The accuracy of the Alvarado score in predicting acute appendicitis in the black South African population needs to be validated

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Background: The Alvarado score is the most widely used clinical prediction tool to facilitate decision-making in patients with acute appendicitis, but it has not been validated in the black South African population, which has much wider differential diagnosis than developed world populations. We investigated the applicability of this score to our local population and sought to introduce a checklist for rural doctors to facilitate early referral.

Methods: We analyzed patients with proven appendicitis for the period January 2008 to December 2012. Alvarado scores were retrospectively assigned based on patients' admission charts. We generated a clinical probability score (1–4 = low, 5–6 = intermediate, 7–10 = high).

Results: We studied 1000 patients (54% male, median age 21 yr). Forty percent had inflamed, nonperforated appendices and 60% had perforated appendices. Alvarado scores were 1–4 in 20.9%, 5–6 in 35.7% and 7–10 in 43.4%, indicating low, intermediate and high clincial probability, respectively. In our subgroup analysis of 510 patients without generalized peritonitis, Alvarado scores were 1–4 in 5.5%, 5–6 in 18.1% and 7–10 in 76.4%, indicating low, intermediate and high clinical probability, respectively.

Conclusion: The widespread use of the Alvarado score has its merits, but its applicability in the black South African population is unclear, with a significant proportion of patients with the disease being potentially missed. Further prospective validation of the Alvarado score and possible modification is needed to increase its relevance in our setting.

Contexte : Le score d'Alvarado est l'outil de prédiction clinique le plus couramment utilisé pour faciliter la prise de décision chez les patients présentant une appendicite aiguë, mais il n'a pas été validé dans la population noire sud-africaine chez qui le diagnostic différentiel est beaucoup plus vaste que dans les populations des pays industrialisés. Nous avons exploré l'applicabilité de ce score à notre population locale et tenté de présenter une liste de vérification aux médecins ruraux pour accélérer les demandes de consultation.

Méthodes : Nous avons analysé les dossiers de patients atteints d'une appendicite avérée pendant la période allant de janvier 2008 à décembre 2012. Les scores d'Alvarado ont été assignés rétrospectivement selon les dossiers d'admission des patients. Nous avons généré un score de probabilité clinique (1–4 = faible, 5–6 = intermédiaire, 7–10 = élevé).

Résultats : Nous avons ainsi étudié 1000 patients (54 % de sexe masculin, âge médian 21 ans). Quarante pour cent présentaient des appendices enflammés non perforés et 60 % des appendices perforés. Les scores d'Alvarado se situaient à 1–4 chez 20,9 %, à 5–6 chez 35,7 % et à 7–10 chez 43,4 %, correspondant à une probabilité clinique faible, intermédiaire et élevée, respectivement. Dans notre analyse de sous-groupes sur 510 patients indemnes de péritonite généralisée, les scores d'Alvarado se situaient à 1–4 chez 5,5 %, à 5–6 chez 18,1 % et à 7–10 chez 76,4 %, correspondant à une probabilité clinique faible, intermédiaire et élevée, respectivement.

Conclusion : L'utilisation répandue du score d'Alvarado a ses mérites, mais son applicabilité dans la population noire d'Afrique du Sud est indéterminée, la maladie risquant de passer inaperçue chez une proportion significative de patients. Il faudra procéder à une validation prospective plus approfondie du score d'Alvarado et le modifier peut-être si l'on veut en accroître la pertinence dans notre contexte.

It is increasingly accepted that the omission of surgical care from the Millennium Development Goals was a serious oversight, and over the last decade there has been an increased awareness of the important role that surgery plays in global health.[1,2] Disparities in access to surgical care result in major discrepancies in the outcomes of patients with common surgical conditions, and our group has studied the outcomes of acute appendicitis in our setting.[3–5] We have demonstrated that acute appendicitis in rural South Africa has a very different disease profile to that seen in the developed world.[3] It is associated with prolonged delays to definitive surgical care and significant morbidity due to intra-abdominal sepsis.[4,5] We proceeded to investigate the reasons behind these lengthy delays in presentation and identified rural origin as an independent risk factor for poor outcome from this disease.[5] It would appear that rural patients in South Africa experience delays before presenting to district hospitals, and once they have presented to these district facilities they experience further delays owing to failure of staff to diagnose the condition and refer them through to regional centres with surgical capacity.[5] There is a causal relationship between delay to definitive surgery and poor outcome in the management of acute appendicitis, and strategies to reduce these delays are urgently required.[6]

One of the suggested strategies aimed at facilitating the diagnosis of acute appendicitis is the introduction of tick-box-style clerking sheets to facilitate clinical decision-making among junior doctors working in relatively unsupervised, resource-constrained environments. A number of authors have advocated the use of clinical prediction rules (CPRs) to assist with clinical decision-making in cases of acute appendicitis.[7,8] These CPRs attempt to quantify the possibility of a disease being present based on key symptoms, signs and the results of special investigations and to generate a score that predicts the probability of the disease being present.[8] We sought to generate a tick-box-style sheet with a CPR that would allow junior staff working in relatively unsupervised district hospitals to triage patients with abdominal pain into those who require urgent referral and those who can be discharged home.

The Alvarado score is the most widely used CPR for acute appendicitis and sums up 3 symptoms and 3 signs as well as the results of standard blood tests to give an overall score out of 10 (Box 1).[9] On the basis of this score, 3 groups of patients are identified.[9] Patients with a score of 1–4 can be discharged home, those with a score 5–6 should be admitted and those with a score of 7–10 should be considered candidates for surgery. A recent review of the published data on the Alvarado score reported that it is most useful in predicting the absence of appendicitis, and an Alvarado score below 5 has a sensitivity of 94%–99% for appendicitis not being present.[10] The authors concluded that a score of 5 or less rules out appendicitis.[10] When it comes to positively establishing the presence of acute appendicitis, the score is less reliable; the same review stated that "the pooled diagnostic accuracy in terms of 'ruling in' appendicitis at a cut-point of 7 points is not sufficiently specific in any patient group to proceed directly to surgery." The score is well calibrated in men, but tends to overpredict the presence of acute appendicitis in women.[10] In children, the score has also been shown to be inaccurate.[7] The applicability of the Alvarado score in South Africa is unclear, and there is evidence to suggest that the clinical presentation of acute appendicitis is different to that in the developed world.[3,11] Furthermore, the differential diagnosis of abdominal pain in South Africa is much broader than in the developed world. There is a high incidence of childhood diarrheal illness; HIV; and tropical diseases, such as amoebiasis, abdominal tuberculosis and typhoid, which may all present with acute abdominal symptoms.[12] Prior to designing a possible tick-box-style sheet for abdominal pain to be used in our rural hospitals, we set out to establish the validity of the Alvarado score at our institution.

Methods

We obtained ethics approval to audit acute appendicitis from the Umgungundlovu Health Ethics review board and from the Biomedical Research Committee of the University of KwaZulu-Natal. This study was conducted at Edendale Hospital, a large regional hospital in Pietermaritzburg, the capital city of KwaZulu-Natal, South Africa. Edendale Hospital drains a predominantly black African population from the urban areas around Pietermaritzburg and from the deep rural areas of Sisonke Health District (SHD), a rural area in southwestern KwaZulu-Natal with a population of half a million people and 4 district hospitals. This study was conducted from January 2008 to December 2012. For the period from January 2008 to December 2009, we retrospectively reviewed the records of all patients with acute appendicitis and entered the data into an Excel database. From January 2010 onwards, data from all patients with acute appendicitis were entered prospectively into the same database. Individual Alvarado scores were generated for all patients using data from their charts, and a score was

Box 1. The Alvarado score

Feature	Score
Migration of pain	1
Anorexia	1
Nausea	1
Right lower quadrant tenderness	2
Rebound pain	1
Elevated temperature > 37.5° C	1
Leucocytosis	2
Left shift of white cell count	1
Total	10

assigned to each patient. On the basis of each individual score a clinical probability score was generated, as previously described.[9]

Statistical analysis

We entered all data into an Excel spreadsheet for processing. All statistical analysis was performed using SPSS version 19 (IBM Corp).

Results

Our study sample comprised 1000 patients (54% male, 46% female, median age 21 [range 12–26] yr) with acute appendicitis confirmed both intraoperatively and with histology during the 5-year period from January 2008 to December 2012. Medical care was sought on average 4.2 days after the onset of symptoms. Half of the patients presented from rural areas and the other half from urban areas. A total of 490 patients were considered to have generalized peritonitis at presentation, and the remaining 510 patients presented with localized peritonitis or nonspecific abdominal pain. Intraoperative findings were as follows: 405 (40.5%) had inflamed, nonperforated appendices and 595 (59.5%) had perforated appendices. Of the cohort with perforated appendicitis 177 (29.7%) had perforation-associated localized intra-abdominal sepsis, and 418 (70.2%) had perforation-associated generalized intra-abdominal sepsis. In all, 234 (23.4%) patients required temporary abdominal closure, and 406 (40.6%) patients required revision laparotomy for residual sepsis. Ninety-five (9.5%) patients required postoperative intensive care admission owing to perforation and generalized sepsis. The mean length of stay in intensive care was 6 days. The remaining patients were admitted to the general surgical wards. Overall complications were as follows: 82 (8.2%) patients had hospital-acquired pneumonia, 57 (5.7%) had acute kidney injury, 142 (14.2%) had wound sepsis, and 20 (2.0%) experienced other complications. Overall mortality was 1.3%.

Table 1. Comparative data between the US Department of Defense and our institution

Comparative data	US Department of Defense	Edendale Hospital
Year	1997	2008–2012
Patients, no.	4950	1000
Centres, no.	147	1
Patients/centre/yr, no.	25	200
Perforation rate, %	24	60
Mortality, %	0.08	1
Intensive care unit, %	NA	10
Reoperation rate, %	0.5	23
Temporary abdominal closure, %	NA	41

NA = not available.

Table 1 compares the outcomes of acute appendicitis at our institution with those in institutions in the developed world.[11]

Alvarado score

For the entire cohort of 1000 patients, Alvarado scores were 1–4 in 20.9%, 5–6 in 35.7% and 7–10 in 43.4%, indicating low, intermediate and high clincial probability, respectively. The frequency of occurrence of each item on the Alvarado score and relative clinical probabilities are shown in Tables 2 and 3. Figure 1 provides a summary of the Alvarado scores for all patients with acute appendicitis.

Subgroup analysis

For the purpose of subgroup analysis, a total of 510 patients (65.5% male, 34.5% female, median age 19 [range 11–25] yr) who did not have generalized peritonitis on presentation were analyzed separately. A total of 393 of 510 (77.1%) patients had inflamed, nonperforated appendices and 117 (22.9%) had perforated appendices associated with localized intra-abdominal sepsis.

The Alvarado scores of all 510 patients were 1–4 in 5.5%, 5–6 in 18.1% and 7–10 in 76.4%, indicating low, intermediate and high clinical probability, respectively. The frequency of occurrence of each item on the Alvarado score and relative clinical probabilities are

Table 2. Alvarado score for all patients with acute appendicitis in, *n* = 1000

Alvarado score	No.	(%)
1	20	(2.0)
2	25	(2.5)
3	44	(4.4)
4	120	(12.0)
5	155	(15.5)
6	202	(20.2)
7	110	(11.0)
8	120	(12.0)
9	135	(13.5)
10	69	(6.9)

Table 3. Clinical probability according to Alvarado score, *n* = 1000

Score	Clinical probability	No.	(%)
1–4	Low	209	(20.9)
5–6	Intermediate	357	(35.7)
7–10	High	434	(43.4)

shown in Tables 4 and 5. Figure 1 provides a summary of the Alvarado score with separate subgroup analysis.

The Alvarado scores of the 393 patients with inflamed, nonperforated appendices were 1–4 in 6.9%, 5–6 in 21.9% and 7–10 in 71.2%, indicating low, intermediate and high clinical probability, respectively. The frequency of occurrence of each item on the Alvarado score and relative clinical probabilities are shown in Tables 6 and 7.

The Alvarado scores of the 117 patients with perforated appendices (localized sepsis) were 1–4 in 0.9%, 5–6 in 5.1% and 7–10 in 94.0%, indicating low, intermediate and high clinical probability, respectively. The frequency of occurrence of each item on the Alvarado score and relative clinical probabilities were shown in Tables 6 and 7.

Table 4. Alvarado score for all patients without generalized peritonitis on presentation, *n* = 510

Alvarado score	No.	(%)
1	0	(0)
2	0	(0)
3	9	(1.8)
4	19	(3.7)
5	31	(6.1)
6	61	(12.0)
7	87	(17.0)
8	114	(22.4)
9	124	(24.3)
10	65	(12.7)

Table 5. Clinical probability score according to Alvarado score, *n* = 510

Score	Clinical probability	No.	(%)
1–4	Low	28	(5.5)
5–6	Intermediate	92	(18.0)
7–10	High	390	(76.5)

Table 6. Alvarado score for subgroups of patients without generalized peritonitis

	Group; no. (%)			
Alvarado score	Inflamed *n* = 393		Perforation, local sepsis *n* = 117	
1	0	(0)	0	(0)
2	0	(0)	0	(0)
3	9	(2.3)	0	(0)
4	18	(4.6)	1	(0.9)
5	29	(7.4)	2	(1.7)
6	57	(14.5)	4	(3.4)
7	69	(17.6)	18	(15.4)
8	81	(20.6)	33	(28.2)
9	85	(21.6)	39	(33.3)
10	45	(11.4)	20	(17.1)

Discussion

Acute appendicitis is an important clinical problem in South Africa, and the incidence appears to be increasing among the general population.[1,13] It is associated with long delays to definitive surgery, major morbidity and high cost.[3–5] While there is evidence to suggest that patients do not present early and that a great deal of the morbidity is related to the presence of barriers to care, there is a concern that even once contact with the health system has been made, clinical failure to recognize the condition exacerbates the delays.[5] There are a number of structural reasons for the high incidence of clinical failure that revolve around junior staff working in areas of limited resources with inadequate supervision.[14] However, it has been suggested that the clinical presentation of the disease in South Africa is also different to that in the developed world.[3,11] Abdominal tuberculosis; HIV; and other tropical diseases, such as typhoid, amoebiasis and pediatric diarrhea, may all mimic acute appendicitis.[12] In our previous study on acute appendicitis, only a small proportion of our patients presented with the classic migratory abdominal pain.[3] The most common symptoms encountered were all nonspecific, and these findings were similar to those previously reported in Durban, South Africa.[15] The nonspecific nature of these symptoms has implications for the clinical assessment of black African patients. The present results seem to support our suspicion that the presentation of acute appendicitis among the South African population is different to that in the developed world.[3,16]

Limitations

There are a number of limitations to our study. As the Alvarado score was applied retrospectively to patients already known to have the disease, there is a significant

Table 7. Clinical probability score, subgroup

		Group; no. (%)			
Score	Clinical probability	Inflamed, *n* = 393		Perforation, local sepsis, *n* = 117	
1–4	Low	27	(6.9)	1	(0.9)
5–6	Intermediate	86	(21.9)	6	(5.1)
7–10	High	280	(71.2)	110	(94.0)

potential for selection bias, and it is quite possible that the average Alvarado score of patients in our study is higher than that of patients presenting to our institutions with nonspecific abdominal pain who did not receive surgery.

We are interested in developing a triage tool for rural hospitals. The concept would be to create tick-box-style clerking sheets in district hospitals that would enable junior doctors to score each patient presenting with abdominal pain. Patients meeting a specific score could then be triaged for urgent referral to a regional institution with surgical capacity. However, before the widespread introduction of the use of the Alvarado score in our setting, we need to prospectively investigate its applicability in our institutions. We have increasingly used tick-box-style clerking sheets to improve the quality of care in our setting. This is taken directly from the aviation industry, which makes frequent use of tick-box-style checklists to improve safety.[17] The assessment of abdominal pain may be amenable to such an intervention, and a major attractions of the Alvarado Score is that it can be tabulated into a routine clerking sheet.[18,19] However, our study has shown that using the Alvarado score, more than one-quarter of all patients with proven acute appendicitis would have been classified as having a low to intermediate probability of the disease being present and that slightly less than 5% of these patients would have been discharged home despite having the disease. The implications of this finding for staff in rural district hospitals are unclear. These individuals are usually busy generalists with limited access to advanced imaging who are unable to undertake the operation themselves.[14] There appear to be 3 options available to them: discharge, admit or transfer the patient. Our results suggest that approximately 20% of patients who have the disease may have been admitted to a district hospital for ongoing observations. Yet we know from our previous research that there is already a delay in transferring patients from district to regional hospitals, so this may simply exacerbate the problem.[5] A further 5% of patients with the disease would have been sent home. Similarly, we know that a substantial number of patients are in fact incorrectly sent home from a district-level facility despite the presence of the disease.[5] The concern with the Alvarado score remains that in our under-resourced hospitals its use may exacerbate rather than improve the current situation.

Conclusion

Acute appendicitis remains a common clinical diagnostic problem, and in our environment it is associated with significant delays and poor clinical outcomes. The widespread use of the Alvarado score as a clinical prediction tool has its merits, but its applicability in the black South African population is unclear, with a significant proportion of patients with the disease being potentially missed. This is likely to be related to a much wider range of pathologies and atypical clinical presentations. Future prospective research must be undertaken to validate the Alvarado score, with a possible modification, in order to improve its relevance in our environment.

Competing interests: None declared.

Contributors: All authors designed the study. V. Kong acquired the data, which V. Kong, S. van der Linde, J. Handley and D. Clarke analyzed. V. Kong and J. Handley wrote the article, which all authors reviewed and approved for publication.

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