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Lecture: *Injury Risk Curves from Impact Biomechanical Experiments for Risk Analysis in Motor Vehicle Crashes*

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Abstract:

Injury probability curves form the primary basis to mitigate injuries and fatalities in environments such as motor vehicle crashes. They are used in US Federal Motor Vehicle Safety Standards (FMVSS) for ensuring crashworthiness and safety of vehicles sold in the USA, consumer information appearing as star ratings in the MSRP stickers displayed on the automobiles for public awareness, and designs of safety systems such as seatbelts and airbags, and their evaluations using crash test devices, also termed anthropomorphic test devices or dummies.

The presence or absence of injures identified from testing human cadavers (termed post mortem human subjects, PMHS, in impact biomechanics literatures) are used in conjunction with biomechanical outcomes such as force, deflection, and acceleration to derive injury probability curves. They are then converted to dummy risk curves for purposes stated above. For example, the US frontal and side impact FMVSS have used results from human cadaver tests and applied to Hybrid III and ES-2re dummies, respectively. Experimental design followed in PMHS impact biomechanics research yields: (1) right censored data wherein the subject responds to the dose (impact) with no injury, (2) left censored data wherein the subject responds to the dose with injury, or, (3) interval censored data wherein the same subject responds to the lower dose with no injury and a higher dose with injury. The exact dose for injury (uncensored data point) is difficult to discern from these tests and have not been used in any Standards/regulations. This study focuses on the statistical methods, in particular the use of Bayesian hierarchical modeling techniques for the development of these injury probability curves and a discussion of experimental design in these contexts.