

### Ch04.9A Headache as a Sign of Hemorrhagic vs. Ischemic Stroke

Based on a classic paper by Panzer et al(1), but some details have been modified.

Consider a study of the accuracy of headache in differentiating between hemorrhagic stroke (due to bleeding) and ischemic stroke (due to not enough blood flow, usually from a clot) in 179 patients with an acute neurologic deficit. The index test is current or recent headache (yes/no) and the gold standard is brain CT scan (hemorrhage – yes/no; everyone who does not have hemorrhage can be assumed to have an ischemic stroke):

		Hemorrhage on CT		
		Yes	No	
Headache	Yes	23	87	179
	No	14	55	
		37	142	

There were an additional 195 patients with acute neurologic deficits who would have been eligible for inclusion but did not receive a CT (the gold standard) and therefore could not be included in the table above. None of these patients had a current or recent complaint of headache. Assume that 13 of these 195 excluded patients had a hemorrhagic stroke (further explanation for interested readers after part (c)):

No CT (and No Headache)		
Hemorrhagic Stroke		
Yes	No	195
13	182	

- a) Create a 2×2 table that includes these excluded individuals:

*Begin Answer:*

		Hemorrhage on CT		
		Yes	No	
Headache	Yes	23	87	374
	No	27	237	
		50	324	

*End Answer*

- b) Based on all the information presented above, what is the best estimate of the sensitivity of headache for hemorrhagic stroke?

*Answer:  $23/(37 + 13) = 23/50 = 46\%$  – sensitivity goes down when additional false negatives are included (and verification bias removed).*

- c) Exclusion of potential study subjects with negative index test results because they did not receive the gold standard as part of their clinical care has what effect on specificity?

*Answer: This would cause partial verification bias, which makes the specificity estimate falsely low.*

**Further information for interested readers:**

In fact, Panzer et al had an unbiased sample in which the gold standard CT was obtained on all stroke patients regardless of headache and other (for the time) standard indications (vomiting and altered mental status) to obtain a head CT. They then simulated a biased sample by excluding from the original sample all patients without one of the indications. This left the initial table above. The excluded patients by definition did not have a headache and 13 of them had a hemorrhage. You recreated their unbiased sample in Part (a).

1. Panzer RJ, Suchman AL, Griner PF. Workup bias in prediction research. *Med Decis Making*. 1987;7(2):115-9.