Critical Review Form
Diagnostic Test

Probing to Bone in Infected Pedal Ulcers: A Clinical Sign of Underlying Osteomyelitis in Diabetic Patients, *JAMA* 1995; 273:721-723

Objective: **"In search of an inexpensive, safe method to diagnose osteomyelitis adjacent to infected pedal ulcers, we prospectively examined the relationship between the detection of bone by probing and the presence of osteomyelitis". (p. 721)**

Methods: **This was a secondary data analysis of a prospective industry sponsored antibiotic trial for limb-threatening diabetic foot ulcers in hospitalized patients at New England Deaconess Hospital (Boston) from December 1988 to December 1990. Exclusion criteria for the current manuscript included patients without pedal ulceration, those with non-healing recent surgical wounds, or with surgical debridement that would have exposed the bone. If wounds were covered by an eschar, probing was performed after removing the superficial eschar. Probing was performed by one of two investigators using a sterile, blunt, 14.0 cm, 5F stainless steel eye probe "held as one would hold a pencil." (p. 721) A positive probe test was defined when "on gentle probing, the evaluator detected a rock-hard, often gritty structure at the ulcer base without the apparent presence of any intervening soft tissue." (p. 721)**

Biopsy specimens were only obtained if bone was palpable on initial probing, or if bone became exposed during debridement, or if bone was resected because of severe uncorrectable ischemia. Wound and blood cultures and plain x-rays were obtained on all patients at the time of bone-probe testing, but additional imaging studies such as CT, Technetium (Tc 99m) bone scan, or other radionuclide studies were only obtained at the discretion of the attending physician.

Histologic criteria for osteomyelitis included the presence of inflammatory cells within the bone or fibrosis of intertrabecular soft tissue or destruction/necrosis of bone with reactive new bone formation. If bone was not available for histology, osteomyelitis was diagnosed via "radiological evidence of bone destruction in association with an infected ulcer and/or identification of purulent friable nonviable bone by the surgeon performing debridement." (p. 722) Osteomyelitis was considered absent if none of these conditions were met and if the infected ulcer healed without recurrence after an abbreviated (i.e. not 10-weeks osteomyelitis) course of antibiotics. Follow-up was conducted at 2-3 months with primary care physician and by telephone thereafter.

Guide		Comments
I.	**Are the results valid?**	
A.	**Did clinicians face diagnostic uncertainty?**	Yes. Investigators conducted the probe test before imaging or histologic results became available.
B.	**Was there a blind comparison with an independent gold standard applied similarly to the treatment group and to the control group?** **(Confirmation Bias)**	Yes. "Histological examination of bone was performed by one pathologist who was not aware of whether the bone had been detected by probing or exposed after extensive debridement". (p. 721)
C.	**Did the results of the test being evaluated influence the decision to perform the gold standard?** **(Ascertainment Bias)**	No. This study suffers from definite work-up (ascertainment) bias since a positive probe test was one of three criteria defined *a priori* to obtain the criterion standard bone biopsy. However, although obtaining a bone biopsy on every subject would have been preferable methodologically, ethically and financially this may have been problematic. In addition, the investigators' assessment of ulcer recovery rates without recurrence after abbreviated antibiotic therapy offer face-validity to the notion that non-biopsy; non-radiologically defined "no osteomyelitis" cases were true-negatives (unless the current recommendations for prolonged antibiotics for osteomyelitis are in fact erroneous).
II.	**What are the results?**	

A.	**What likelihood ratios were associated with the range of possible test results?**	• 76 diabetic foot ulcers in 75 patients were assessed with mean age 60-years and 69% were men. 79% were IDDM and the mean duration of DM was 19 years. • The distribution of diabetic ulcers were 34 toe, 28 metatarsal, six toe & metatarsal, one previously heeled amputation site, four tarsal-midfoot, and three heels. • Among those with osteomyelitis: **cellulitis was always present**; 74% had purulent drainage; 35% had lymphangitis; and 35% had a temperature >37.8°C • The **prevalence of osteomyelitis was 66%** (50/76) and 92% (46/50) were diagnosed by histopathology at a mean of 8-days (range 1-28 days) after the probe test. In the other four cases osteomyelitis was diagnosed by clinical criteria twice, by imaging once and by clinical criteria plus imaging once. • Among the 26 cases without osteomyelitis, only seven were biopsy negative. In the remaining 19, 15 had no imaging evidence of osteomyelitis and the mean duration of parenteral antibiotic therapy was 12.5-days with no recurrence noted during a median 83-week follow-up. • Probe to bone offered the following diagnostic test characteristics Osteomyelitis + - Probe + 33 4 - 17 22 Sen 66% (95% CI 58-71) Spec 85% (95% CI 70-94) LR+ 4.3 (95% CI 1.9-10.8) LR- 0.4 (95% CI 0.31-0.6)

III.	How can I apply the results to patient care?	
A.	**Will the reproducibility of the test result and its interpretation be satisfactory in my clinical setting?**	Uncertain. Only two clinicians (both ID specialist, perhaps with an expertise in diabetic foot ulcers?) performed the probe test. What is the external validity for EP's who may evaluate 1-2 diabetic foot ulcers meeting their inclusion criteria annually? Future studies will need to assess a) inter-rater reliability (Kappa) and b) patient acceptance for probe testing while assessing the diagnostic accuracy of this physical exam test in ED populations.
B.	**Are the results applicable to the patients in my practice?**	Probably on a patient-level since hospitalized patients with diabetic foot ulcers are probably much like urban American ED patients with diabetic foot ulcers.
C.	**Will the results change my management strategy?**	Yes. Pending evidence yet to be published to the contrary probe to bone testing should be part of the standard ED evaluation for deep diabetic foot ulcers prior to debridement. A positive probe test, as defined by the authors, should be incorporated into diagnostic and therapeutic algorithms to reduce unnecessary confirmatory testing in lieu of definitive biopsy and admission.

D.	**Will patients be better off as a result of the test?**	Perhaps, but would need RCT to be certain. Although this physical exam diagnostic test offers one potential, biologically plausible, and cheap option to quickly diagnose probable osteomyelitis of diabetic foot ulcers, further research is needed to verify the reliability and diagnostic accuracy of this test in the hands of emergency providers. In addition, the willingness of EP's and specialists to incorporate the results of probe testing into diagnostic and therapeutic algorithms to obviate the need for expensive and time-consuming imaging modalities like bone scan and MRI would only be delineated in an RCT. **If inpatient consultants would not skip these traditional imaging tests when presented with positive probe test results then the test will not save time or money.**

Limitations

1) **Work-up bias since not every patient had definitive bone biopsy.**

2) **Limited external validity since only two investigators conducted probe test without any measurement of reliability (Kappa).**

3) **Extensive delay between probe test and criterion standard. The longer the delay the more investigators risk false negative or false positive results since ongoing treatment or progressing infection can change the findings present during the initial assessment.**

4) **No assessment of LR's or potential cost-effectiveness implications of probe testing.**

Bottom Line

The probe to bone test offers a cheap, readily available bedside test by which to risk stratify diabetic foot ulcer patients for osteomyelitis. However, the test is inadequate to single-handedly significantly increase (LR^+ 4.3) or especially to decrease (LR^- 0.4) the likelihood of osteomyelitis. Future research is needed to assess the accuracy and reliability of this physical exam test in ED settings. If such research finds that the test is sufficiently accurate and reliable (LR^+ > 5, Kappa > 0.6) then subsequent RCT's should assess the impact of this test on ED length-of-stay, healing and amputation rates, functional recovery, and overall healthcare costs.