Figure 1. Relationship of HIC and Head AIS.

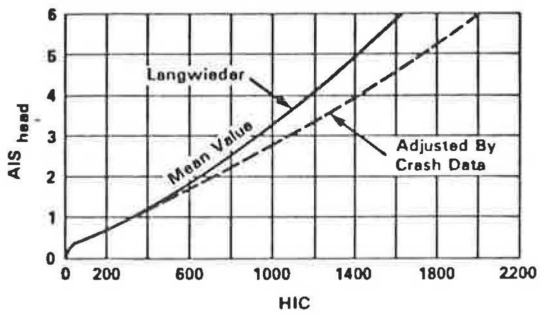


Figure 2. Relationship of CSI and Chest AIS.

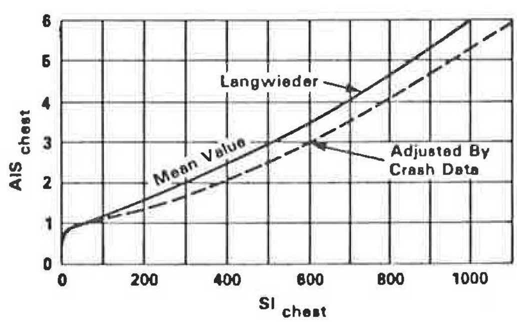
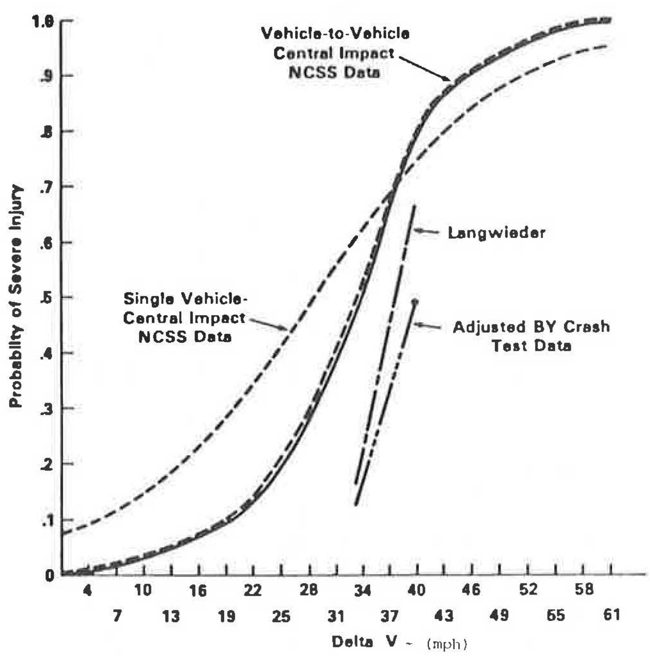


Figure 3. Logistic Curves for Front Impact Subsets (Age = 30 Yrs.).



SUMMARY OF PART 2

Jarvis D. Michie, Southsest Research Institute

In support of benefit/cost analysis procedures of roadside safety programs, the seven presenters in this session outlined data needs and limitations associated with current data acquisition methods using computer simulation and physical testing.

Ross delineated the need to have baseline data of the untreated roadside for use as a reference for safety improvement comparisons and appurtenances warrants development. Nordlin discussed the impracticality of using full-scale crash tests to investigate all possible collision conditions and the importance of evaluating appurtenance under field conditions. In evaluating field performance of appurtenances, Bronstad cautions the investigators of the importance in assessing the compatibility of the specific hardware with the traffic and site characteristics. Reilly stressed the need to acquire detailed clinical data from selected accident cases; in addition, he sees the need of establishing a substantial data base of inadvertent roadside encroachments that are generally not reported because the errant motorist is able to drive his vehicle from the accident site. With this information and with projections of vehicle sales trend, Reilly maintains that testing procedures and test matrices can then be validated or modified to correspond to actual conditions and, therefore, made more effective.

As a complement to vehicle crash testing methods during appurtenance development, computer simulations have been shown to be cost effective under certain conditions. However, Chiapetta has alerted the reader to difficulties and limitation of current simulation technology.

With regard to establishing a linkage between vehicle crash test severity and potential injury of vehicle occupants, Friedman discussed the use and limitation of anthropometric dummies and indicated that dummy responses are currently insufficient for use in the benefit-cost analysis procedures. On the other hand, Hollowell presented some promising findings from recent NHTSA efforts to establish a link between FMVSS 208 and accident severity.

From the standpoint of physical testing and analysis, data needs for cost-benefit analysis procedures have been assessed. Whereas considerable information pertaining to a specific appurtenance hardware items can be acquired before the item is introduced into actual service, it is recognized that extensive in-service evaluation including numerous collision cases is necessary to develop sufficient input to the cost-benefit equation.

Part 3: Session 2, Field Performance Studies: Evaluation and Data Issues

Forrest M. Council, Highway Safety Research Center, University of North Carolina

The second part of the overall program was designed to raise issues related to the use of field data in determining severity indices for highway hardware. To open the session, the moderator presented a brief introduction to the two basic issues or areas of interest: study design problems and accident data. Presenters were chosen to raise problems and to generate discussion in each of these two areas.

STUDY DESIGN PROBLEMS

WEAKNESSES IN CURRENTLY USED STUDY DESIGNS AND ALTERNATIVE RECOMMENDED DESIGNS

Lindsay I. Griffin, III, Texas Transportation Institute, Texas A&M University

While the study design area has many inherent problems, perhaps the most important involve (a) which criterion should be used in answering a specific question, (b) the pre-determination of sample size to be used to ensure that statistical significance and (c) the choice of and planning for a strong study design. This last issue, the choice of study design, is the most important of all. Because of its importance, this initial presentation will discuss the strengths and weaknesses of three designs that have been used to evaluate highway safety improvement programs related to roadside hardware. These include (a) the before/after design, (b) the before/after design with a comparison group and (c) the before/after design with a comparison group and a check for comparability.

The before/after design consists of two measurements in time separated by the imposition of a treatment. The assumptions which are made in using this design are (a) the after measure would have been the same as the before measure without the treatment and (b) any difference observed between these two measures is totally due to the treatment imposed rather than to any other cause. Testing to determine whether an observed difference is statistically significant is relatively straightforward with:

$$Z = (Y-X)/(Y+X)$$

where

X = accidents during the before period and
Y = accidents during the after period.

While very popular in the highway accident research field, this design is the weakest design possible. Any results determined with this design must be viewed with great skepticism. Indeed, two of the leading experts in research design, Campbell and Stanley, in a monograph entitled Experimental and Quasi-Experimental Designs for Research indicate that the before/after design is susceptible to all eight possible threats to internal validity. As such, they dismiss this design as a pre-experimental design. Similar sentiments have been expressed by other authors. Unfortunately, the design is still used by quite a few highway researchers, even in current studies. The disturbing part is that with little extra work, much more powerful designs, and thus much more reliable results, are possible.

An alternative to the simple before/after design, and one that can provide much stronger results, is the before/after design with a comparison group. In essence, a treatment is implemented at a given set of locations. A second set of locations (as "similar" to the first set as possible) is left untreated as a comparison group. Measurements are again taken before and after treatment is imposed in both sets of locations. The comparison made is between the rate of change of the treatment and comparison groups. (This rate of change comparison is the same as "predicting" the after level in the treatment group based on what happens in the comparison group and then comparing the observed after level to the "predicted" after level in the treatment group.)

The most appropriate statistical procedure to be used in this testing is:

Calculate tau = the cross product ratio = (BC)(AT)/(AC)(BT)

where

BC = accidents for the comparison group during the before period,
AT = accidents for the treatment group during the after period,
AC = accidents for the comparison group during the after period, and
BT = accidents for the treatment group during the before period.

Also, calculate VAR (ln tau) = (1/BC) + (1/AT) + (1/AC) + (1/BT)

Then,

$$Z = (\ln \tau)/(VAR(\ln \tau))1/2$$

This design can help protect against two threats that seriously affect the before/after design--regression to the mean and the "history" threat (other causes occurring at the same time as the treatment). The strength of this design rests on how comparable the comparison group is.

The final design discussed is referred to as the before/after design with a comparison group and a check for comparability. The difference between this and the preceding design is that multiple before and after readings are taken at both the treatment and control locations. The purpose of these multiple before and after readings (particularly those in the before period) is to determine whether or not the two groups were comparable (i.e., whether "trends" in the data are similar). Here, the treatment and comparison data in the period are first checked for "non-comparability" (independence) using a likelihood ratio chi-square:

$$G2 = -2 X \ln (E/X)$$

where

X = observed accident frequency for a given condition (treatment or comparison) and a given time period (year) and
E = expected accident frequency for a given condition (treatment or comparison) and a given time period (year).

If the trends are comparable (not significantly different), the data in the periods are collapsed and a simple before/after with comparison group analysis is carried out just as was done for the second design. If the data are not similar, the evaluation is terminated since results will be meaningless. This design helps control for both underlying trends and regression effects.

In conclusion, the simple before/after design should never be used in highway accident research due to its inherent weaknesses. The before/after with a comparison group is a clear improvement. Even stronger is the recommended design--the before/after design with a comparison group and a check for comparability.