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Clinical Usefulness of the Ottawa Ankle Rules for Detecting Fractures of the Ankle and Midfoot

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Clinical Question: What is the evidence for the accuracy of the Ottawa Ankle Rules as a decision aid for excluding fractures of the ankle and midfoot?

Data Sources: Studies were identified by searching MEDLINE and PreMEDLINE (Ovid version: 1990 to present), EMBASE (Datastar version: 1990–2002), CINAHL (Winspires version: 1990–2002), the Cochrane Library (2002, issue 2), and the Science Citation Index database (Web of Science by Institute for Science Information). Reference lists of all included studies were also searched, and experts and authors in the specialty were contacted. The search had no language restrictions.

Study Selection: Minimal inclusion criteria consisted of (1) study assessment of the Ottawa Ankle Rules and (2) sufficient information to construct a 2×2 contingency table specifying the false-positive and false-negative rates.

Data Extraction: Studies were selected in a 2-stage process. First, all abstracts and titles found by the electronic searches were independently scrutinized by the same 2 authors. Second, copies of all eligible papers were obtained. A checklist was used to ensure that all inclusion criteria were met. Disagreements related to the eligibility of studies were resolved by consensus. Both authors extracted data from each included study independently. Methods of data collection, patient selection, blinding and prevention of verification bias, and description of the instrument and reference standard were assessed. Sensitivities (using the bootstrap method), specificities, negative likelihood ratios (using a random-effects model), and their standard errors were calculated. Special interest was paid to the pooled sensitivities and negative likelihood ratios because of the calibration of the Ottawa Ankle Rules toward a high sensitivity. Exclusion criteria for the pooled analysis were (1) studies that used a nonprospective data collection, (2) unknown radiologist blinding (verification bias), (3) studies assessing the performance of other specialists (nonphysicians) using the rules, and (4) studies that looked at modifications to the rules.

Main Results: The search yielded 1085 studies, and the authors obtained complete articles for 116 of the studies. The reference lists from these studies provided an additional 15 studies. Only 32 of the studies met the inclusion criteria and were used for the review; 5 of these met the exclusion criteria. For included studies, the total population was 15 581 (range = 18–1032), and average age ranged from 11 to 31.1 years in those studies that reported age. The 27 studies analyzed (pooled) consisted of 12 studies of ankle assessment, 8 studies of midfoot assessment, 10 studies of both ankle and midfoot assessment, and 6 studies of ankle or midfoot assessment in children (not all studies assessed all regions). Pooled sensitivities, specificities, and negative likelihood ratios for the ankle, midfoot, and combined ankle and midfoot are presented in the Table. Based on a 15% prevalence of actual fracture in patients presenting acutely after ankle or foot trauma, less than a 1.4% probability of fracture existed. Because limited analysis was conducted on the data from the children, we elected to not include this cohort in our review.

Conclusions: Evidence supports the use of the Ottawa Ankle Rules as an aid in ruling out fractures of the ankle and midfoot. The rules have a high sensitivity (almost 100%) and modest specificity. Use of the Ottawa Ankle Rules holds promise for saving time and reducing both costs and radiographic exposure without sacrificing diagnostic accuracy in ankle and midfoot fractures.

Key Words: radiography, clinical guidelines, lower extremity injuries, ankle sprains

COMMENTARY

Previous authors have estimated that 80% to 98% of patients reporting to emergency rooms with injuries to the ankle, midfoot, or both undergo radiography during evaluation, but fewer than 15% of these patients have a significant fracture, resulting in undue health care costs, emergency room wait times, and radiation exposure.[1,2] Stiell et al[3] first introduced the Ottawa Ankle Rules in 1992 as a guideline with which to reduce costs and increase time effectiveness (eg, decrease wait times) in the emergency department setting in terms of ruling out serious ankle and midfoot fractures in the nonathletic, adult population. Stiell et al[3] recommended radiography for patients who (1) were 55 years of age or older, (2) were unable to bear weight for 4 steps both immediately and at the time of evaluation, (3) experienced bone tenderness at the posterior edge (6 cm) or inferior tip of the lateral malleolus, or (4) had bone tenderness at the posterior edge or inferior tip of the medial malleolus. Radiography of the midfoot was recommended for patients with bone tenderness at the base of the fifth metatarsal, cuboid, or navicular. Exclusion criteria for the use of the Ottawa Ankle Rules were (1) chronic

Table. Pooled Indices of Clinical Usefulness of the Ottawa Ankle Rules for Ankle, Midfoot, and Combined Fractures[a]

Anatomical Area	Sensitivity, % (95% Confidence Interval)	Specificity, % (Interquartile Range)	Negative Likelihood Ratio, % (95% Confidence Interval)
Ankle	98.0 (96.3, 99.3)	39.8 (27.9, 47.7)	0.08 (0.03, 0.18)
Midfoot	99.0 (97.3, 100)	37.8 (24.7, 70.1)	0.08 (0.03, 0.20)
Ankle and midfoot combined	96.4 (93.8, 98.6)	26.3 (19.4, 34.3)	0.17 (0.10, 0.30)

[a] Data in this table have been reprinted with permission from Bachmann LM, Kolb E, Koller MT, Steurer J, ter Riet G. Accuracy of Ottawa Ankle Rules to exclude fractures of the ankle and mid-foot: systematic review. *BMJ.* 2003;326(7386):417–423.

injury (more than 10 days), (2) pregnancy, (3) the presence of isolated injuries to the skin (eg, lacerations, abrasions, burns), and (4) patients under 18 years of age.

The Ottawa Ankle Rules were designed to have high sensitivity for the purpose of detecting significant fractures.[3] Test sensitivity represents the number of the total group of patients with the condition who have a positive test, compared with a definitive standard. In the case of the Ottawa Ankle Rules, with a sensitivity range of 96.4% to 99.0%, a negative test finding is a reasonable indicator that no fracture is present.[4] Test specificity represents the number of the total group of patients without the condition who have a negative test, based on a definitive standard.[4] Specificity can be useful as a metric of the number of unnecessary events (eg, radiographs) that can be avoided with a particular decision rule. Stiell et al[3] chose to overlook specificity (range = 26.3%–39.8%) in favor of high sensitivity.

Positive and negative likelihood ratios reflect the shift in the probability of the condition being present once the clinical test results are obtained.[4] A negative likelihood ratio is between 0 and 1; ratios closer to 0 increase the odds that the condition will truly be absent with a negative test.[4] The Ottawa Ankle Rules have a pooled negative likelihood ratio of 0.08 for the ankle and 0.08 for the midfoot. Negative likelihood ratios of these sizes represent a large and nearly conclusive shift in the probability that the condition is not present.[4]

Although not included in the systematic review of Bachman et al,[5] a modification of the Ottawa Ankle Rules is the Buffalo Rule.[6] The Buffalo Rule was derived to increase the diagnostic accuracy of the Ottawa Ankle Rules, with the point tenderness criterion directed to the crest or midportion of the malleoli (distal 6 cm of the fibula and tibia), reducing the likelihood of palpating over injured ligament structures.[6] The other Ottawa Ankle Rules criteria remain the same for the Buffalo Rule.[6] In the 2 studies to date that assessed the diagnostic accuracy of the Buffalo Rule, sensitivity for malleolar pain was reported to be 100% (that is, all patients with malleolar pain had fractures; 95% confidence interval [CI] = 59%, 100%)[6] and 100% (95% CI = 78%, 100%),[7] and specificity for malleolar pain was reported to be 59% (95% CI = 47%, 71%)[6] and 45% (95% CI = 43%, 46%).[7] Both studies[6,7] were conducted in university sports medicine departments and assessed sport-injured populations.

The Ottawa Ankle Rules are reported[6,7] to result in a 19% to 38% reduction in radiography costs associated with excluding ankle fractures after sprain injury. The Buffalo Rule is reported[6] to result in a 54% reduction in radiography costs. National cost savings estimates with implementation of the Ottawa Ankle Rules range from $18 to $90 million annually (depending on the payor mix involved).[8]

Bachmann et al[5] provided a high-quality systematic review of the literature on the accuracy of the Ottawa Ankle Rules. However, several limitations in the studies were cited. Only a few of the authors reported on the characteristics of the clinicians (for example, if they were physicians, residents, physician assistants, or nurse practitioners as well as their number of clinical years of experience), and all of the research reported to date has been conducted in the emergency departments of hospitals. The extent to which these findings can be generalized to the sport-injury population is unknown, because limited assessment has occurred in this population (eg, Buffalo Rule[6,7]), and no implementation study has focused on certified athletic trainers. Tolerance for missed fractures may be higher in the general population than in the athletic population. Thus, the role of the certified athletic trainer as a physician extender only reinforces the need for such assessment. Limited assessment of the Ottawa Ankle Rules and no assessment of the Buffalo Rule have been conducted on children (those less than 18 years of age). Although modifications of criteria for radiography may be necessary in the immature population as a result of potential physeal injury, assessment of these rules' effectiveness in the secondary school setting is warranted.

As the athletic training profession progresses in its implementation of evidence-based practice, it becomes imperative to remain current with clinical decision aids, which are developed for the purpose of enhancing patient care through informed decision making. Furthermore, incorporation of clinical guidelines as competencies in athletic training education programs will serve to strengthen their use in clinical practice. Based on the current research, it is recommended that the Ottawa Ankle Rules and, by extension, the Buffalo Rule be included in both athletic training clinical practice and educational programs. In the present era of cost containment, increased awareness of unnecessary tests and procedures will only become more meaningful. Accordingly, clinicians will need to use the information presented in the systematic review, combined with their own practical experience and their patients' values, to determine how best to apply the data in an evidence-based manner.

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