Injury Risk Assessment and Criteria Development

Identifying Optimal Biomechanical Metrics for Development of Human Injury Risk Curves

Human injury risk curves (IRC) for blast loading are needed to improve and assess safety in military operational environments. Biomechanical metrics from human cadaver tests can be used to develop IRCs, but the optimal metric for determining injury risk in these studies is not clear. Researchers at Medical College of Wisconsin (Milwaukee, WI) used the Brier Score Metric (BSM) to identify the metric that best describes the underlying response to injury.

To demonstrate use of BSM, the researchers developed optimal IRCs for skull fracture from head injury tests using previously published data from 12 cadaver specimens (*Yoganandan and Banerjee, 2018*). Failure force, deflection, energy, linear stiffness, and secant stiffness variables were evaluated for hierarchical relevance to determining the risk of injury. The mean magnitudes sufficient to cause skull fracture for these variables were 9168 N (force), 8.9 mm (deflection), 30.8 J (energy), 2418 N/mm (linear stiffness), and 1425 N/mm (secant stiffness). Optimal distributions and normalized confidence interval sizes were determined for each variable.

Lognormal distributions were used for all variables except failure force, for which a Weibull distribution was applied. Based on BSM scores and confidence interval tightness, failure force was the optimal metric for determining risk of skull fracture, followed by deflection and energy. Failure forces of 3687, 4734, and 9104 N were associated with 5, 10, and 50 percent probabilities of skull fracture, respectively.

Using BSM-identified optimal metrics to develop IRCs will lead to better correlates of injury from mechanical loads in computational models, and it will have greater power and robustness in predicting Service member injury.

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REFERENCES:

Yoganandan, N., & Banerjee, A. (2018). Survival Analysis-Based Human Head Injury Risk Curves: Focus on Skull Fracture. J Neurotrauma, 35(11), 1272-1279. doi:10.1089/neu.2017.5356