CE 467 / 567 Highway Safety and Operations
Before-After Example

As mentioned in class on October 17, the example was given as 10 sites in Michigan that were initially 2-way stop signs and which were "treated" with a 4-way stop. The 10 sites each had a 3-year "before" period and a 3-year "after" period. In the "before" period, a total of 146 crashes were observed (in 3 years, at 10 sites). In the "after" period, a total of 33 crashes were observed (in 3 years, at 10 sites).

The notion is that this simple comparison might be an exaggerated estimate of the actual safety benefits, due to two facts: (1) these sites may be at the top of the distribution of crash sites simply due to random variations; (2) there may be a related bias in the selection of these sites, based on the high crash frequency at these sites.

The Empirical Bayes procedure corrects for these two problems, *by accounting for the random variation*. In this way, what remains after the Empirical Bayes correction is the "true" safety value, after removing the random variation.

A reference population of 2-way stop locations had an average crash frequency of 0.28 crashes in a 3-year period (per site), with a variance of 0.53 (crashes/3 yrs)^2 per site. [This is what I was missing in class.] In this case, using the Empirical Bayes formula,

$$a = \frac{1}{1 + \frac{Var[l_{pop}]}{E[l_{pop}]}} = \frac{1}{1 + \frac{0.53}{0.28}} = 0.3457$$

This clearly weighs the population average at a relatively lower level, because of its high variance relative to the mean. This would then place a higher weight on the local experience of the specific sites. That is:

$$E[l_{pop} \mid \hat{l}_i] = a\,E[l_{pop}] + (1-a)\,\hat{l}_i$$

$$E[l_{pop} \mid \hat{l}_i] = (0.3457)\cdot(0.28 \text{ crashes/3 yrs per site } \cdot 10 \text{ sites}) + (1-0.3457)\cdot(146 \text{ crashes})$$

$$E[l_{pop} \mid \hat{l}_i] = 96.5 \text{ crashes / 3 years}$$

This estimate of 96.5 crashes in 3 years removes the random variation and leaves the "true" estimate of the crash frequency at these sites, without the treatment.

The net benefit would be the difference between 96.5 crashes in 3 years (the expected effect if there were ***no treatment***) versus 33 crashes in 3 years with the treatment, or 63.5 crashes in 3 years. This is a 66% reduction in crashes, which is still very significant. However, it is not as big as the "naive" estimate of 146 crashes reduced to 33 crashes, a reduction of 113 crashes in 3 years or a 77% reduction in crashes.