# *The Columbia Registry and Early Signs of APBD*

by Larry Schwartz, December 2017

## *INTRODUCTION*

Usually, it is stated that the neurogenic bladder is the first sign of (possible) APBD. But from the analysis of the Columbia Registry data, I cannot conclude that the onset ages of the neurogenic bladder occur ahead of the onset ages of some other APBD signs.

In this brief note, I present graphical, data, and statistical analyses on this question.

## *ANALYSIS*

Table 1 presents the basic statistics for the onset ages of neurogenic bladder, feet numbness, and gait problems.[1] It shows that their means are close together, ranging from about 54 to 56 years of age. And that their standard deviations (spreads around their means) are not far apart either, measuring about 6 or 7 years. [2]

What seems odd is that the neurogenic bladder and gait problems have the earliest onsets, in the 30-age bracket, while that of feet numbness comes much later, at age 45. But you should not draw too much from this comparison because there is only a single patient with a 30s-aged onset for either the neurogenic bladder or the gait problem.

### *Table 1. Basic Statistics for the Onset Ages of Three APBD Signs*

| APBD Sign | Onset Age | | | | |
|---|---|---|---|---|---|
| | ***Observations*** | ***Mean*** | ***Standard Deviation*** | ***Earliest*** | ***Latest*** |
| Neurogenic bladder | 37 | 53.7 | 7.0 | 35 | 69 |
| Gait problems | 39 | 54.7 | 6.1 | 38 | 65 |
| Feet Numbness | 24 | 55.5 | 5.9 | 45 | 69 |

[1] **Note that a reasonable number of the registry patients answered the onset ages for these three APBD signs. But there were much less responses for the onset ages of other APBD signs; and therefore, they are excluded from this analysis.**

[2] **Statisticians usually compare the variability of different data sets by normalizing them with their means; the coefficient of variation (CV) does exactly that. But it is unnecessary to calculate the CV in these cases because their means and standard deviations are so close to one another. Nevertheless, the CV is 13 percent for the neurogenic bladder (7.0/53.7), 11 percent for the gait problems, and 11 percent for the feet numbness---all indicating similarly low variations**.

With correlation analysis, I find there are strong associations between the onset ages of neurogenic bladder and that of other signs of APBD. Table 2 presents the correlation matrix for the onset ages of the three APBD signs under consideration. In general, associations among variables are considered strong when their correlations exceed 0.50. This is true for these associations, especially between feet numbness and gait problems, as you would expect, where the correlation is 0.87. But strong associations do not necessarily mean that these different APBD signs have the same onset ages throughout.[3]

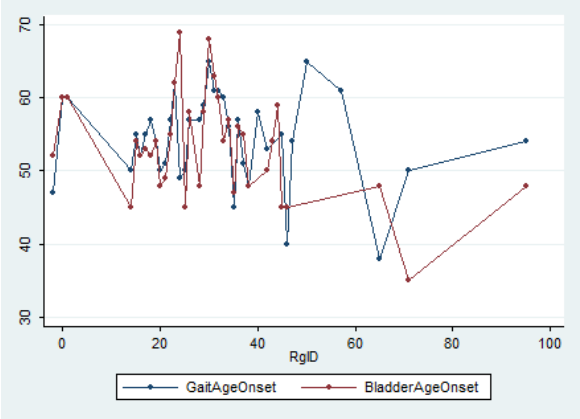
***Table 2. Correlation Matrix for the Age Onsets of APBD Signs***

| | Bladder | Gait | Feet Numbness. |
|---|---|---|---|
| Bladder problem | 1.00 | 0.69 | 0.63 |
| Gait problem | 0.69 | 1.00 | 0.87 |
| Feet Numbness. | 0.63 | 0.87 | 1.00 |

From this point on, I focus on the neurogenic bladder and the gait problem, putting aside feet numbness. This is because feet numbness has much fewer observations than the others----causing distortions in any technical or graphic analysis to follow.

Graph 1 shows the onset ages for the two APBD signs on the vertical axis and the Registry ID number assigned to the patients on the horizontal axis. By inspection of this graph, there is not a clear picture that neurogenic bladder comes before gait problems.

***Graph 1. Onset Ages for Neurogenic Bladder and Gait Problems by individual***

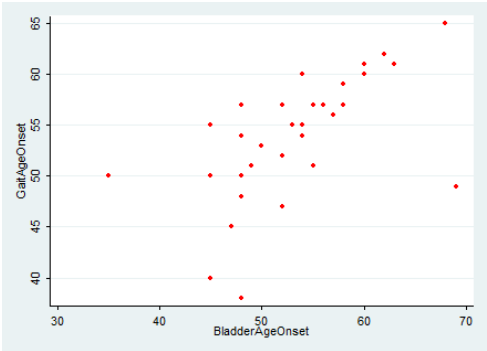



**[3] It is possible that there is a strong correlation between the two APBD problems, yet their onset ages do not match each other throughout all years. This will become clear in the analysis that follows.**

By data analysis of the individual patient entries in the Columbia registry, the age onset of neurogenic bladder is as likely or not to precede the gait problem. Specifically, there are only 17 cases out of a possible 35 where the bladder problem comes before the gait problem. In the remaining 18 cases, the onset age of neurogenic bladder was either equal to that of the gait problem (eight) or the bladder problem came after the gait problem (10).

For the ultimate proof, I perform technical statistical tests: Are there statistically significant differences in the onset ages of the neurogenic bladder and gait problems? On an intuitive level, Graph 2 shows how the onset ages of gait problems seem to move together with the onset ages of the neurogenic bladder.

***Graph 2. The Relationship Between Onset Ages of Bladder and Gait Problems***




As suggested by Graph 2, the null hypothesis is that the onset ages of the two moves precisely together on a 45-degree line or are equal at all ages. Statistical rejection of the null hypothesis would support the conventional wisdom that the bladder problem precedes the gait problem.

To find out whether the null hypothesis holds up or not statistically, I estimate the OLS regression between the age onset of the neurogenic bladder and the age onset of the gait problem. Table 3 shows its statistics (the R-square of this regression is 0.39, based on 35 observations).

***Table 3. Regression Statistics***

| Parameter | Estimate | Standard Error |
|---|---|---|
| Constant | 13.60 | 8.69 |
| Slope | 0.74 | 0.16 |

In keeping with the definition of a 45-degree line in Graph 2, I do statistical tests for the constant in the regression equal to zero and its slope equal to unity. First, I test for the constant and slope independently of one another as some do; second, I test for the two jointly as strictly required. Both tests give us the same result: Namely, I cannot reject the null hypothesis that the age onsets of neurogenic bladder and gait problem are equal to one another, or fall on a 45-degree line. [4]

For the independent tests, I calculated the t value for the constant with values in Table 3: (13.60-0)/8.69=1.50. With the Table of t showing a higher critical value of 2.03 at the 95 percent confidence level for 34 degrees of freedom, this constant is not statistically significantly different from zero. For the slope of unity, I calculated its t value: (0.74-1.00)/0.16= -1.62; also below its critical t value of 2.03, thereby indicating that the slope is not statistically significantly different from unity.

But we also need a joint test for the constant=0 and the slope=1 occurring simultaneously. For that we turn to the (more complicated) quadratic form of the joint distribution of the constant and the slope, or so-called Q; and subject it to an F Test.[5] That F Test also indicated that the slope is not statistically significantly different from unity and simultaneously the intercept is not statistically significantly different from zero.

## *CONCLUSION*

From the statistical, graphical, and data evidence presented, I cannot conclude that the onset ages for the neurogenic bladder occurs ahead of the onset ages for the gait problems.

**[4] These statistical statements are like the ones involved in proving the efficacy of a clinical trial.**

**[5] For the formula for Q, see Johnston, J. Econometric Methods, 1963, page 24.**