04.05.A **Pain over speed bumps and diagnosis of acute appendicitis**
(with thanks to Kali Zhou, Michelle Gomez Mendez, John Sy, and Benjamin Lee, Epi 204 2016)

Acute appendicitis is an important cause of emergency department visits for abdominal pain. In an Ig-Nobel prize-winning (see http://www.improbable.com/ig/winners/) article, Ashdown et al [1] looked into utilizing speed bumps as a potential diagnostic tool for acute appendicitis. The abstract is excerpted below.

Objective: To assess the diagnostic accuracy of pain on travelling over speed bumps for the diagnosis of acute appendicitis.
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Participants: 101 patients aged 17-76 years referred to the on-call surgical team for assessment of possible appendicitis.
Main outcome measures: Sensitivity, specificity, positive and negative predictive values, and positive and negative likelihood ratios for pain over speed bumps in diagnosing appendicitis, with histological diagnosis of appendicitis [i.e., examination of the removed appendix under a microscope] as the reference standard.
Results: The analysis included 64 participants who had travelled over speed bumps over their journey to the hospital. Of these, 34 had a confirmed histological diagnosis of appendicitis, 33 of whom reported increase pain over speed bumps. The sensitivity was 97% (95%CI 85-100%), and the specificity was 30% (15% to 49%). The positive predictive value was 61% (47% to 74%), and the negative predictive value was 90% (56% to 100%). The likelihood ratios were 1.4 (1.1 to 1.8) for a positive test result and 0.1 (0.0 to 0.7) for a negative result. Speed bumps had a better sensitivity and negative likelihood ratio than did other clinical features assessed, including migration of pain and rebound tenderness.
Conclusions: Presence of pain while travelling over speed bumps was associated with an increased likelihood of acute appendicitis. As a diagnostic variable, it compared favorably with other measures commonly used in clinical assessment. Asking about speed bumps may contribute to clinical assessment and could be useful in telephone assessment of patients.

A) Below is a 2 × 2 table that summarizes the results on the 64 patients who had traveled over speedbumps. Are their values for positive and negative predictive value correct? [2]

	Appendicitis	No Appendicitis	Total
Positive	33	21	54
Negative	1	9	10
Total	34	30	64

Yes, PPV = 33/54 = 61%; NPV = 9/10 = 90%. The values are correct. There is no evidence that they used case-control sampling, so they should be able to calculate PPV directly from the table above.

B) The 33 patients who did not recall traveling over speed bumps were excluded from the

study. If many of them had, in fact, gone over speed bumps, but did not remember because it had not hurt, what kind of bias would result from excluding these patients from the study, and how would it affect reported sensitivity and specificity? [2]

Patients who had no pain going over speed bumps (Test –) would be under-sampled, which would cause partial verification bias, which would tend to falsely raise sensitivity and lower specificity. This is like the babies with less jaundice being under-sampled in the example in Chapter 4.

C) Assume that those excluded from the study because they did not remember traveling over speed bumps were otherwise similar (in terms of appendicitis risk) to those who remembered traveling over speed bumps, but not feeling pain. How would the exclusion of these subjects affect the negative predictive value? [2]

If the excluded patients are otherwise similar (in terms of appendicitis risk) their exclusion should have no effect on the estimate of the negative predictive value (NPV). As discussed in chapter 2, if we have representative samples of Test + and Test – subjects, even if they are over- or undersampled, predictive value will not be affected, but sensitivity and specificity may be biased.

This is another example where the sampling is by test result (going horizontally in a 2 × 2 table), so PPV and NPV may still be OK, just as sensitivity and specificity are OK with case-control sampling. See problem 2.5, about the referral screening tool for BRCA mutations.

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D) Another possibility is that the reason why those 33 patients did not recall going over speed bumps was that they deliberately avoided them because they thought it would hurt. If just this (and not forgetfulness from part B) caused some of the 33 patients to be excluded, how would that affect the reported sensitivity and specificity, compared with including them and counting them as positive for pain over speed bumps? (Hint: don't try to name this bias.) [2]

In this case we are now under-sampling test + subjects, so the effect would be the opposite of verification bias above: lower sensitivity and higher specificity.

E. The diagnosis of appendicitis was confirmed histologically in all cases. However, the diagnosis of no appendicitis was sometimes made clinically (e.g., pain resolved without surgery). If appendicitis sometimes resolved spontaneously and those with positive speed bump tests were more likely to have appendectomies, what bias would that cause, and how would it affect reported sensitivity and specificity? [2]

This would cause differential verification bias, increasing both sensitivity and specificity.

(Ashdown HF, D'Souza N, Karim D, Stevens RJ, Huang A, Harnden A. Pain over speed bumps in diagnosis of acute appendicitis: diagnostic accuracy study. *BMJ.* 2012;345:e8012.)