A new practical score for early diagnosis of appendicitis in the emergency department

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Abstract:

Background: Acute abdominal pain is the most common complaint encountered in the emergency department. Appendicle pathology, the most frequent cause of this acute abdominal pain, can be extremely challenging to identify, requiring laboratory testing, and layered diagnostic imaging. In this case, clinical scoring systems can be helpful.

The purpose of this study is to develop and validate a new predictive score based on clinical and laboratory variables that can help the physician to identify patients at high or low risk for appendicitis in the emergency department.

Materials and methods: This study was designed as a prospective one-year study from January to December 2017 and included 200 patients older than 16 years admitted to the emergency department with abdominal pain indicating acute appendicitis. The final diagnosis of acute appendicitis was provided by the specific examination of the surgical specimen. Statistical analysis was performed using SPSS version 21. A score was derived from a multiple regression analysis. The ROC curve was obtained from which the appropriate cut-off value was identified for dichotomization.

Results: There were 200 patients enrolled in this study divided into two groups: 97 were diagnosed with acute appendicitis and 103 hadn't appendicitis. Our final score was composed of 7 variables: WBC count > 10,000 (2 points), tenderness in RLQ (2 points), migration of pain from the epigastrium to the RLQ (2 points), a positive Blumberg sign (1 point), a positive Rovsing sign (1 point), a sensible abdomen (2 points), vomiting≥ 2 (1point). The discrimination power of the constructed score was good (area under the receiver operating characteristic curve= .937), even better than the Alvarado score (area under the ROC curve=.887). Our score performed well (P = .88). The score has good sensitivity and negative predictive value at a cutoff value of 4.

Conclusion: bio-clinical scores can be used as a basis for a structured algorithm for the management of patients consulting for abdominal pain, several scores have been developed (Alvarado, Andersson, François ...) but this is not common practice. In this study, we have developed a new clinical-biological predictive score (SAAS score) for acute appendicitis which is practical and easy but it remains to be validated in external centers.

Keywords: Appendicitis; Emergency Department, Clinical Score, Predictive Factors.

INTRODUCTION

Acute non-traumatic abdominal pain is a frequent reason for emergency room visits, the most frequent etiology of which is acute appendicitis (AA) but which only represents 50% of cases of pain syndrome in the right iliac fossa (RIF) (1). The incidence of AA is highest between 10 and 30 years of age, but it can occur at any age (2, 3).

The diagnosis of AA most often represents a challenge for the clinician because of the large number of differential diagnoses (4), and its management is controversial (5,6): either surgical exploration at the slightest doubt, hoping to avoid perforated AA, but at the cost of a high rate of negative explorations, which does not seem acceptable at present, that is close surveillance, thus making it possible to reduce the number of unnecessary surgical procedures, but at the cost of the significant cost of hospitalization and repeated examinations.

The diagnosis is essentially based on a careful clinical examination and a few simple biological examinations with a large amount of subjectivity linked to the practitioner's experience.

Thus to improve «clinical expertise» and to ensure the proper use of additional examinations, clinical-biological scores have been proposed. Several scores have been developed over the years such as the Alvarado score which is the best-known and published in the literature (7, 8).

In the emergency department of Sahloul hospital, the first experience in 2016 resulted in a predictive acute appendicitis score more suited to the Tunisian population.

The major problem linked to the scoring system is the decrease in its performance when it is tested on a new population different from that which led to its birth, hence the interest in validating any new score (9).

The objective of our study is to evaluate a new practical score for early diagnosis of appendicitis.

METHODS

This is a mono-centric, prospective, observational study carried out in the emergency department of Sahloul hospital in Sousse, conducted over a period of one year from January 2017 on a population of 200 patients consulting the emergency room for a pain syndrome of the right iliac fossa.

We included in this study any patient aged ≥ 16 years who consults for an IDF pain syndrome suggestive of AA. Non-inclusion criteria age <16 years, patients with a history of appendectomy, post-traumatic abdominal pain, abdominal pain associated with vital failure, and patients referred with an established diagnosis.

The data were collected using a pre-established form (Annex 1) comprising the following parameters: surname and first name, date of consultation, file number, demographic characteristics: age, sex, functional signs: characteristics of pain (localization, paroxysmal, constant, worsening, irradiation of the epigastrium towards the RIF), associated signs (number of vomiting, stopping of materials and gases, micturition burns), duration of evolution, Physical examination: temperature, abdominal examination (normal, RIF sensitivity or defense,

generalized contracture), Rovsing sign, Blumberg sign.

Para-clinical examinations: Biological (white blood cells, CRP, others) and Radiological (ultrasound or abdominal scanner)

The SAAS (Acute Appendicitis Score for Sahloul Emergency) score was calculated for all patients. During a period of six months from January 2016, the first study was made, in the emergency department of Sahloul0, on 400 patients consulting for suspected acute appendicitis, leading initially to the development of a predictive score acute appendicitis (version 1) which constitutes the main core of our SAAS score (version 2). The area under the ROC curve of this first score was 0.903.

The endpoint is the positive diagnosis of acute appendicitis which is purely pathological.

For non-operated patients, the outcome measure was the absence of appendicitis during the short-term follow-up of these patients (on D3).

- ***Statistical analysis:*** The data analysis was carried out using SPSS version 21 software. We calculated simple frequencies and relative frequencies (percentages) for the qualitative variables. We calculated means, medians, and standard deviations and determined the extreme values for the quantitative variables. Percentage comparisons on independent series were performed by the Pearson chi-square test; and if this test is not valid, compare 2 percentages, by Fisher's exact bilateral test. The calibration involves comparing the number of predicted events with the number observed. The calibration was verified using the Hosmer Lemeshow test. The Alvarado score represents the best-known and most described score in the literature. One of the aims of this study was to compare this score to our SAAS score by determining its sensitivity, its specificity, and area under the ROC curve in our study population

RESULTS

This study was conducted over a period of one year, between January and December 2017, on a population of 200 patients consulting our emergency for a pain syndrome of the right iliac fossa. Table 1 details the demographic characteristics of our sample.

The average age was 38±17 years. The distribution by age group showed a clear predominance of young adults. 46.5% of this population was under 30 years of age compared to 13% for subjects over 60 years of age. A slight predominance of women was also noted with a sex ratio of 0.94 (103 women versus 97 men).

Vomiting is the most common clinical sign. They were present in 50% of the cases. The second clinical sign in terms of frequency (24% of cases) was epigastric pain radiating to the right iliac fossa.

The other functional signs such as cessation of materials and gases and voiding burns are less frequent in this population with numbers of 10 and 29 respectively.

Regarding pain in the right iliac fossa, the main reason for consultation, it was present in 100% of the cases and it was paroxysmal in 77% of the cases. Nine patients had generalized contracture. The signs of Rovsing and Blumberg are present at 36% and 20% respectively. In biology, the

blood count was systematically requested in all patients. Hyperleukocytosis is defined as a white blood cell value greater than 10,000 elements / mm3. It was noted in 129 patients or 64.5% of cases.

Table 1: demographic characteristics of the population

Parameters	Appendicitis (n=97)	No Appendicitis (n=103)	p
Age (years); mean±SD	35 ±16	38±14	0.241
Gender; n(%)			
Male	51.5	45.7	0.440
Female	8.4	54.3	
Pain description; n(%)			
RIF pain	97 (48.5)	103 (51.5)	*0.160*
migrant pain	42 (43.8)	6 (5,9%)	*0.003*
Materials and gases stop	5 (4,9)	5 (5.2)	*0,857*
Voiding burns	4 (4.1)	25 (24.5)	*0.255*
Vomiting	50 (50.5)	49 (49.5)	*0.182*
Number of vomits ≥2	43 (44.3)	37(36)	0.002
Physical signs; n(%)			
Fever	46 (47.4)	25 (24.5)	*0.24*
Soft abdomen	1(1)	35(34.3)	*0.16*
Sensitivity RIF	96 (99)	15 (14.7)	*<0.001*
Defense RIF	49 (50.5)	3 (2.9)	*0.004*
Generalized contracture	6(6.2)	3 (2.9)	*0.898*
Rovsing	71 (74)	1 (1)	*<0.001*
Blumberg	39 (40.6)	1 (1)	*0.016*
Blood count analysis			
WBC<10000	14 (14.4)	37 (36)	*0.02*
WBC>10000	79 (81.4)	49 (47.5)	
Imaging			
Ultrasound	78 (80)	96 (93)	
CT scan	8 (8)	18 (17)	
CT scan complementary to ultrasound	2 (2)	4 (4)	

Imaging was requested in 68% of the cases, abdominal ultrasound in 81% of the cases, and an abdominal scanner in 23% of the cases. Acute appendicitis was demonstrated by abdominal ultrasound in 48 patients and by abdominal CT scan in 10 patients. In 6 cases, the abdominal ultrasound was inconclusive, hence the request for an abdominal scanner as an additional examination for diagnosis. One hundred patients were operated on. Pathological examination showed a pathological appendage in 97 cases. A phlegmonous appendix was observed in 36.5% of cases, 18% of patients had a suppurative appendage, and only 6 patients had a gangrenous appendage. A histologically healthy appendix was observed in 3 patients. During this study, 127 patients were hospitalized, or 63.5% of the cases, including 97 patients who presented a diseased appendage to the pathology examination. In 63.5% of cases (n=127), patients were hospitalized, or 63.5% of the cases, including 97 patients who presented a diseased appendage to the pathology examination. The follow-up of the patients on D 3 (by telephone contact) showed the absence of acute appendicitis for the 73 patients who were sent home. During a period of six months from January 2016, the first study was made, within the emergency department of Sahloul, on 400 patients consulting for suspected acute appendicitis (10) leading initially to the development of a predictive acute appendicitis score (version 1) which constitutes the main core of the SAAS score (version 2) (Table 2).

Table 2: Acute appendicitis score for Sahloul emergencies (SAAS) (Version 2)	
Pain radiating from the epigastrium to the right iliac fossa	2
Rovsing positive sign	1
Blumberg sign positive	1
Sensitive abdomen	2
Defense of the right iliac fossa	2
Number of vomiting ≥ 2 episodes	1
White blood cells> 10,000	2

The area under the ROC curve of this first score was 0.903. From this primary score and by simplifying its rating while retaining its diagnostic power, we were able to identify our new SAAS score (Figure 1).

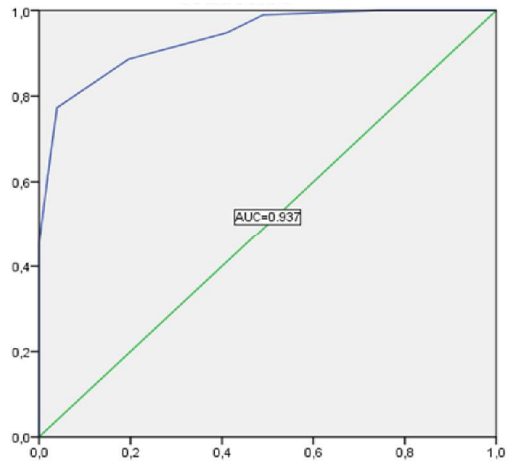

Figure 1: Discriminatory power of the SAAS score in the diagnosis of acute appendicitis

Studying the distribution of this SAAS score in the study population allows us to conclude the following characteristics: Our score varies from 0 to 11 with an average of 4.87 ± 2.90.

- We mainly found patients with scores of 5, 6, and 7; respectively 13.5%, 14%, and 12.2% of the cases.

Three diagnostic probability zones have been defined:

Zone (1): "unlikely appendicitis" for a score value strictly less than 4; containing 65 patients, only 5 of whom had acute appendicitis.

Zone (2): "diagnostic doubt, probable appendicitis" for a score value between 4 and 7; containing 91 patients, 48 of the "appendicitis" group and 43 of the "non-appendicitis" group.

Zone (3): "very probable appendicitis" for a score value strictly greater than 7; containing 44 patients all with appendicitis.

SAAS score validation

This phase consists in determining the qualities of our SAAS score when it is applied to a population different from that leading to its construction and can be summarized in two principles, discrimination and calibration.

The discrimination of a test is its ability to separate subjects who may or may not have the disease. It is linked to sensitivity and specificity. Our SAAS score has excellent sensitivity at 90% and good specificity at 80%.

The discrimination of the SAAS score in the external population is excellent with an area under the ROC curve of 0.937 and uncut-off equal to 4.5 (Table 3).

Table 3: Discriminatory power of the SAAS score in the diagnosis of acute appendicitis			
Score	0-3	4-7	8-11
Sensibility (%)	5.2	49.5	45.4
Specificity (%)	58.8	41.2	0
VPP (%)	7.7	53.3	100
VPN (%)	92.3	46.7	0

A good agreement between appendicitis observed and the expected appendicitis was noted with a Hosmer Lemeshow test at 7

(p = 0.88) which shows a prediction of the SAAS score which is close to reality.

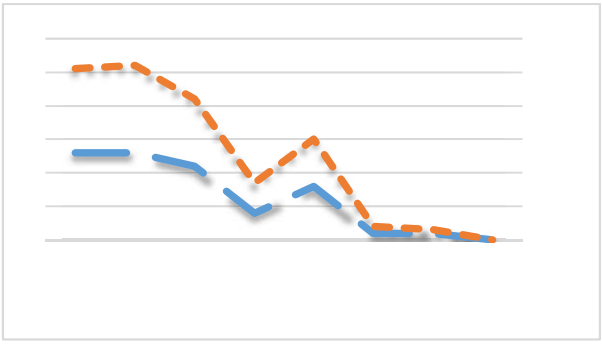

Figure 2: Appendicitis observed (------) and expected (……) according to the SAAS score

The Alvarado score has a good discriminating power in our population with an area under the ROC curve equal to 0.887; and an acceptable sensitivity and specificity which are equal to 85% and 76% respectively (Figure 3, Table 4).

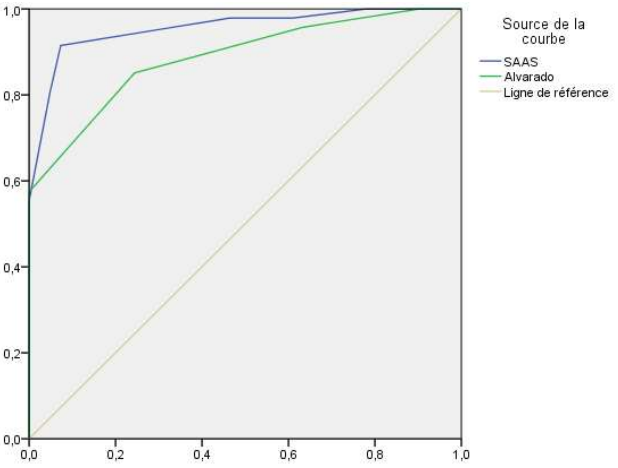

Figure 3: SAAS vs Alvarado score ROC curve

Table 4: SAAS vs Alvarado Score

	SAAS Score	Alvarado Score
Sensibility	90%	85%
Specificity	80%	76%
AUC	0.937	0,887

DISCUSSION

The first stage of our study was carried out in 2016 in the emergency department of Sahloul, on 400 patients consulting for suspected acute appendicitis, whose main objective was to establish a predictive score for acute appendicitis which resulted in a score of 6 items with a total rating of 0 to 17 (10). During this work, we concluded with a score made up of different items according to their probability rate as follows: migration of pain from the epigastrium to the right iliac fossa (2 points), a sign of positive Rovsing (1 point), positive Blumberg sign (1 point), non-flexible abdomen (8 points), white blood cells> 10,000 elements / mm3 (2 points), defense of the right iliac fossa (3 points). To establish a more practical, reliable, reproducible, and easier-to-use diagnostic tool, we have tried to revise this initial score. The objective of creating this score was to stratify the risk of acute appendicitis, thereby guiding the request for additional examinations and the final decision (return home, close surveillance, surgical intervention).

In 1996, Wagner carried out a systematic review of the literature, the objective of which was to assess the discriminating value of elements of the history of the disease and clinical examination for the diagnosis of acute appendicitis in adults. (11). As in our study, the reference test was the pathological examination. In this review including eleven studies (5275 patients), three clinical signs with a likelihood ratio between 3.18 and 8 suggest that one of them must be present to make the diagnosis of acute appendicitis: the pain of the right iliac fossa, migrant pain, and defense.

On the other hand, no sign considered individually had a likelihood ratio large enough to allow, when absent, to exclude the diagnosis of acute appendicitis.

Another study, Anderson's meta-analysis, analyzed the diagnostic value of elements relating to the history of the disease, symptoms, clinical signs, and biological variables in patients admitted for suspected acute appendicitis (12). The analysis combined the results of 24 consecutive prospective studies including 5833 patients. The prevalence of acute appendicitis in this work varied between 26.7 and 60.6% with a median value of around 41%. In this meta-analysis, the clinical signs which have a certain diagnostic value are Migrant pain, Abdominal defense, and Rovsing's sign.

In 2010, the American College of Emergency Physicians (ACEP) (13) issued recommendations with the primary objective of managing patients admitted to the emergency room with suspected acute appendicitis. The main signs and symptoms are Pain in the right iliac fossa, Migrating pain, Sensitivity in the right iliac fossa, and abdominal defense.

By analyzing our results and reviewing the literature, we note that the combination of clinical data and biological markers could have a discriminating power greater than that of the variables considered separately [14]. In fact, in our series, the area under the ROC curve of our SAAS score was 0.937 with excellent sensitivity at 90% and good specificity at 80%.

Based on this principle, several algorithms have been proposed to assess, according to a scoring system, the probability of acute appendicitis. Some clinical-biological scores are easier to use than others depending on the number of items. Several scoring systems have been described. The oldest (created in 1986), the best known and most used in the literature for its simplicity [15, 16] was the Alvarado score (Table 5).

It makes it possible to set up a well-defined attitude of care according to the probability of acute appendicitis. It is effective in excluding the diagnosis of acute appendicitis for a score less than 5, thus allowing the patient to return home provided that he can quickly reconsult in case of worsening of the symptomatology (17). The two major problems with this score are the presence of a selection bias, especially since it was established from a population of patients operated on for suspected appendicitis and not from patients consulting for suspicion of acute appendicitis such as our SAAS score.

Table 5: Alvarado Score

Items	Score
Migrating pain to the right iliac fossa	1
Anorexia	1
Nausea / Vomiting	1
Temperature ≥ 37 ° C	1
Defense in right iliac fossa	2
Percussion defense in right iliac fossa	1
White blood cells ≥ 10,000 / mm3	2
Neutrophils> 75%	1
Total	10

By way of comparison, the application of the Alvarado score to our study population showed good results concerning the area under the ROC curve which was 0.887, and its sensitivity and specificity which were 85% and 76 respectively. %; but compared to our SAAS score, we found more interesting results.

A study comparing multiple diagnostic scores for acute appendicitis [18] showed that the Fenyö-Lindberg score had very good sensitivity, especially for the male population, despite the selection bias where the included population was already selected for suspicion. of acute appendicitis. The limit value for the diagnosis of acute appendicitis in this scoring system is (-2). This score showed a positive predictive value significantly higher than clinical examination alone, 90% versus 79% (19). In women aged 15 to 50, the positive predictive value was significantly improved by this score, 86% compared to 68% for the clinic alone (20). A negative point to this score is that it includes several items and therefore is difficult to use.

To set up an algorithm for management in the emergency department, the use of the SAAS score could guarantee an adequate therapeutic decision with an acceptable cost, especially when one can get rid of a good number of radiological examinations when one is in the low score area. Hence the idea of a new study deserves to be conducted to establish the impact of the use of our SAAS score on the use of additional examinations.

CONCLUSION

The SAAS score varies from 0 to 11. When the value of the SAAS score is strictly greater than seven, the indication for an appendectomy can be urgently asked in front of an excellent PPV which is 100%. On the other hand, when this value is strictly lower than four, the patient will not have another investigation considering his good VPN which is at 92.3%. On the other hand, when it is between four and seven, the SAAS score can be reassessed remotely before starting the investigations. It is therefore a score that is more efficient in an informed environment.

In the end, our new SAAS score, with excellent discrimination (the area under the curve is 0.937) and a good calibration (Lemeshow test = 7), was successfully validated on a population admitted for suspected acute appendicitis which most closely corresponds to the population to which this score will be applied in the future, and has also shown better diagnostic performance than the Alvarado score for acute appendicitis.

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