Original Article **Brunei Int Med J.** 2010; 6 (1): 17-26

Evaluation of the RIPASA Score: a new scoring system for the diagnosis of acute appendicitis

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ABSTRACT

Introduction: We recently developed a scoring system for diagnosis of acute appendicitis. This study prospectively evaluates the Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) score for the diagnosis of acute appendicitis in patients presenting to the Accident and Emergency department or the Surgical wards with right iliac fossa pain. **Materials and Methods:** From November 2008 to April 2009, consecutive patients presenting to the Accident and Emergency department or the surgical wards with right iliac fossa pain were recruited for the study. The RIPASA score was applied but the decision for radiological investigations or emergency appendicectomy was made based on clinical judgement. Receiver operating curve (ROC), sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of the new scoring system were derived. Ethical approval for the study was obtained from the Medical and Health Review Ethics Committee. **Results:** Within six months, 144 consecutive patients with a mean age of 29.5 ± 13.3 yrs were recruited to the study. Ninety-eight patients underwent emergency appendicectomy of which 79 were confirmed histologically for acute appendicitis. The observed negative appendicectomy rate was 19.4%. The optimal cut-off threshold score from the ROC was 7.5, with a sensitivity of 97.5%, specificity of 81.8%, PPV of 86.5%, NPV of 96.4% and a diagnostic accuracy of 91.8%. The predicted negative appendicectomy rate was 13.5%, which is a 5.9% reduction from the observed rate of 19.4% (p=0.3). **Conclusion:** The RIPASA score is a more suitable appendicitis scoring system developed for our local settings with a population that is reflective of our region in South-east Asia and has high sensitivity, specificity and diagnostic accuracy.

Keywords: Acute appendicitis, appendicectomy, diagnostic techniques, surgical, symptoms

INTRODUCTION

Acute appendicitis is one of the most common surgical emergencies in clinical practice, with an estimated life time prevalence approximately 1 in 7.[1] The incidence is 1.5 to 1.9 per 1000 in male and female with approximately 1.4 times greater in men than in women.[2]

Diagnosis of acute appendicitis is based purely on clinical history and examina-

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tion combined with a few laboratory investigations such as elevated white cell count. Despite being a common problem, acute appendicitis remains a difficult diagnosis to establish in some cases, particularly in the young, elderly and female patients of reproductive age where a host of other genitourinary and gynaecological inflammatory conditions can also present with similar signs and symptoms of acute appendicitis.[3] Several scoring systems have been developed to aid in the decision making process of deriving a diagnosis of acute appendicitis in the fastest and cheapest way. The 'Alvarado score' and the 'Modified Alvarado score' are the two most commonly used scoring system available.[4,5] Reported sensitivity and specificity for both Alvarado and the Modified Alvarado scores ranges from 53 to 88% and 75 to 80% respectively.[4,5] However, these scoring systems were developed in western countries and several studies have reported very low sensitivity and specificity when applied to a population with a completely different ethnic origin and diet.[6-8]

The Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) score is a simple qualitative scoring system based on 14 fixed clinical parameters (two demographics, five clinical symptoms, five clinical signs and two clinical investigations) and one additional parameter (foreign national Identity card) as shown in the Appendix. We recently reported our retrospective analysis of the RIPASA score which showed a sensitivity and specificity of 88% and 67% respectively with a diagnostic accuracy of 81%.[9] In this study, we report on the prospective evaluation of the RIPASA score in patients presenting with right iliac fossa (RIF) pain.

MATERIALS AND METHODS

Patients: 144 consecutive patients presenting to the Accident and Emergency department (AED) or the Department of Surgery at Raja Isteri Anak Saleha (RIPAS) Hospital from November 2008 to April 2009, with RIF pain were recruited for the study. All patients of all age groups presenting with RIF pain, suspected to be acute appendicitis were included in this study. Patients presenting with non-RIF pain and those who have been admitted by other specialties for other complains but who subsequently developed RIF pain were excluded from the study. Ethical approval to conduct the study was granted by the Medical and Health Review Ethics Committee (MHREC) at RIPAS Hospital.

Scoring of RIPASA score sheet: Prospective evaluation of the RIPASA score was done by the completion of the score sheet (Appendix). The score sheet does not contained the actual scores for each parameter in order to avoid the total score biasing the judgement of the admitting surgeon in his/her decision making with respect to appendicectomy, which was still solely based on the surgeon's own clinical judgement for this prospective evaluation study.

Initial scoring was performed by an AED senior medical officer (SMO) if the patient is seen in the AED. Scoring thereafter will be carried out by the admitting surgeon when the patient is admitted to the surgical ward or if the patient has been referred directly to the admitting surgical team by the general practitioner. Only scores derived by a surgeon of senior grade (Post membership SMO or equivalent registrar or consultant) will be considered.

Scoring was performed at every review; either two hourly or at the next morning ward round if the patient's was admitted in the early hours of the morning, until a decision was made for either appendicectomy or continued conservative observation/treatment. Completed forms were collected by the ward clerk and kept in a folder specifically for the study. There were later collected by the study coordinator at regular intervals.

Data regarding patients' admission and discharge dates, date of appendicectomy if performed, name and signature of confirming surgeon, post-operative complications and use of radiological investigations were recorded in the score sheet. All histological confirmation of appendicular specimens obtained from emergency appendicectomy were reviewed by a single senior pathologist at Department of Pathology, RIPAS hospital.

Patients who were treated conservatively and subsequently discharged were reviewed once in the surgical out-patient clinic a week after discharge. Patients who were discharged from the AED were reviewed at the AED clinic. All patients with true negative RIPASA score status were later contacted via telephone within a month to confirm their true negative RIPASA score status and that they have not been readmitted and have undergone emergency appendicectomy either at RIPAS or at another hospital at a later date.

As all pathological specimens were sent to the Department of Pathology at RIPAS hospital, confirmation of true negatives were further collaborated by cross referencing with the patient's name to specimens at the Department of Pathology services.

Statistical Analysis: Receiver operating curve (ROC) at the optimal cut-off threshold score for the RIPASA score was derived using StatsDirect statistical software version 2.7.2 (StatsDirect Ltd, Cheshire, UK 2008). Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and diagnostic accuracy at the optimal cut-off threshold score were also derived from the ROC. Predicted negative appendicectomy rates for the RIPASA score was also derived and compared with the observed negative appendicectomy rate using the Chi-square test for statistical analysis.

RESULTS

Demographic and operative details for the 144 study patients are shown in Table 1. The mean age of the group was 29.5 ± 13.3 years with slightly more female (male:female ratio, 1:1.3).

Ultrasound investigations were performed in only 25.7% of all patients with majority (81.8%) performed in female patients (Table 1) and 62.2% were in patients with score <7.5 (Table 2).

Of the 144 patients, 98 patients had emergency appendicectomy for high clinical suspicion of acute appendicitis. The remaining patients were managed conservatively as the clinical suspicions for acute appendicitis were low. Of the patients who had appendicectomy, 79 had histologically confirmed acute appendicitis, of which seven cases (9.1%) had perforated appendicitis (Table 2). Nineteen cases were negative for acute appendicitis and histology specimen showed normal appendix in 14 and peri-appendicitis (serosal inflammation without mucosal involvement) in five pa

patients, indicating a negative appendicectomy rate of 19.4%. The mean duration of hospital stay was 4.4 ± 1.9 (1 to 16) days. Post-operative complications rate was 4.1% (Table 1). All 144 patients were discharged alive.

RIPASA score

Table 2 showed the distribution of the 144 patients in 4 groups, according to the RIPASA score at cut-off threshold score of 7.5. Of the 79 positive cases of acute appendicitis, 77 were in patients with RIPASA scores >7.5 (true positive). Only two cases with positive appendicitis had RIPASA score <7.5 (false negative). Of the 19 patients who had negative appendicitis, 12 were in patients with RIPASA scores >7.5 (false positive) and seven were in patients with RIPASA score <7.5 (true negative). In total 53 patients had true negative RIPASA scores with confirmation of true negative RIPASA score status in 46 patients through telephone contact at one month after the episode.

There were no difference in the mean age among all four groups (p=0.6). The mean total RIPASA scores for each group is shown in Table 2. The true positive cases had a higher mean RIPASA scores of 10.4 ± 1.8 (7.5 to 15) compared to the true negative cases (5.8 ± 1.0, [3.0 to 7.0]). The patients with perforated appendicitis had a mean RIPASA score of 10.4 ± 2.4. Both the true negative and false negative groups have significantly more RIPASA score readings performed than the true positive and false positive groups (Table 2). Patients in the true positive group had a median number of readings of one performed before a decision was made for emergency appendicectomy. Those with multiple readings, the trend of the total score remained high (Fig. 2a). Compared with the true negative group, the median number of readings was three with the RIPASA score decreasing after the second reading (Fig. 2b).

Table 1: Demographic and operative details of patients (n =144).

Demographic	
Mean age	29.5 ± 13.3 years
Gender (Male: Female)	62 (43.1): 82 (56.9)
Admission diagnosis	
Clinical suspicion of acute appendicitis	98 (68.1)
None appendicitis	46 (31.2)
Operative details	
Total emergency appendicectomy	98 (68.1)
Laparoscopic appendicectomy	22 (15.4)
Open appendicectomy	122 (84.6)
Histology findings	
Confirmed appendicitis	79 (54.9)
Normal appendix	19 (19.4)
Post-operative complications	4 (4.1)
Superficial wound infection	4 (4.1)
Bowel obstruction	1 (1.0)
Haematuria secondary to urinary catheter	1 (1.0)
Mean Hospital stay	4.4 ± 1.9 days (1-16)

Figures presented in parenthesis are percentage

Table 2: Distribution of patients according to RIPASA scores with cut-off threshold at 7.5.

	RIPASA score				P
	True +ve >7.5	**False –ve** >7.5	**True –ve** <7.5	**False –ve** <7.5	
Sample size (n)	77	12	53	2	
Gender (Male : Female)	45 : 32	3 : 9	14 : 39	0 : 2	
Mean age (yrs)	27 ± 14.8	24.2 ± 10.8	24.7 ± 11.5	20 ± 4.2	0.6
Median number of scores taken (range)	1 (1-4)[*†]	2 (1-3)[*‡]	3 (1-6)[*]	3.5 (3-4)[† ‡]	[*]<0.0001 [†]0.02 [‡]0.04
Total score (range)	10.4 ± 1.8 (7.5-15)	9.5 ± 1.3 (7.5-11.5)	5.8 ± 1.0 (3.5-7.0)	5.5 ± 0.7 (5-6)	
Ultrasound investigation	32.4% Male=5, Female=7	5.4% Female=2	53.8% Male=2, Female=19	5.4% Female=2	
Mean hospital stay (range)	5.3 ± 2.0 * (3-16 days)	4.3 ± 1.2 (3-8 days)	3.0 ± 1.1 * (1-7 days)	4.0 ± 1.4 (3-5 days)	*<0.0001
Diagnosis					
Acute appendicitis	70 (90.9%)			2 (100%)	
Perforated appendicitis/abscess	7 (9.1%)				
Peri-appendicitis		3 (25%)	2 (3.8%)		
Normal appendix		9 (75%)	5 (9.4%)		
Non-specific abdominal pain			34 (64.2%)		
Gynaecological pathology			4 (7.5%)		
Constipation/adhesion colic			1 (1.9%)		
? Early appendicitis			7 (13.2%)		
Predicted negative appendicectomy rate			13.5%		

The hospital stay was significantly longer in the true positive group compared with the true negative group (Table 2, p<0.0001), which corresponded to the longer post-operative period observed in the former following emergency appendicectomy.

ROC, sensitivity, specificity, PPV and NPV of the new appendicitis scoring system

The optimal cut-off threshold score derived from the ROC analysis was 7.5 as shown in Fig. 3. Based on this optimal cut-off threshold score of 7.5, the calculated sensitivity and specificity were 97.47%% (95% CI: 91.15% to 99.69%) and 81.82% (95% CI: 70.39% to 90.24%) respectively. The PPV and NPV were 86.52% and 96.43% respectively (Fig. 3). The diagnostic accuracy was 91.79% (95% CI: 86.91% to 96.67%). The predicted negative appendicectomy rate at the optimal cut-off threshold score of 7.5 was 13.5% which is a 5.9% reduction from the raw data (19.4%), however this did not achieve statistical significance (p=0.28).

DISCUSSION

Acute appendicitis is one of the most common surgical emergencies encountered especially by junior doctors during on call duties with emergency appendicectomy making up 10% of all emergency abdominal surgeries.[10,11] Despite this, making a quick and accurate diagnosis of acute appendicitis can be difficult. Radiological investigations such as computed tomography (CT) scan has been reported to have high sensitivity (94%) and specificity

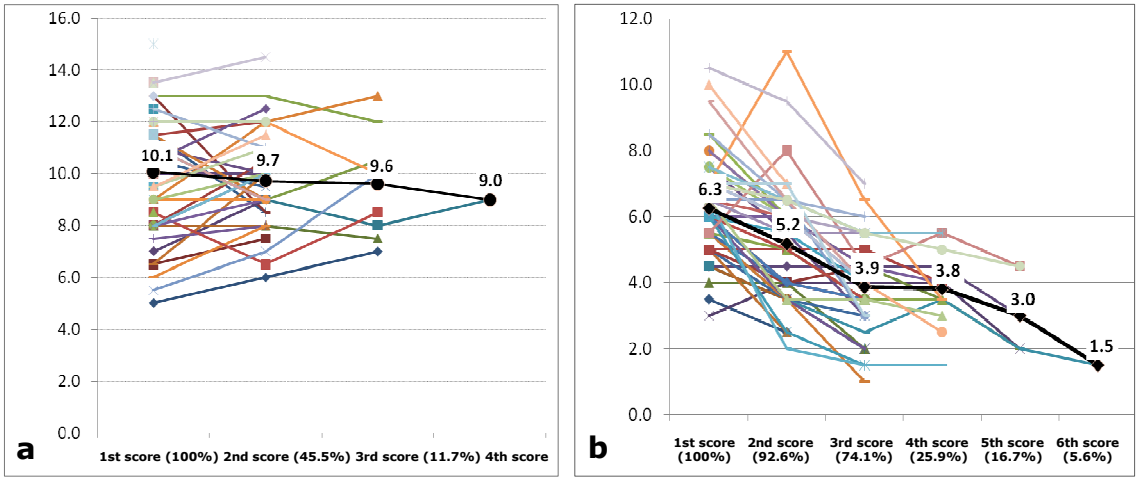

Figure 2: (a) Chart showing a horizontal trend of total RIPASA score which remains above 7.5, despite repeated scoring, in the true positive group of patients with confirmed acute appendicitis (RIPASA score >7.5). (b) Chart showing decreasing trend of total score with each repeated scoring, in the true negative group of patients (RIPASA score <7.5). (Note: x-axis represents the number of scoring performed and the percentage in bracket represents the percentage of patients with scoring performed).

(95%) for diagnosing acute appendicitis.[12] It is now common practice in major centres to perform a CT scan in all patients suspected of having acute appendicitis.[13] However, such practice can be very costly and stretch an already overburdened national healthcare system. Furthermore, arrangement for CT scan may delay emergency appendicectomy. Recent reports have suggested that the indiscriminate use of CT scan may lead to the detection of early low-grade appendicitis and these patients may then be subjected to unnecessary appendicectomy, in a condition that would otherwise have resolved spontaneously with antibiotics therapy.[14]

Several scoring system such as the Alvarado and the Modified Alvarado scoring system had been introduced since 1986 to help with clinical decision making process in achieving an accurate diagnosis of acute appendicitis in the fastest and cheapest way.[4,5] Such scoring systems also provide guidelines to help junior doctors to select patients for either emergency appendicectomy or conservative management with further radiological investigations if required.[4,5]

Despite good sensitivity and specificity when applied to a western population, both these scoring systems have been shown to achieve low sensitivity and specificity, ranging from 50 to 59% and 23 to 94% respectively, when applied to Middle Eastern, Asian or oriental populations.[6-8] Because of the poor sensitivity and specificity of both the Alvarado and the Modified Alvarado scoring systems, our unit has developed the RIPASA score which is more applicable to our local population.

This prospective evaluation of our RIPASA score correctly classified 97% of all patients with confirmed histological acute appendicitis to the high probability group (score >7.5) and 81.5% of negative appendicitis to the low probability group (score <7.5). Only 9.7% of the patients remained in the indeterminate group, a group of patients who may require further radiological investigations in the form of an abdominal ultrasound. These results clearly out perform both the Alvarado

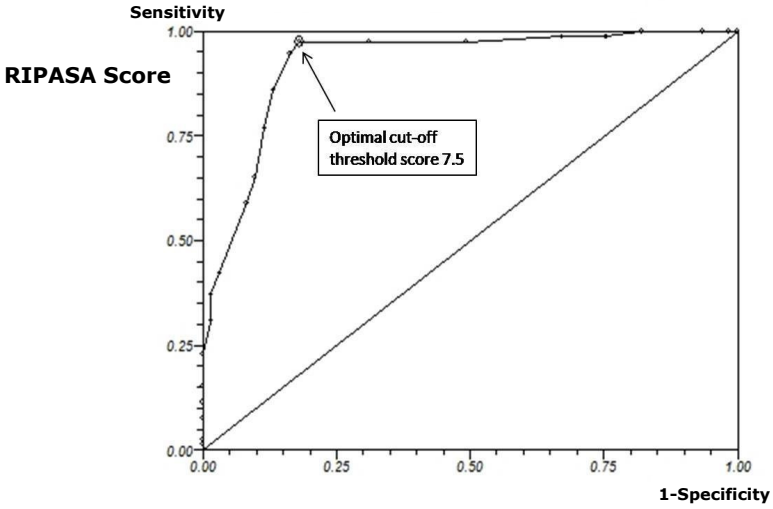

Figure 3: ROC plot for the RIPASA score.

and the Modified Alvarado scores when applied to a similar population. [6-8]

Recently, a new scoring system called 'Appendicitis inflammatory response score' was introduced by Andersson *et al* in 2008. This scoring system had a sensitivity of only 96% and a specificity of 73% for a cut-off threshold set at >4 or a sensitivity of 37% and specificity of 99% if the cut-off threshold was set at >8.[13] Using this Appendicitis inflammatory response score, 73% of the non-appendicitis patients (true negative and false positive) were classified to the low probability group while 67% of patients with advanced appendicitis (true positive and false negative) were classified to the high probability group with a high accuracy, in comparison with 97% and 82% respectively for the RIPASA score. In the Appendicitis inflammatory response score, a significantly higher percentage (37%) of patients were in the indeterminate group, in comparison with 9.7% for the RIPASA score (p<0.0001). [13]

Using the RIPASA score, the predicted negative appendicectomy rate was 13.5%, which is a 5.9% reduction from the observed rate of 19.4%. However, the difference did not achieve statistical significance (p=0.28), probably due to the small sample size. With a sample size of more than 300 patients as reported in our development phase of the RIPASA score, we were able to achieve a predicted negative appendicectomy rate of 6.9%, a significant reduction of 9.3% from the observed rate of 16.3% (p<0.0007). [6,9] This reduction in unnecessary negative appendicectomy would translate to significant healthcare cost saving as well as unnecessary morbidity subjected to the patients. Furthermore, the sensitivity and specificity achieved by the RIPASA score is equivalent to those achieved with CT scan for acute appendicitis.[12] Hence by applying the RIPASA score, the number of costly CT scans performed to exclude acute appendicitis can be reduced to only the indeterminate group (9.7%).

Based on the results of this prospective evaluation, guidelines for management of patients suspected of acute appendicitis based on the RIPASA score were drawn up as shown in table 3. For female patients with

Table 3: Management guidelines for patients presenting with RIF pain suspected of acute.

Total RIPASA Score	Management guidelines
<5.0	Probability of acute appendicitis is unlikely, observe patient in the AED day-ward and repeat score after 1 to 2 hrs, if reducing score, discharge and review in clinic. If increasing score, treat according to score level.
5.0-7.0	Low probability of acute appendicitis, observe in the AED day-ward and repeat scoring after 1 to 2 hrs or perform radiological investigations (abdominal ultrasound) to rule out acute appendicitis. If reducing score, discharge and review in clinic. If increasing score or no change, patient may need admission for observations, discussed with surgeon on-call.
7.5-11.5	Probability of acute appendicitis high, refer patient to on-call surgeon for admission and repeat score in 1 to 2 hours time. If remain high, prepare patients for appendicectomy procedure. In female patients, suggest perform radiological investigations such as an abdominal ultrasound investigations to rule out gynaecological causes of RIF pain.
>12	Definite acute appendicitis, refer to surgeon on-call for admission and appendicectomy. Keep nil by mouth. Start appropriate antibiotics based on institutional antibiotic guidelines.

score between 7.5 and 12, it would be advisable to perform further investigations such as an abdominal ultrasound to exclude pelvic pathology, as 75% of patients in the false positive group were female.

The RIPASA score is a simple and easy to use quantitative scoring system and as shown in Appendix, most of these 14 clinical parameters are easily obtained from a good clinical history and examination. This also include a urinalysis which can be easily performed on the spot. Hence a score can be obtained quickly and a rapid diagnosis made without having to wait for the full investigations to be available when a score of >7.5 is obtained. The additional parameter which is unique to our local population consists of foreign nationality. As previously explained, foreign nationals were included as an additional parameter as the probability of acute appendicitis among foreign nationals presenting with RIF pain was 0.96 based on logistic regression analysis.[6,9]

Although the RIPASA score was specifically developed for our local population, the 14 fixed clinical parameters are general to all populations and hence the RIPASA score can be applied in any country. The additional parameter of foreign NRIC can be included to the score in countries where there is a large foreign work-force like our own who have to pay for any healthcare treatment.

In conclusions, the RIPASA score is a simple scoring system with high sensitivity and specificity for the diagnosis of acute appendicitis. The 14 clinical parameters are all present in a good clinical history and examination and can be easily and quickly applied. Therefore, a decision on the management can be made early. Although the RIPASA score was developed for our local population, we believe that it should be applicable to all regions.

ACKNOWLEDGEMENTS

RIPASA scoring prospective evaluation study group consisted of the following:

Department of Surgery: Chee Fui CHONG, Amy THIEN, Ahamed Jiffri Ahamed MACKIE, Aung S TIN, Sonal TRIPATHI, Mohammad Ady Adillah AHMAD, Lian Tat TAN, Firdaus Mohamad MAT DAUD and Caroline TAN.

Department of Pathology: Pemasiri Upali TELISINGHE.

Department of Accident and Emergency: Swee Hui ANG.

Special thanks to Kim Khee TAN, Kenneth Yuh Yen KOK, Varkey Vallikad MATHEW, Oo PAW, Hock Beng CHUA, Samuel Kai San YAPP, all from the Department of Surgery and staffs at Wards 2 (Paediatric), 6, 7 (Surgical) and RIPAS Hospital Accident and Emergency Department for their help.

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RIPAS APPENDICITIS (RIPASA) SCORE

PATIENT'S NAME:_____ **AGE**: _____

NRIC NO:_____ **Hospital Record No**:_____

Date of Assessment							
Time of Assessment							
	Score	**Score**	**Score**	**Score**	**Score**	**Score**	**Score**
Patient's Demographic							
Female	**0.5**						
Male	**1.0**						
Age < 39.9 yrs	**1.0**						
Age > 40 yrs	**0.5**						
Symptoms							
RIF pain	**0.5**						
Pain migration to RIF	**0.5**						
Anorexia	**1.0**						
Nausea & Vomiting	**1.0**						
Duration of symptoms <48 hrs	**1.0**						
Duration of symptoms >48 hrs	**0.5**						
Signs							
RIF tenderness	**1.0**						
Guarding	**2.0**						
Rebound tenderness	**1.0**						
Rovsing's Sign	**2.0**						
Fever >37ºC, <39ºC	**1.0**						
Investigations							
Raised WCC	**1.0**						
Negative urinalysis	**1.0**						
Additional Scores							
Foreign I.C.	**1.0**						
Total							

The total score is achieved by adding all the score for each category together. Additional score is added for patient with foreign identification card. Repeat scoring should be performed at every review of the patient.

*** Guidelines for management according to total score:**

<5 = Probability of acute appendicitis is unlikely, observe patient in the A&E dayward and repeat score after 1-2 hrs, if reducing score, discharge. If increasing score, treat according to score level.

5-7.0 = Low probability of acute appendicitis, observe in the A&E dayward and repeat scoring after a 1-2 hrs or perform abdominal ultrasound investigations to rule out acute appendicitis. Patients may need admission for observations, discussed with surgeon on-call.

7.5-11.0 = Probability of acute appendicitis high, refer patient to on-call surgeon for admission and repeat score in 1-2 hours time. If remain high, prepare patients for appendicectomy procedure. In female patients, suggest perform abdominal ultrasound investigations to rule out gynaecological causes of RIF pain.

>12 = Definite acute appendicitis, refer to surgeon on-call for admission and appendicectomy.

Date of Appendicectomy: …… Histology: ……

Signature of surgeon confirming diagnosis: …… Name: ……...

ONCE SCORING IS DONE, PLEASE ATTACH THIS FORM TO PATIENT'S NOTES AS PART OF PATIENT'S CLERKING IN SHEET. THANK YOU.

NOTE: During the study period, the scores for the different variables (grey column) and the guidelines (*) were removed to blind the attending surgeons to RIPASA score of the patients.