WG20 Static Geometric UK Cost-Benefit

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GTR Meeting, Basildon

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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]

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

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**

	Male driver	Male FSP	Female driver	Female FSP	Totals
Rear impact	15223	3047	15197	6481	
Front impact	29919	6423	21142	9711	
Total	45142	9470	36339	16192	107143

- **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**

	Male driver	Male FSP	Female driver	Female FSP	Totals
Rear impact	582	116	581	248	
Front impact	670	144	474	218	
Total	1,252	260	1,055	465	3,032

- **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)**

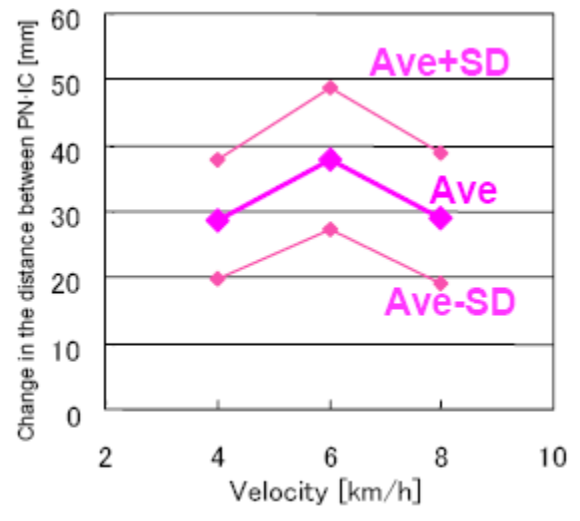
Biofidelity test condition	Ramping-up (mm)	Test subjects	Seat type	Peak acceleration (g)	Delta-*v* (km.hr^{-1})
LAB	20-60	PMHS	Lab seat	12	10
Chalmers/Allianz	20-35	Volunteers	Lab seat with stiffness designed to represent a Volvo 850 seat	3-4	7
JARI	20-40	Volunteers	Lab seat	3.5	7
TRL	28-40	Volunteers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

Ramping-up from WG12 rear impact dummy biofidelity tests

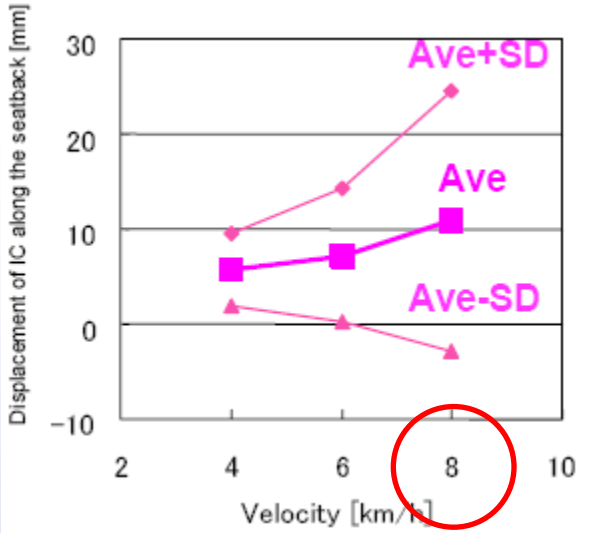
Option 2: Head restraint height

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

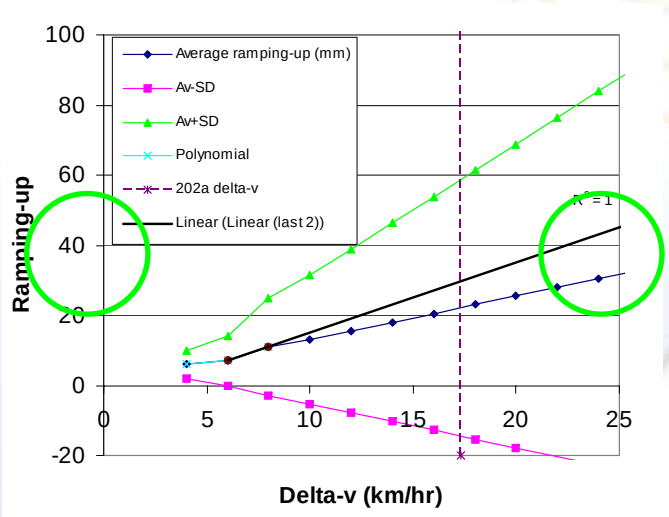
Straightening - change in distance between PN-IC



Ramping-up - displacement of IC along seat back

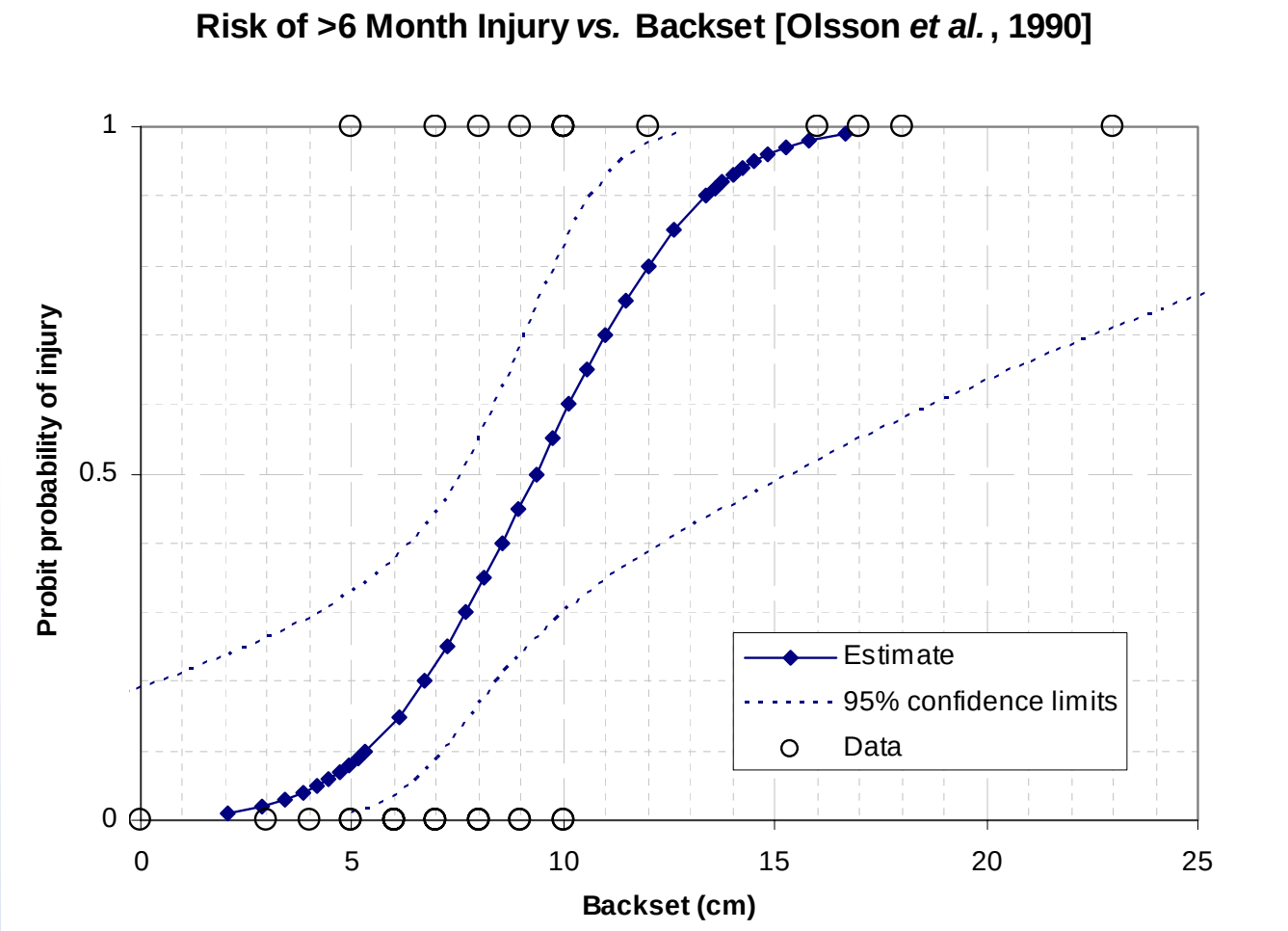


Ramping-up - extrapolated to 25 km.hr^{-1}



Option 3: Head restraint backset

- **Injury risk for different backsets**



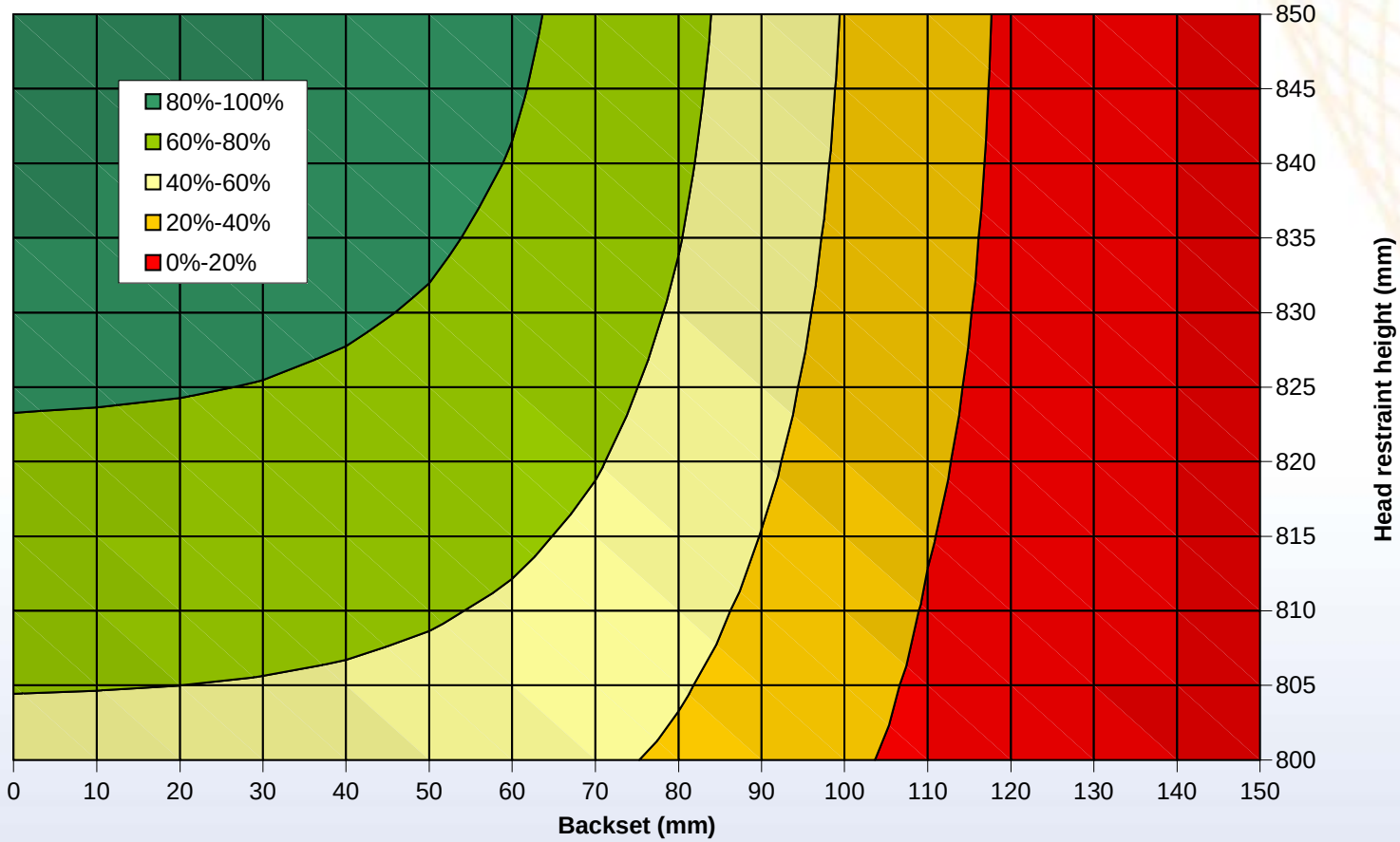
Option 3: Head restraint backset

Injury risk for different backsets

- **Assumptions**
  - Rear impact pulse in 1980s Volvo's struck by a.n.other 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

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