WG20 Static Geometric
UK Cost-Benefit

David Hynd
GTR Meeting, Basildon
8th November, 2007
Introduction

- **General scope**

  - Cost-benefit analysis for UK
  
  - Costs of whiplash casualties based on DfT willingness-to-pay approach
  
  - Savings based on number of casualties saved x cost of casualty
  
  - Cost to industry based on NHTSA 202a costs to make modifications to seats and head restraints
Basis for whiplash injury costing

- **DfT willingness-to-pay approach**
  - Hopkin and Simpson [1995]
  - Whiplash costed separately to other slight injuries
  - c.f. insurance cost - look at which components of H&S included in insurance payout

- **DfT Casualty valuations (2005 values)**
  - Fatal  £1,428,460
  - Serious £160,510
  - Slight  £12,380

- Slight = average of whiplash (high cost) and other slights (very low cost)
### Hopkin and Simpson [1995]

<table>
<thead>
<tr>
<th>Category</th>
<th>Up to 1 year (90% of slights)</th>
<th>1-3 years (whiplash) (10% of slights)</th>
<th>All slight</th>
<th>Whiplash cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lost output</strong></td>
<td>£390</td>
<td>£8,620</td>
<td>£1,220</td>
<td>£8,620</td>
</tr>
<tr>
<td><strong>Medical and support costs</strong></td>
<td>Recover 3-4 months</td>
<td>Mild disability</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>£201</td>
<td>£633</td>
<td>£520</td>
<td>£520</td>
</tr>
<tr>
<td><strong>Human costs</strong></td>
<td>Minor slights (80%)</td>
<td>Whiplash (20%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>£120</td>
<td>£25,490*</td>
<td>£5,190</td>
<td>£25,490</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td>£6,920 (sic)</td>
<td>£34,630</td>
</tr>
</tbody>
</table>

1995 Prices  * 5% value of a death
Basis for whiplash injury costing

- **Hopkin and Simpson [1995]**
  - Human cost of injury = £25,490
    - Half ‘state W’ (recover 3-4 months) = £14,570
    - Half ‘reduced state X’ (recover 1-3 years) = £36,420
      - (Full ‘state X’ = 40,060 - reduced as respondents considered 1-3 year whiplash slightly better than ‘state X’)

- **H&S Inflated to 2005 values**
  - Whiplash value = £61,362
Basis for whiplash injury costing

• **However…**
  - Seems very high for short-term whiplash

  • Galasko *et al.* [1996] (part of H&S study) found that 59.1% whiplash injuries (all impact directions) were > 6 months
  • Recent Thatcham data suggests 70% UK rear impact whiplash injuries are long-term: mean 9 month recovery

• **So…**
  - Apply £61k casualty value to *long-term* injuries only
  - Assume 59.1% for rear and front impact

  • Casualty cost for short-term = £1,260
Cost of whiplash in UK

- **Slight injuries UK 2005**

<table>
<thead>
<tr>
<th></th>
<th>Male driver</th>
<th>Male FSP</th>
<th>Female driver</th>
<th>Female FSP</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rear impact</td>
<td>15223</td>
<td>3047</td>
<td>15197</td>
<td>6481</td>
<td></td>
</tr>
<tr>
<td>Front impact</td>
<td>29919</td>
<td>6423</td>
<td>21142</td>
<td>9711</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>45142</td>
<td>9470</td>
<td>36339</td>
<td>16192</td>
<td>107143</td>
</tr>
</tbody>
</table>

- **Proportion under reported 45%**
  - Galasko *et al.* [1996] (part of H&S study)

- **Proportion with whiplash**
  - 58% rear impact
  - 34% front impact

- **Proportion long-term injury 59.1%**
  - Galasko *et al.* [1996]

- **Value of long-term whiplash injury £61,326**
  - UK willingness-to-pay value
Cost of whiplash in UK

- **Long-term whiplash injury value**

<table>
<thead>
<tr>
<th></th>
<th>Male driver</th>
<th>Male FSP</th>
<th>Female driver</th>
<th>Female FSP</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rear impact</td>
<td>582</td>
<td>116</td>
<td>581</td>
<td>248</td>
<td></td>
</tr>
<tr>
<td>Front impact</td>
<td>670</td>
<td>144</td>
<td>474</td>
<td>218</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1,252</td>
<td>260</td>
<td>1,055</td>
<td>465</td>
<td>3,032</td>
</tr>
</tbody>
</table>

- **Total cost of long-term whiplash injuries = £3 billion**
Cost-benefit options

• **Option 1:** Do nothing

• **Option 2:** Increase head restraint height
  • In the range 800 to 850 mm

• **Option 3:** Control head restraint backset
  • In the range 40 to 100 mm

• **Option 4:** Increase head restraint height and control backset
  • Height in the range 800 to 850 mm, combined with
  • Backset in the range 40 to 100 mm
Cost-benefit options

- **Option 1: Do nothing**
  - Assumptions for benefit
    - No additional benefit derived from Regulatory activity
    - No increase in benefit from consumer testing
  - Assumptions for cost
    - No cost to industry from Regulatory activity

- **Option 2: Increase head restraint height (800 to 850 mm)**
  - Assumptions for benefit
    - No direct benefit from increase in height requirement
    - Increased height allows proportion of backset benefit
    - Benefit to backset ‘all-or-nothing’ - i.e. if HR level with CoG of ‘ramped-up’ occupant, improved backset can work, else backset cannot be effective
  - Assumptions for cost
    - NHTSA costs for adjustable and fixed head restraints
    - Proportional to height increase
Cost-benefit options

• **Option 3: Control head restraint backset (40 to 100 mm)**
  - Assumptions for benefit
    - Benefit can arise from this, but only for occupants whose HR is high enough
    - Benefit for different backsets only proportion of occupants protected by current 800 mm Reg height
  - Assumptions for cost
    - No cost for changing backset (NHTSA assumption)

• **Option 4: Increase head restraint height and control backset**
  - Assumptions for benefit
    - Increased backset benefit for progressively higher head restraints (protecting greater proportion of UK population)
  - Assumptions for cost
    - Option 2 cost only - proportional to height increase
Option 2: Head restraint height

- **Calculation of head restraint height required to protect proportions of the UK population**
  - **Calc method**
    - Essentially the same as used by Hans Amerlaan (WD136)
    - Slightly different values for some parameters
    - 40 mm used for ramping-up
  - **Justification for ramping-up value (40 mm)**
    - Japan GTR doc giving ramping-up (10 mm) separate from spine straightening - but only at 8 km.hr⁻¹ Δv - gives ~30 mm (to 60 mm) at 25 km.hr⁻¹
Option 2: Head restraint height

- Justification for ramping-up value (40 mm)

<table>
<thead>
<tr>
<th>Biofidelity test condition</th>
<th>Ramping-up (mm)</th>
<th>Test subjects</th>
<th>Seat type</th>
<th>Peak acceleration (g)</th>
<th>Delta-v (km.hr⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAB</td>
<td>20-60</td>
<td>PMHS</td>
<td>Lab seat</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>Chalmers/Allianz</td>
<td>20-35</td>
<td>Volunteers</td>
<td>Lab seat with stiffness designed to represent a Volvo 850 seat</td>
<td>3-4</td>
<td>7</td>
</tr>
<tr>
<td>JARI</td>
<td>20-40</td>
<td>Volunteers</td>
<td>Lab seat</td>
<td>3.5</td>
<td>7</td>
</tr>
<tr>
<td>TRL</td>
<td>28-40</td>
<td>Volunteers</td>
<td>Lab seat</td>
<td>2</td>
<td>7</td>
</tr>
</tbody>
</table>

Ramping-up from WG12 rear impact dummy biofidelity tests
Option 2: Head restraint height

- Justification for ramping-up value (40 mm)
  - Japan GTR doc HR-7-9

Straightening - change in distance between PN-IC

Ramping-up - displacement of IC along seat back

Ramping-up - extrapolated to 25 km.hr⁻¹
Option 3: Head restraint backset

- Injury risk for different backsets

Risk of >6 Month Injury vs. Backset [Olsson et al., 1990]
Option 3: Head restraint backset

Injury risk for different backsets

• Assumptions
  • Rear impact pulse in 1980s Volvo’s struck by another 1980s car is similar to pulses in modern fleet
    • Pulse so dependent on other factors, probably OK
      • Over-ride and under-ride
      • Overlap of impact
      • Mass ratio of impact partners
      • Stiffness ratio of impact partners
      • Bumper design
      • …
  • Seat back stiffness of 1980s Volvo’s similar to current fleet
    • Volvo had already stiffened seat backs by this time to combat ramping in rear impact (e.g. Carlsson et al. [1985])
Option 4: Height and backset

- Product of height and backset

Long-term whiplash injury savings
Issue with Reg17 height test

• **Issue with Reg17 measurement method**
  • Measures to top-back corner of the head restraint
  • Example of height overestimation for seat in UTAC presentation - plus matching benefit overestimation based on height calcs above
  • Implications for US benefit analysis
    • Note - can’t base height improvements on RCAR data as head restraint test positions different (highest use position in Reg, mid notch or lowest adjustment position in RCAR)

• [Reg 17 Height Measurement Presentation](#)
WG20 Static Geometric
UK Cost-Benefit

Presented by David Hynd

GTR Meeting, Basildon

8th November, 2007