

## 2.7 Anal-Cranial Inversion

We were big Car Talk fans. (It was a call-in radio show on National Public Radio.) Imagine our delight when we heard a "puzzler" about diagnostic tests! If you don't want to read the banter between Tom and Ray Magliozzi, you can skip to **Question**.

**Ray:** Hi, we're back. You're listening to Car Talk with us, Click and Clack, the Tappet Brothers, and we're here to talk about cars, car repair, and the final Puzzler of the current Puzzler season.

**Tom:** So I should, like, savor this one? It's going to be a doozy, isn't it? A real season-ending splash.

**Ray:** Jerk. All right. There's a rare disease sweeping through your town ... and the disease is called ACI, and it produces irreversible anal-cranial inversion. You may have noticed that my brother has it. Now, of all people exposed to ACI, only 0.1 percent actually contract it. OK?

**Tom:** Point one percent.

**Ray:** A tenth of a percent. OK?

**Tom:** Zero point one percent.

**Ray:** And if you catch it early, before the symptoms present, you can get treatment and maybe you can be cured. Fortunately, there's a diagnostic test, which can detect ACI up to a year before the inversion occurs. So anyway, you go to your doctor and he administers the test, and it comes out positive.

**Tom:** Yeah?

**Ray:** And you say, "Oh, I'm done for." Then you're getting a little bit encouraged. You say, "Wait a minute, doc. Is this test 100 percent accurate? And he says, "Well, not really, but it's 95 percent accurate."

**Tom:** Ninety-five percent accurate.

**Ray:** All right? He says, in other words, 5 percent of the people who take the test will test positive but they don't really have it. The question is: What are the chances that you will actually have an irreversible anal-cranial inversion?

**Question:** Assume sensitivity = 100%, specificity = 95%, and prior probability = 0.1%. What is the post-test probability after a positive test? (2 points: 1 pt for correct equation/approach, 1 pt for calculation)

**Prior odds × LR = posterior odds. The LR is  $P(\text{result}|D+)/P(\text{result}|D-) = 100\%/5\% = 20$**

**Without converting prob to odds, this is:  $0.001 \times 20 = 0.020$  (2%).**

**In this case, it's fine to skip converting prob to odds and odds back to prob, but it isn't always, so the full steps are:**

- 1) **Convert pre-test probability to odds:  $0.001 \rightarrow 0.001/0.999 = 0.001001$**
- 2) **Multiply by LR:  $0.001001 \times 20 = 0.02002$**
- 3) **Convert to post-test odds to probability  $0.02002 \rightarrow 0.02002/(1+0.02002) = 0.0196$**

**This is also explained using the 2x2 table method:**

		ACI			
		Yes	No		
Test	Positive	1	50	<b>51</b>	$1/51 = 1.96\%$
	Negative	0	949	<b>949</b>	
		<b>1</b>	<b>999</b>	<b>1000</b>	

