EEVC WG12
Rear Impact Biofidelity Evaluation Programme

Presented by David Hynd
Chairman, EEVC WG20
Introduction

- EEVC WG20 formed in 2003 to develop test procedures for rear impacts
  - Prime focus on neck injury reduction

- EEVC WG12 to recommend dummies, injury criteria and injury risk functions for WG20 test procedures
  - Based on biomechanical evidence
EEVC WG12 - Dummy Issues

WG12 will make recommendations on

- Selection of a dummy
  - With appropriate biofidelity in low-speed rear impact test conditions

- Injury criteria
  - With a biomechanical basis

- Injury risk functions
  - With a biomechanical basis
EEVC WG12 Biofidelity Evaluation

- Several dummies used in or proposed for low-speed rear impact test procedures
  - BioRID II, RID$^{3D}$, Hybrid III
  - Most have been evaluated in certain test conditions, but…

  - … No consistent evaluation of the latest versions of each dummy across a range of test conditions

- WG12 have selected a range of biofidelity test conditions to
  - Evaluate the BioRID II, RID$^{3D}$ and Hybrid III dummies
    - BioRID II and RID$^{3D}$ included as purpose-designed rear impact dummies
    - Hybrid III included as proposed in rear impact GTR
Biofidelity Test Conditions

- Rear impact biofidelity requirements chosen, based on
  - The availability of the full data set
  - Quality of the test set-up and instrumentation
  - Reproducibility
  - Relevance of the test conditions, loading condition and velocity change
  - Distribution of subject anthropometry, gender and age
  - The number of tests and test subjects

- Biofidelity requirements
  - 4 based on volunteer data
  - 1 based on PMHS data
Biofidelity Test Conditions

AZT/Chalmers volunteer tests

TRL volunteer tests
Biofidelity Test Conditions

JARI volunteer tests

LAB PMHS tests

GDV/Allianz volunteer tests
Biofidelity Requirements

- Most relevant criteria prioritised
  - E.g. head angle, T1 angle, head CoG displacement…

- New target corridors developed using a standardised method
  - EEVC WG9 method
  - Mean ± 1 std dev
  - Straight line approximation for tabulation

LAB - head angle wrt T1 co-ordinate system
Biofidelity Analysis

- **Subjective analysis**
  - Performance with respect to target corridors
  - Influence of seat type and relevance to real-world seat testing

- **Objective analysis**
  - CORA analysis - goodness of fit of each dummy response to each mean PMHS or volunteer response
    - Algorithm developed by PDB
    - Score 1 if entirely within inner corridor (mean human ±1 std dev)
    - Score 0 if entirely outside outer corridor (mean ±2 std dev)
    - Linear aggregation between these limits
Biofidelity Results

- Some typical results…

LAB test results - head CoG x-axis displacement w.r.t. the sled - PMHS, no head restraint
Biofidelity Results

- Some typical results…

JARI test results - head rotation w.r.t. T1 - volunteer, no head restraint
Biofidelity Results

- Some typical results…

Chalmers/AZT test - T1 angle w.r.t. the sled
Biofidelity Results

- Some typical results…

Chalmers/AZT test - Head rotation w.r.t. the sled
Biofidelity Results

- **Biofidelity - Hybrid III**
  - Head motion w.r.t. T1 not biofidelic
  - Head rotation good in some seats, poor in others - biofidelity seat dependent
  - T1 rotation generally not biofidelic
  - Head acceleration poor
  - Seat back interaction least humanlike
  - Head restraint interaction least humanlike - contact force too low
Biofidelity Results

- **Biofidelity - RID\(^3D\)**
  - Biofidelity better at higher test severity
  - Not as able to accommodate different seat structures as BioRID and seat back interaction not as good as BioRID
  - Head restraint interaction comparable to BioRID II

- **Biofidelity - BioRID II**
  - Best overall biofidelity, although z displacements not good (nor for Hybrid III nor RID\(^3D\))
  - Head restraint interaction comparable to RID\(^3D\)
  - Seat back interaction most humanlike
Biofidelity Results

- **Objective CORA analysis**

<table>
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<th>Parameter</th>
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<th>BioRID II</th>
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<td>0.38</td>
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Conclusions

- Hybrid III, RID\textsuperscript{3D} and BioRID II successfully evaluated in five biofidelity test conditions
- Hybrid III had insufficient biofidelity to be considered further as a test tool for low-speed rear impact
- For many parameters, RID\textsuperscript{3D} and BioRID II were similarly biofidelic wrt target corridors
  - Subjectively, BioRID slightly better
  - Objectively (CORA analysis) BioRID scored higher (0.59) than RID\textsuperscript{3D} (0.53) - average of seven parameters from five test conditions
- BioRID showed better seat back and head restraint interaction
Conclusions

- Overall, recommend that based on the currently available biofidelity data, BioRID II is the most suitable dummy for use in a low-speed rear impact test procedure
  - Scope for improvement of T1 vertical motion

- Repeatability and reproducibility evaluation underway
  - Testing complete
  - Analysis available soon
End of Presentation

Presented by David Hynd
Chairman, EEVC WG20

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