**Overview of the Sensitivity and Specificity project guidance**

The dataset will allow you to use sensitivity and specificity to determine what is the best cut-off value to use on a caloric test screen. It will allow you to reproduce the study performed by Lightfoot et al (2009) on the mono-thermal caloric test screen, or the Zapala (2008) study. Your findings will be different as this is fabricated data.

# background

The full caloric test consists of 4 caloric irrigations: warm right (WR), warm left (WL), cool right (CR) and cool left (CL), to produce 4 caloric responses. These 4 caloric responses can be used to produce clinical parameters as follows:

**Canal paresis (CP) = ((WR+CR) - (WL+CL)) / (WR+WL+CR+CL)\*100%**

A left CP is > 0. A right CP < 0. ±20% is the significant value

**Directional preponderance (DP) = ((WR+CL) - (WL+CR)) / (WR+WL+CR+CL) \*100%**

A DP to the right is > 0. A DP to the left is < 0. ±20% is the significant value

A significant CP suggests the horizontal canal of the ear specified by sign (positive or negative) is not functioning properly, this can be due to problem with the ear itself, the vestibular nerve or the brain.

A significant directional preponderance suggests the brain has a preference turning one way over the other, which has several possible causes.

The caloric test irrigations induce vertigo, nausea and sometimes vomiting and the purpose of the caloric test screen is to save *some* patients from undergoing the full test, while detecting *most* of the patients who need to have the full test.

Depending on which irrigations were performed first, the mono-thermal caloric screen for is either

Warms performed first, Warm Mono-thermal screen = (WR-WL)/(WR+WL) \*100%.

Or

Cools performed first, Cool Mono-thermal screen = (CR-CL)/(CR+CL) \*100%

If the answer is > 0 it is a left asymmetry, if its < 0 a right asymmetry.

The Lightfoot 2009 paper provides more detail.

# The DATASET

The dataset has 800 subjects.

The column headings are as follows (I have also commented on each heading within the spreadsheet):

* **Order.** W= Warm first C = Cool first
* **WR.** Warm Right caloric response measured in °/s.
* **WL.** Warm Left caloric response measured in °/s.
* **CR.**  Cool Right caloric response measured in °/s
* **CL.** Cool Left caloric response measured in °/s

**Things to note**

An absent response is recorded as 0°/s.

# The analysis

For the analysis, use whatever software you like e.g. excel, MATLAB, SPSS.

From the raw data, for each subject, you need to calculate the:

* The mono-thermal screen outcome dependant on order (warm or cool first).
* Canal paresis
* Directional preponderance

## Gold Standard

**Use the full 4 irrigation caloric test as the gold standard i.e. values of CP and DP**

Determine if the CP was significant finding or an insignificant finding.

Take the absolute value of CP. Use 20% as criterion of significance. (≥20% significant < 20% insignificant).

Do the same for DP.

# The Screen

We want the screen to detect both the CP and/or DP, therefore if either or both of the CP or DP are significant, we will class outcome as a significant finding.

Determine what criteria (cut-off value) you want to use for the mono-thermal screen.

For each subject determine if the screen outcome is a significant or insignificant for your chosen cut-off value. Next, for each subject, compare the screen outcome to the gold-standard outcome to give:

* **TP** (true positive i.e. truly significant)
* **TN** (true negative i.e. truly insignificant)
* **FP** (false positive, i.e. falsely significant)
* **FN** (false negative, i.e. falsely insignificant)

\*Positive is now used to mean significant finding, and negative as insignificant finding

Using these you can calculate sensitivity and specificity of the screen at the cut-off value you chose.

* **Sensitivity** = number of TP/(number of TP+ number of FN)
* **Specificity** = number of TN/(number of TN+ number of FP)

In an iterative manner change the cut off value, and repeat. Choose the best combination of sensitivity and specificity to determine the best cut-off value to use.

The best sensitivity specificity combination depends on the application. In this case, like most screening applications, sensitivity is more important than specificity. We want high sensitivity i.e. to catch as many TP and minimise FN. A FN will not undergo the full test and ‘exit’ after the screen – they will be ‘missed’.

FP will undergo the full test, but too many FP and the screen becomes pointless, i.e. most patients undergo full test so no point screening! Therefore, we want the best sensitivity we can get, without having to trade too much on specificity.

Plotting a receiver operator characteristic curve (ROC) may help you determine the best sensitivity, specificity combination to choose.

## Further work (if you wish)

If you wish you can also calculate accuracy, positive predictive value, negative predictive value, likelihood ratios. You could compare the performance of warm screens to cool screens.

[Sensitivity vs Specificity and Predictive Value - Statistics How To](https://www.statisticshowto.com/probability-and-statistics/statistics-definitions/sensitivity-vs-specificity-statistics/#SPE)

