**Limitations**

The study does not adequtely integrate the mortality of the mice in arriving at conclusions. A drug regimen which reduces the tumors but also has a high mortality rate should not be considered efficacious. Thus, the study may be influenced by survivor bias. The number of mice in the study start at 249 and have been reduced to 130 by timepoint 45, which is a 32% overall mortality rate. The classic example of survivor bias is from World War II: Planes returning from battle had bullet holes everywhere but the engine and cockpit, so allies decided to put additional armor on the planes everywhere but the engine and cockpit; they neglected to consider the locations of bullet holes in planes that were downed.

The sample sizes are reasonable for illustrative purposes, but they are unlikely to produce statistically significant results. There appears to be a duplicate record of mouse g989 in the initial data and only 24 mice are reported as being tested with Stelasyn. This skewed the number of data points for Stelasyn downward relative to the other regimens. The results were not normalized, but normalization would not have had a material impact on the results, since it would have produced about a 4% change in the Stelasyn results. Mouse ID g989 is treated with Propiva and has two sets of differing results. One set of results indicate she dies between timepoint 20 and 25; the other she dies between timepoint 35 and 40. Normally, I would exclude Mouse ID g989 in the data scrubbing; however, I think it was an unintended data error, which we are not expected to correct. I could correct it; however, it does not really relate to the assignment of plotting data.

It does not seem reasonable that the initial tumor volume would be exactly 45.000000 mm3 for all 249 mice in the study. This was apparently an attempt to normalize the results. To initiate 249 trials at that level of precision on the volume of a tumor is suspect. Also the fact that the weight of the mice did not change over time is at best questionable. I do not believe the data.

One measure of a drug regimen’s efficacy is its impact on a cancer metastasizing. The number of metastatic sites was available in the data but was not considered in the analyses.

The mice treated with Capomulin and Ramicane were of notably lower weight than the remain mice, 20.1g vs. 27.6 g. Weight could have been a significant factor in the apparent success of these two regimens.

Gender distribution was inconsistent between samples. It ranged from 37.5% being male for Stelasyn to 64% being male for Ramicane and Ketapril. The control group had 48% male.

Although the comparisons were made between the four most promising regimens, a valid scientific comparison would have required the inclusion of a control group, i.e. the placebo. The distributions of weights and gender should have matched the control group for each cohort being treated in order to provide a valid scientific study. Only 1 variable is allowed to vary between the control group and what is being tested.

This study does not employ the totality of the scientific method, which requires the development of a hypothesis and subsequent testing of it. It does however provide data which can be used to formulate hypotheses.

**Disclaimer**

This study and conclusions were produced for educational and illustrative purposes only and do not constituted a statement of actuarial opinion, nor is this an actuarial communication. As such, neither the study nor this summary are intended to conform to Actuarial Standards of Practice.

**Conclusions**

*Impact of Gender*

Of the 125 male mice in the study, 65 survived; and of the 124 female mice in the study, 62 survived. Given the binomial distributions of survivorship, the estimated standard deviations are approximately 5.6 for males and females. By inspection we can ascertain there is no statistically significant difference in the outcomes based on the sex of the mice. However, the impact of sex on survivorship or tumor volume has not been independently tested as a variable using a controlled study.

*Impact of Weight*

Lower weight appears to improve the effectiveness of treatments. However, given the lower than average weights of the mice treated with Ramicane and Capomulin, we cannot ascertain whether the efficacy of the treatment was due to the drug, the weight or a combination of the two.

*Effectiveness of Drug Regimens*

Ramicane and Capomulin appear to be significantly more efficacious in reducing tumor volume than Infubinol and Ceftamin. However, the lack of a control with the same starting weights prevents this appearance from becoming a conclusion. “The work of science is substitute facts for appearances and demonstrations for impressions” – John Ruskin

*Mortality*

Both Ramicane and Capomulin had higher survivorship rates than the placebo, which had a slightly higher survivorship rate than Infubinol and Ceftamin.

*Overall*

Given the numerous variables which differed from the placebo for the cohorts treated and the relatively small number of tests performed, the results are not statistically or scientifically reliable. However, it appears reasonable that mice with lower than average weights treated with Ramicane or Capomulin have more successful treatment than heavier mice which are untreated or treated with any of the other drugs tested. From a scientific method approach this would be enough to formulate an hypothesis to be scientifically tested.