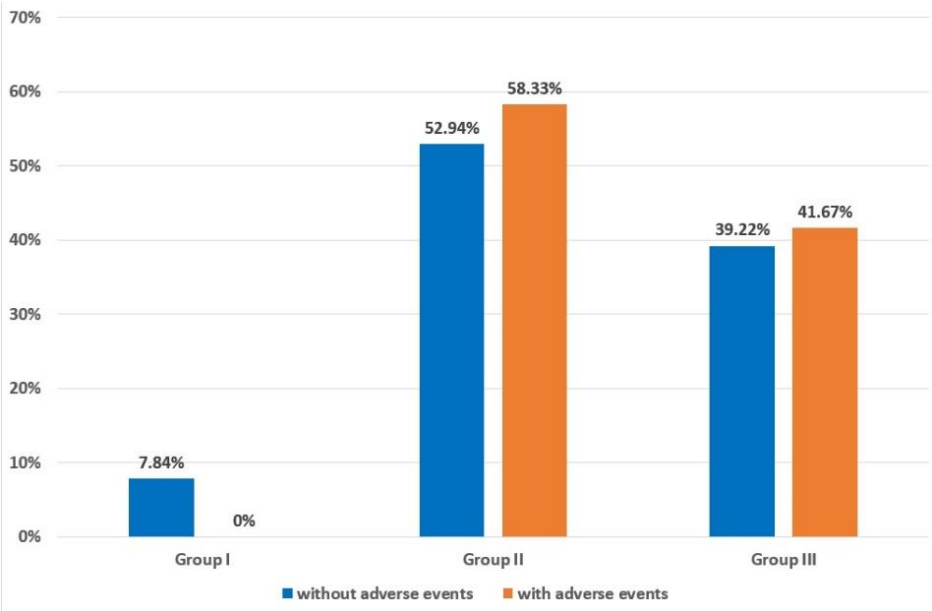

Figure 6. Analysis according to groups of the AIR score and groups without and with adverse events

Discussion

Worldwide, the Alvarado scoring system is the most frequently used scoring system for the diagnosis of AA. Since the announcement of the Alvarado score in 1986, many studies have documented its effectiveness. We managed to extract three major reviews that summarize most of the known data on the diagnostic accuracy of the Alvarado scoring system. In the metanalysis of 42 studies done by Ohle et al. at a cut-off point ≥7, the Alvarado score had sens.=82% and spec.=57%, whereas for a cut-off ≥5, the results were sens.=99% and spec.=47%. Among other, the authors concluded that the Alvarado score performs well as a "rule out" criterion because of its high sensitivity but cannot be used to 'rule in' the diagnosis of appendicitis without surgical assessment and further diagnostic testing [6].

In the metanalysis from 12 studies and exactly 2161 patients done by Frontzas et al., the sensitivity and specificity were 69% and 77% respectively for a cut-off ≥7 [7].

The recent metanalysis by Favara et al. with the data collected from 33 studies showed sensitivity of 72% and specificity of 77% at a cut-off ≥7. In our study, for a cut-off ≥7 the sensitivity was 90.7% and for a cut-off ≥9 the sensitivity was 62.7% [8].

In most of the studies the preferred cut-off point above which the presence of AA should be considered is 7 and, as our results show, we should probably use that cut-off point in practice.

The AIR scoring system was announced 22 years after the creation of the Alvarado score with every intention to surpass its predecessor. The first data of its efficacy were published by its creators Anderson and Anderson where for a cut-off value >4 the results were sens.=96%, spec.=73%, PPV=64% and NPV=97%, and for a cut-off value >8 the results were sens.=37%, spec.=99%, PPV=97% and NPV=76% for all forms of AA. Those results were from exactly 229 patients on whom the system was primarily tested. In 2012, de Castro et al. published their study from the data gathered on 941 patients with suspected appendicitis. The results for all forms of appendicitis for a cut-off value >4 were sens.=93%, spec.=85%, PPV=79% and NPV=95% and for cut-off value >8, sens.=10%, spec.=100%, PPV=100% and NPV=66% [9].

Kularatna et al., in their systematic review from 2017 with the data collected from 34 included studies, concluded that from exactly 12 known scoring systems for establishing the diagnosis of AA so far,

the AIR score appeared to be the best performer with sens.=92% and spec.=63% at a cut-off value >5 that reverted to 20% and 97% respectively, for a cut-off value >8 [10]. In our study, for a cut-off >8 we calculated sensitivity of 40% for the AIR score for all kinds of appendicitis.

The RIPASA scoring system was constructed in 2013 primarily for the Asian and Middle East population, but its usage for worldwide population in the following years has shown excellent results. Malik et al. studied the efficacy of this system on the Irish population and, according to the authors, this was the first study that had researched the usability of the RIPASA scoring system on the Western population. On a sample of 208 patients with suspected AA for cut-off point ≥7.5 they reported the following results: sens.=85.93%, spec.=69.86%, PPV=84.06% and NPV=72.86%. The authors concluded that the efficacy is almost identical to that of the population for which the system was initially constructed [11].

In the metanalysis done by Frontzas in 2018, the following results were reported from a sample of 2161 patients: sens.=94% and spec.=55% for a cut-off value ≥7.5. In the previously mentioned metanalysis by Favara et al., the results at a cut-off ≥7.5 for RIPASA score were sens.=95% and spec.=71%. In our study, for a cut-off ≥7.5 the sensitivity was 96%, and for a cut-off ≥12 the sensitivity was 68 %.

In most of the published studies regarding the scoring systems, there is a comparison between the three systems rather than research of the efficacy of one of them and all of them were with different conclusions. According to the study by Anderson and Anderson where the AIR system was promoted, for a cut-off >8 the AIR score has a significantly higher sensitivity and for a cut-off >4 a significantly higher specificity than Alvarado for all forms of AA as well as for advanced ones separately. De Castro et al. made the same comparison and calculated better efficacy for the AIR system although not statistically significant. Madasi et al. researched the efficacy of the same systems and reported superiority of the AIR over Alvarado with higher sensitivity (95.7% vs 87.3%), higher specificity (90.5% vs 52.4%) and better accuracy (95% vs 85%) [12]. Kollar et al. made a comparison of both systems on a sample of 182 patients.

According to their results, both systems are equally efficient in ruling out the diagnosis when there is no AA. In the cases with concluded AA, Alvarado had significantly higher specificity but significantly lower sensitivity than the AIR scoring system. Regardless, in the end the authors favored the AIR score [13].

Karami et al. compared all three scoring systems on a sample of 100 adult patients with suspected AA of Iranian nationality. The authors concluded that among the Iranian population, the RIPASA scoring system had superior sensitivity, but Alvarado had better specificity [14].

Nanjundiaiah et al. compared the efficacy of the RIPASA and Alvarado scoring systems on a sample of 206 adult patients of Indian nationality.

They concluded that the RIPASA system had higher sensitivity, specificity, and accuracy than Alvarado for Indian population [15].

In the mentioned metanalysis by Frontzas et al., the authors favor the RIPASA scoring system as the best diagnostic tool. The conclusion from the recent metanalysis by Favara et al. was that the RIPASA score had higher sensitivity, but low specificity compared to the Alvarado score. In our study, the results showed that, although without statistical significance, the RIPASA scoring system has higher sensitivity than Alvarado and both have significantly higher sensitivity than the AIR score.

Most of the recent recommendations and guidelines encourage the usage of scoring systems especially in "ruling out" the diagnosis of AA and identifying the intermediate risk patients in need of observation and further diagnostic imaging, The European Association for Endoscopic Surgery (EAES) guidelines recommend that the Alvarado score should be used in determining the likelihood of appendicitis.

In those guidelines, an algorithm is proposed in which the Alvarado score has e major role in stratifying patients with suspected appendicitis for observation, further investigations, or immediate treatment [16].

The recent guidelines of the World Society of Emergency Surgery (WSES) state that although Alvarado and AIR score are both useful in excluding AA and identifying the intermediate risk patients in need of further diagnostic imaging, the AIR score is a better performer as a clinical predictor for AA [17].

These sources state that the use of scoring systems had undoubtedly reduced the need for unnecessary hospitalization, diagnostic imaging, as well as unnecessary surgical interventions.

We found several attempts to use the scoring systems for other than only for establishing the diagnosis of AA. Candranata et al. found a significant relationship between a high Alvarado score and the occurrence of complicated forms of AA in patients with AA who underwent appendicectomy with a 4 times chance of complications if they have a high Alvarado score [18].

De Sousa-Rodriges et al. in their research compared the preoperative values of the Alvarado score and intraoperative evaluation about the stage of AA by the surgeon in 67 patients with histopathologically confirmed AA. The authors concluded that a high score on the scale of Alvarado in patients with appendicitis is correlated with advanced stages of the inflammatory process of AA [19].

Antonachi et al. among other things, investigated the correlation between the values of the Alvarado score and the possibility for conversion to open approach during LA. They did not find a correlation between the groups with and without conversion and the value of the Alvarado score [20].

In our research, we did not find a significant correlation nor association between the values and groups of the Alvarado, AIR and RIPASA score and the emergence of "adverse events" in relation to LA. There was a week positive correlation between higher values of the Alvarado and AIR score and the emergence of adverse events and a week negative correlation between higher value of the RIPASA score and the emergence of adverse events.

Conclusion

The RIPASA scoring system has the highest sensitivity as a diagnostic test in establishing the diagnosis of AA in our population, hence it is the most suitable tool for "ruling out" the diagnosis of AA for our patients.

Throughout the medical facilities in our country the usage of scoring systems in establishing the diagnosis of AA is almost null so the previous statement may be used in choosing just the right scoring system when one wants to start using them. The investigated scoring systems Alvarado, AIR and RIPASA could not be used for predicting a possible unwanted course in patients with AA treated with LA.

Conflict of Interest

The authors declare that they have no conflict of interests.

Ethics Statement

The research was approved by the Ethics Committee for Human Research of the Teaching Scientific Council of the Medical Faculty, at Ss. Cyril and Methodius University in Skopje and by the directors of the corresponding institutions.

Reference

1. Alvarado A. A practical score for the early diagnosis of acute appendicitis. Ann Emerg Med. 1986 May;15(5):557-64.
2. Kalan M., Talbot D., Cunliffe WJ., Rich AJ. Evaluation of the modified Alvarado score in the diagnosis of acute appendicitis: a prospective study. Ann R Coll Surg Engl. 1994 Nov; 76(6): 418–9.
3. Andersson M., Andersson RE. The appendicitis inflammatory response score: a tool for the diagnosis of acute appendicitis that outperforms the Alvarado score. World J Surg. 2008 Aug;32(8):1843-9.
4. Chong CF., Adi MI., Thien A., Suyoi A., Mackie AJ., Tin AS., Tripathi S., Jaman NH., Tan KK., Kok KY., Mathew VV., Paw O., Chua HB., Yapp SK. Development of the RIPASA score: a new appendicitis scoring system for the diagnosis of acute appendicitis. Singapore Med J. 2010 Mar;51(3):220-5.
5. Chong CF., Thien A., Mackie AJ., Tin AS., Tripathi S., Ahmad MA., Tan LT., Ang SH., Telisinghe PU. Comparison of RIPASA and Alvarado scores for the diagnosis of acute appendicitis. Singapore Med J. 2011 May;52(5):340-5.

6. Ohle R., O'Reilly F., O'Brien KK., Fahey T., Dimitrov BD. The Alvarado score for predicting acute appendicitis: a systematic review. BMC Med. 2011 Dec 28;9:139.
7. Frountzas M., Stergios K., Kopsini D., Schizas D., Kontzoglou K., Toutouzas K. Alvarado or RIPASA score for diagnosis of acute appendicitis? A meta-analysis of randomized trials. Int J Surg. 2018 Aug;56:307-14.
8. Favara G., Maugeri A., Barchitta M., Ventura A., Basile G., Agodi A. Comparison of RIPASA and ALVARADO scores for risk assessment of acute appendicitis: A systematic review and meta-analysis. PLoS One. 2022 Sep 30;17(9):e0275427.
9. de Castro SM., Unlu C., Steller EP., van Wagensveld BA., Vrouenraets BC. Evaluationofthe appendicitis inflammatory response score for patients with acute appendicitis. World J Surg. 2012 Jul;36(7):1540-5.
10. Kularatna M., Lauti M., Haran C., MacFater W., Sheikh L., Huang Y., McCall J., MacCormick AD. Clinical Prediction Rules for Appendicitis in Adults: Which Is Best? World J Surg. 2017 Jul;41(7):1769-1781.
11. Malik MU., Connelly TM., Awan F., Pretorius F., Fiuza-Castineira C., El Faedy O., Balfe P. The RIPASA score is sensitive and specific for the diagnosis of acute appendicitis in a western population. Int J Colorectal Dis. 2017 Apr;32(4):491-7.
12. Madasi V. Comparison of predictive validity of Alvarado score and Appendicitis Inflammatory Response (AIR) Score, a hospital based observational study. Int J surg Orthopedics 2016;2(3):29-34.
13. Kollar D., McCartan DP., Bourke M., Cross KS., Dowdall J., Predicting acute appendicitis? A comparison of the Alvarado score, the Appendicitis Inflammatory Response Score and clinical assessment. World J Surg. 2015 Jan;39(1):104-9.
14. Karami MY., Niakan H., Zadebagheri N., Mardani P., Shayan Z., Deilami I., Which one is better? Comparison of the Acute Inflammatory Response, Raja Isteri Pengiran Anak Saleha Appendicitis and Alvarado scoring systems. Ann Coloproctol. 2017 Dec;33(6):227-31.
15. Nanjundaiah N., Mohammed A., Shanbhag V., Ashfaque K., Priya SA.. A comparative study of RIPASA score and Alvarado score in the diagnosis of acute appendicitis. J Clin Diagn Res. 2014 Nov;8(11):NC03-5.
16. Gorter RR., Eker HH., Gorter-Stam MA., Abis GS., Acharya A., Ankersmit M et al. Diagnosis and management of acute appendicitis. EAES consensus development conference 2015. Surg Endosc. 2016 Nov;30(11):4668-4690.
17. Di Saverio S., Podda M., De Simone B., Ceresoli M., Augustin G., Gori A et al. Diagnosis and treatment of acute appendicitis: 2020 update of the WSES Jerusalem guidelines. World J Emerg Surg. 2020 Apr 15;15(1):27
18. Candranata DPE., Christian NWS., Wiargitha K., Suwedagatha G., Adiputra PAT., Sueta MAD. Relationship between high Alvarado scores and complicate acute appendicitis in acute appendicitis patients that undergo appendicectomy surgery. International Journal of Research and Review. 2022; 9(6): 150-156.
19. Sousa-Rodrigues CF., Rocha AC., Rodrigues AK., Barbosa FT., Ramos FW, Valoes SH. Correlation between the Alvarado scale and the macroscopic aspect of the appendix in patients with appendicitis. Rev Col Bras Cir. 2014 Sep-Oct;41(5):336-9.
20. Antonacci N, Ricci C, Taffurelli G, Monari F, Del Governatore M, Caira A, Leone A, Cervellera M., Minni F., Cola B. Laparoscopic appendectomy: Which factors are predictors of conversion? A high-volume prospective cohort study. Int J Surg. 2015 Sep;21:103-7.