

Evaluation of seat performance criteria for rear-end impact testing: BioRID II and insurance data

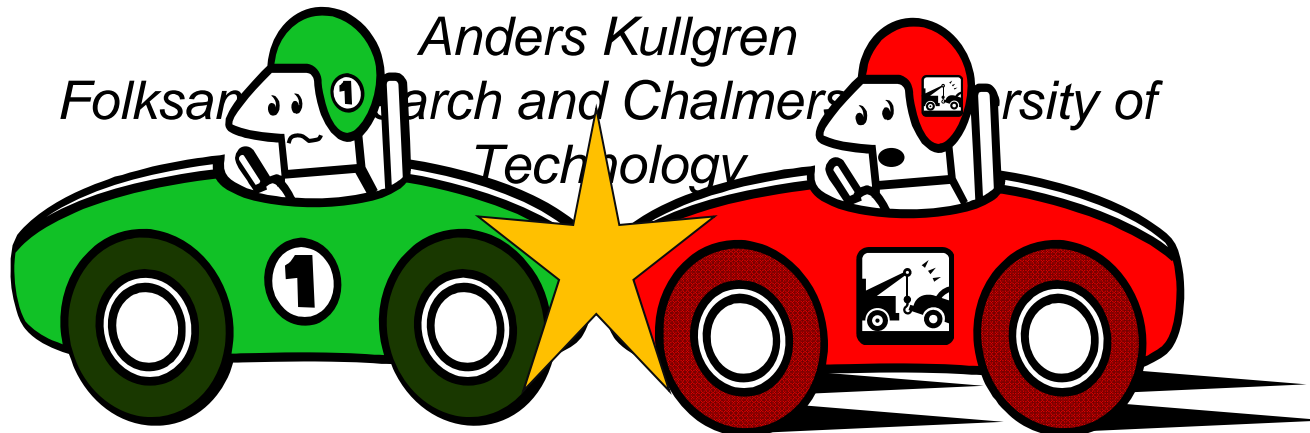
Presented at GTR No7 Injury Criteria Meeting

Berlin, Sept 8-9th 2014

Johan Davidsson

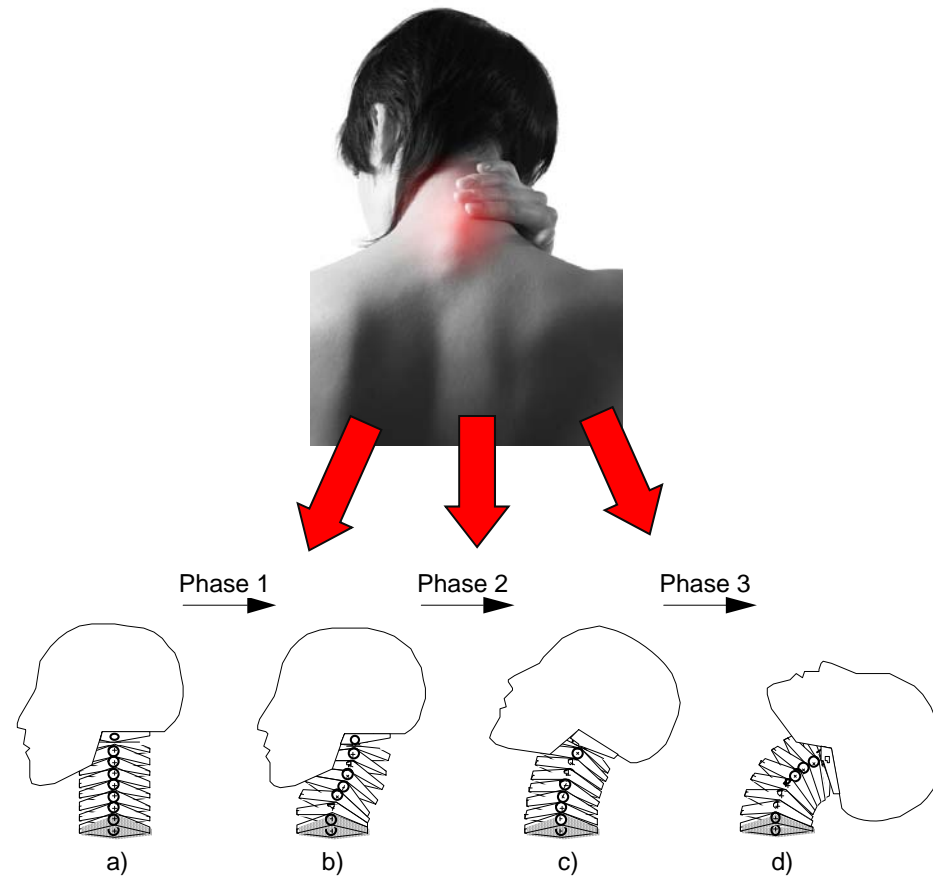
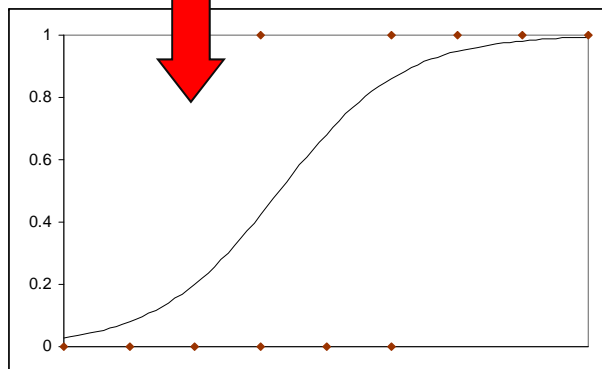
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Background

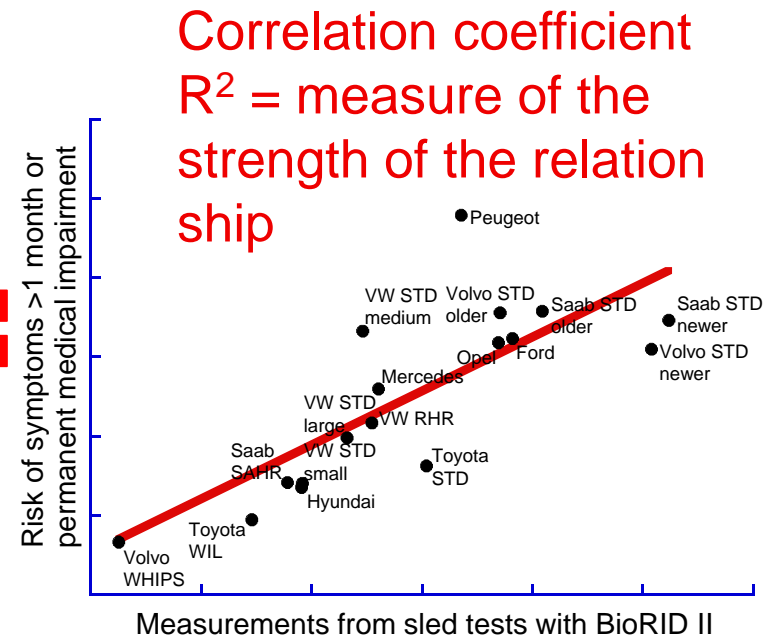
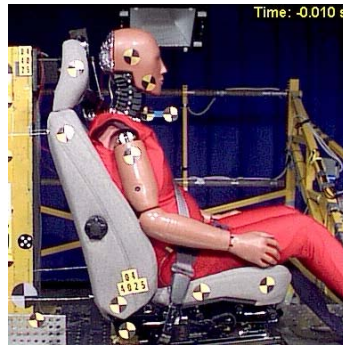
- Traditional approach
- Whiplash Associated Disorders



Objective and Principle method

- Suggest seat performance criteria to be used in rear-end impact seat tests with BioRID II

Folksam
Injury Claim data
from rear-end
impacts



Methods: Data used

Insurance data

- Folksam, Sweden
 - 1998 - 2012
 - Only drivers
 - Only rear +/-30 degrees
 - Only neck and spine injuries
- Risks used:
 - Symptoms for more than one month in case of initial symptoms
 - Permanent medical impairment in case of initial symptoms

BioRID II seat test data

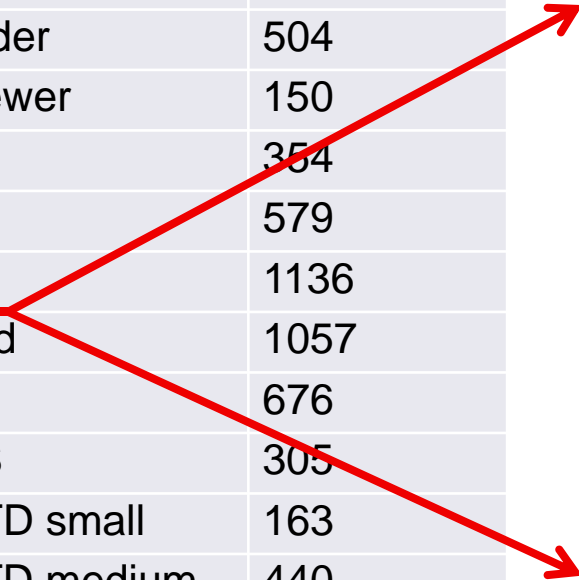
- Euro NCAP medium pulse rear-end impact test data
 - Autoliv, 2004, 2005 and 2006
 - Thatcham, 2004 and 2012
- BioRID II build level E or G
- H-point tool:
 - TechnoSports, Inc.
 - Automotive Accessories, Ltd.

Methods: Grouping insurance data

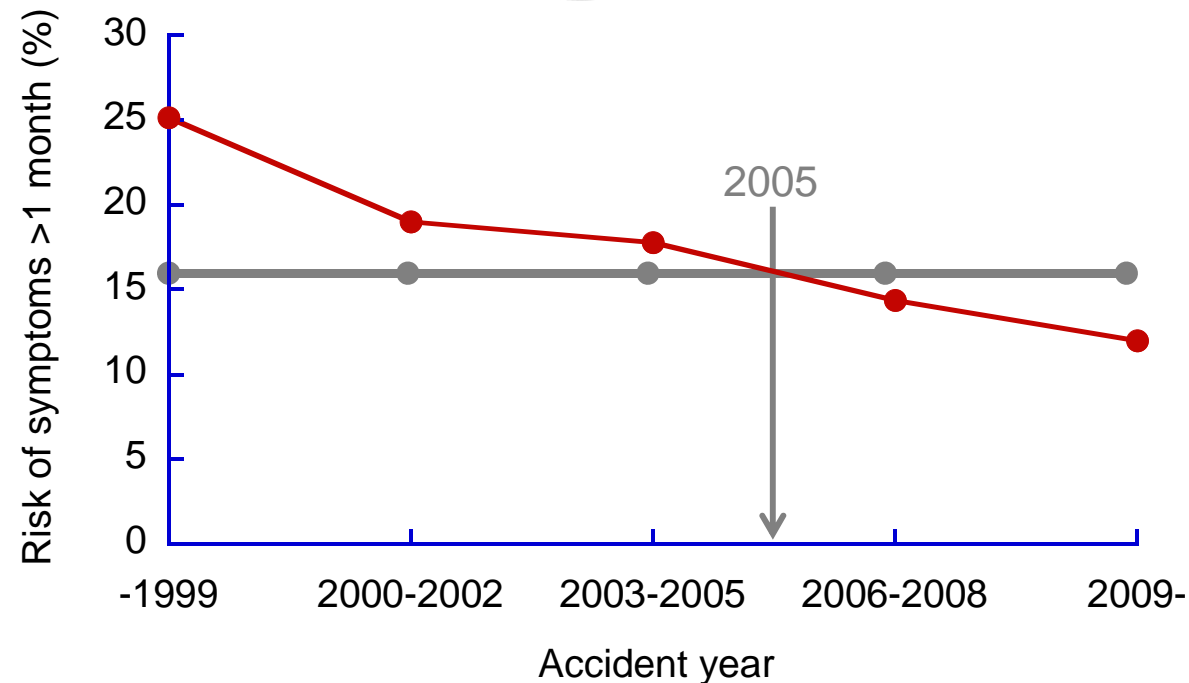
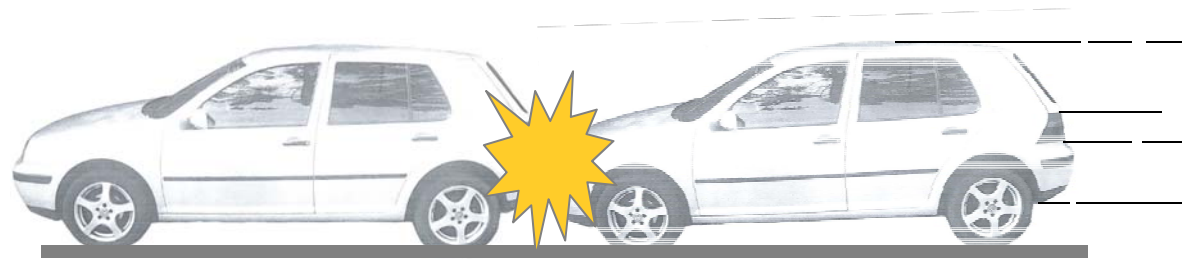
Group names	No. cases
Ford with STD	382
Hyundai with STD	195
Mercedes with STD	191
Opel with STD	500
Peugeot with STD	397
Saab with STD older	504
Saab with STD newer	150
Saab with SAHR	354
Toyota with STD	579
<u>Toyota with WIL</u>	1136
Volvo with STD old	1057
Volvo with STD	676
Volvo with WHIPS	305
VW group with STD small	163
VW group with STD medium	440
VW group with STD large	683
VW group with RHR	181

Insurance data for group Toyota with WIL	
Auris	07-
Avensis	03-08
Avensis Verso	01-05
Camry	01-03
Corolla	02-07
Corolla Verso	02-03
Corolla Verso	04-10
Prius	00-03
Prius	04-09
Rav4	00-04
Rav4	05-
Yaris and Yaris Verso	99-05
Yaris	05-

BioRID tests for group Toyota with WIL	
Model	Yaris
Production year	99-05
Test year	2004
Test facility	Thatcham
BioRID II version	G

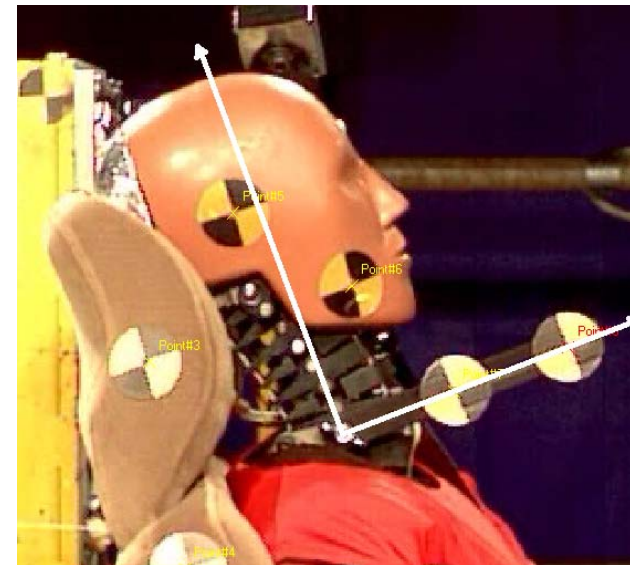


Methods: Compensation for classification of injury

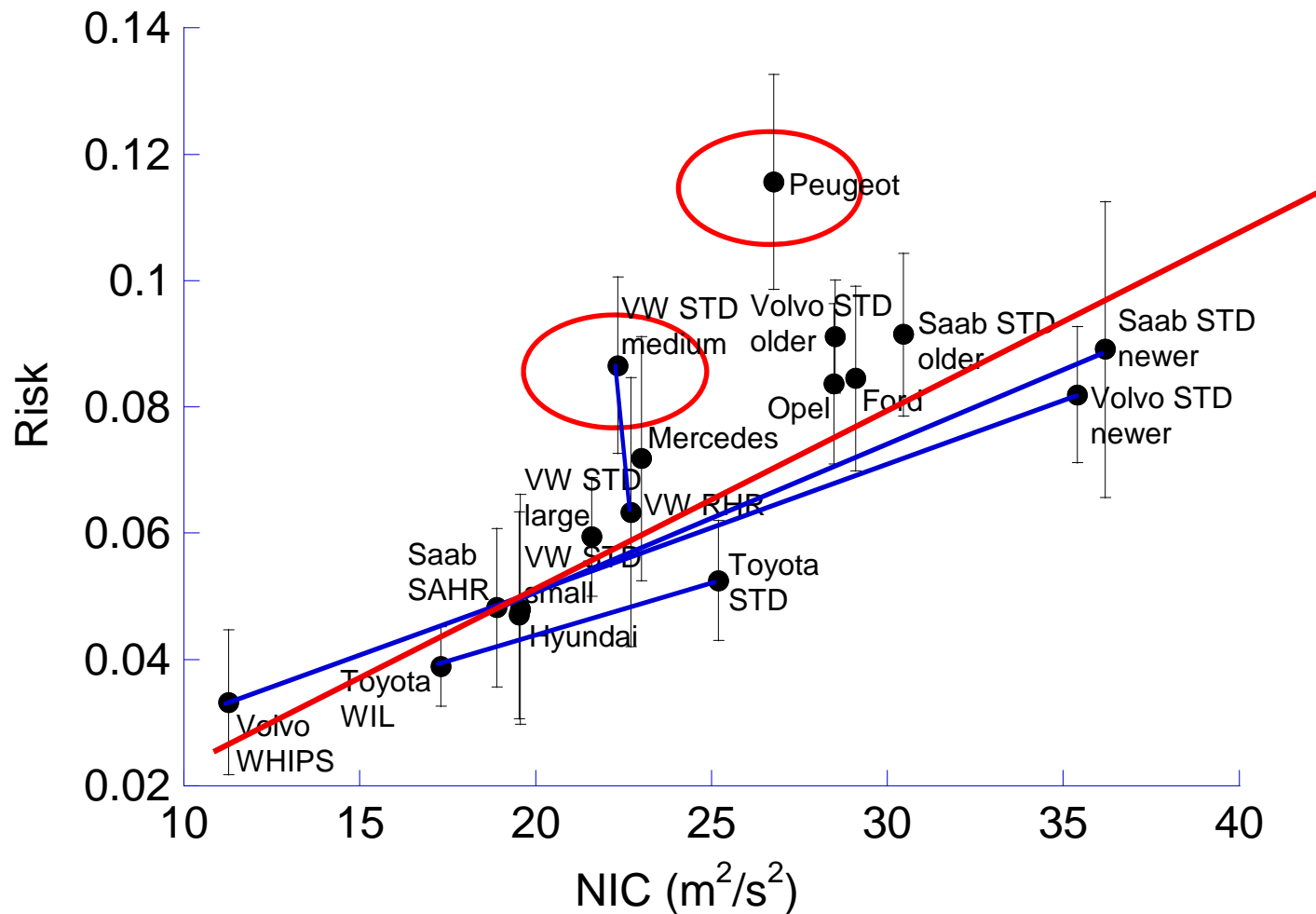


Methods: Studied parameters

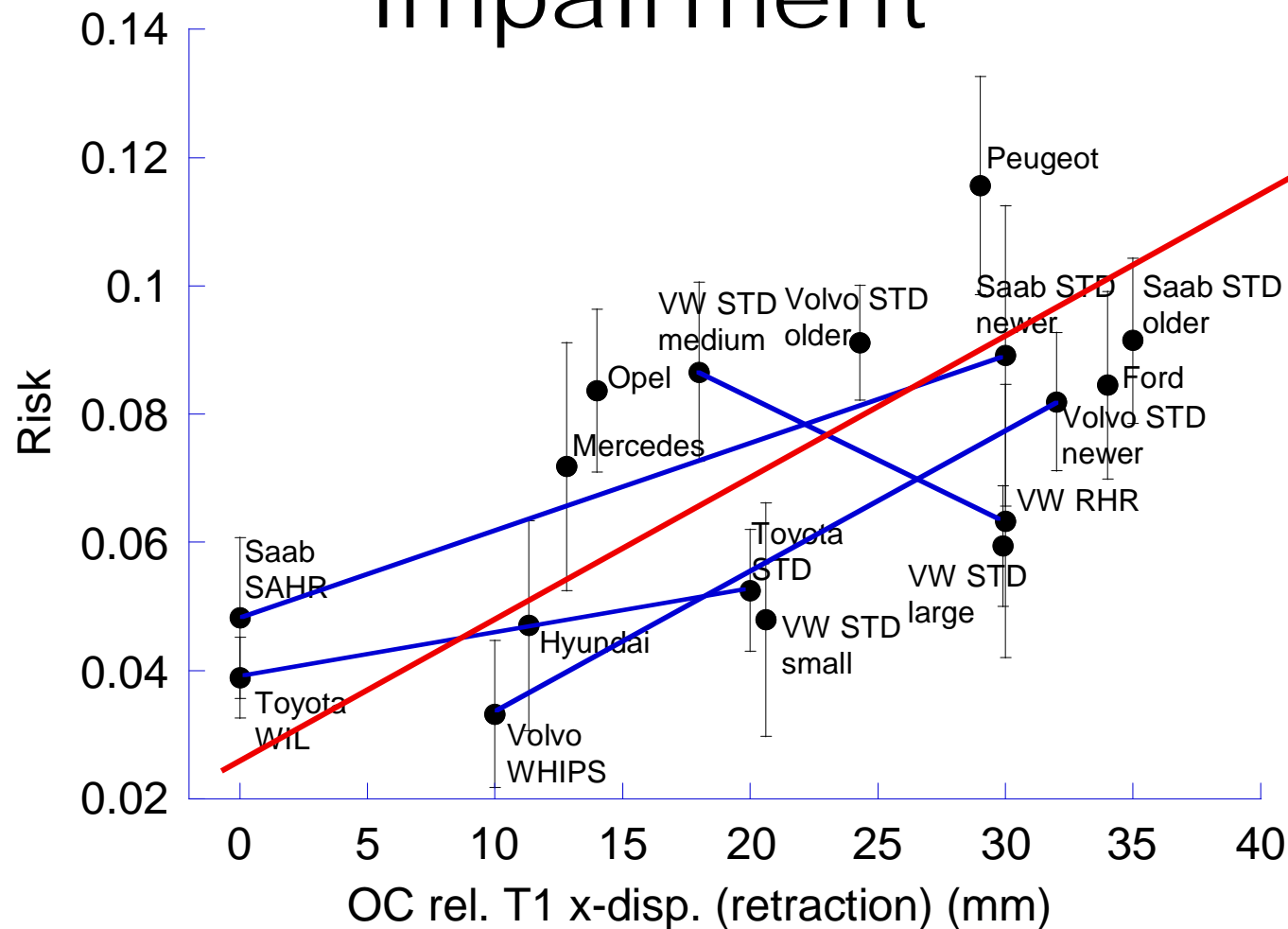
- Maximum Neck Injury Criteria (NIC)
- Maximum Neck Force Criteria (N_{km})
- Maximum Lower Neck Loads Criteria (LNL)
- Maximum Head x- and z-acceleration
- Maximum C4 x- and z-acceleration
- Maximum T1 x- and z-acceleration
- Maximum T8 x- and z-acceleration
- Maximum L1 x- and z-acceleration
- Maximum Pelvis x- and z-acceleration
- Maximum and minimum Upper Neck Loads (F_x , F_z and M_y , before head contact stop)
- Maximum and minimum Lower Neck Loads (F_x , F_z and M_y , before head contact stop)
- Maximum Occipital condyle rel. T1 x- and z-displacement in the T1 frame (OC-x and OC-z)
- Maximum Head rel. T1 angular displacement
- Head Contact Time (HCT)
- Maximum Head Rebound Velocity (HRV)



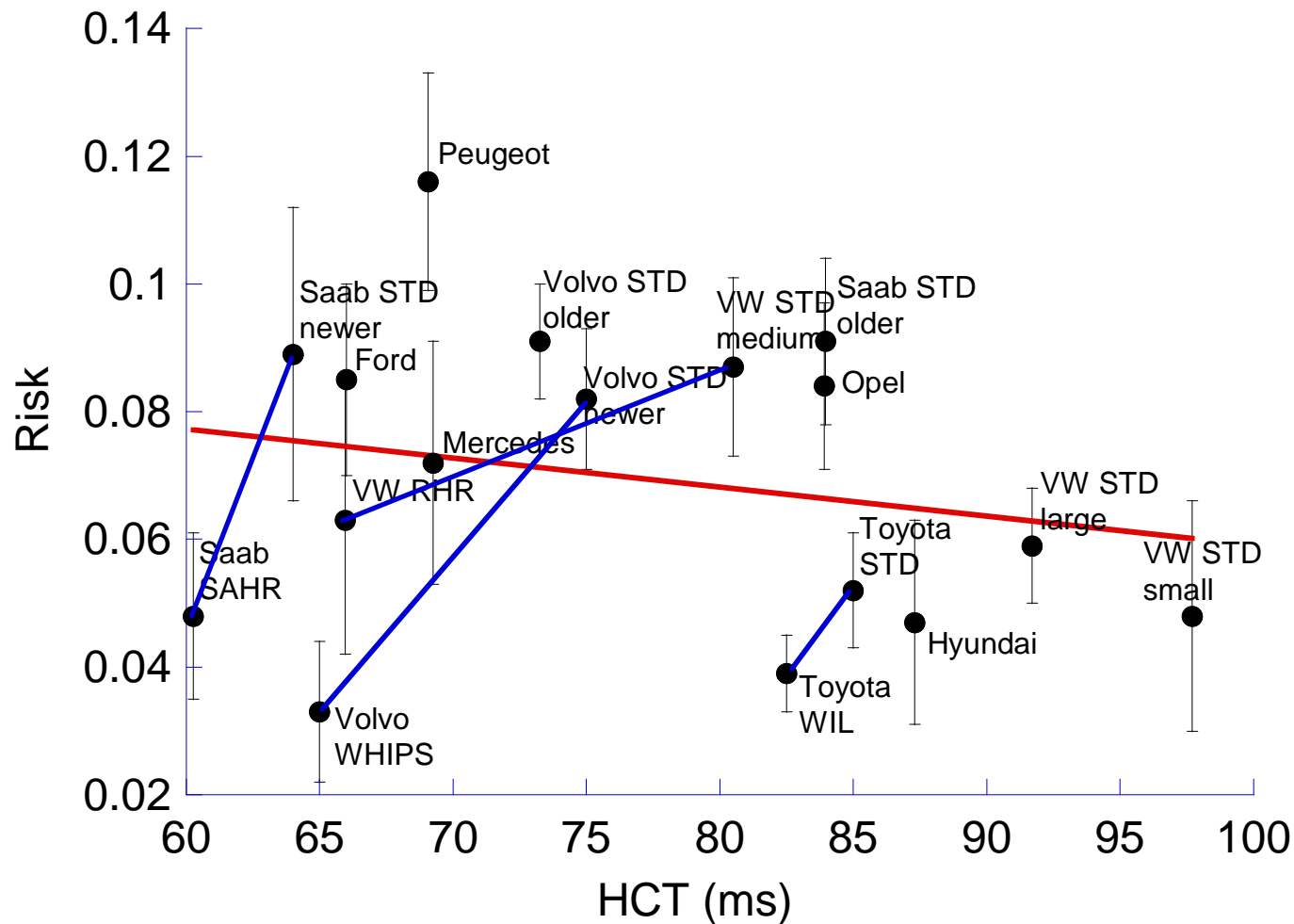
Results: Neck Injury Criteria versus permanent medical impairment



Results: Occipital Condyles rel. T1 x-disp. versus permanent medical impairment



Results: Head Contact Time versus permanent medical impairment



Results: Correlation R^2 values

Parameter	Permanent medical impairment	Symptoms < 1 month
NIC	0.59	0.72
OC rel. T1 x-displacement (retraction)	0.42	0.39
L1 x-acceleration	0.42	0.32
Pelvis z-acceleration	0.40	0.19
L1 z-acceleration	0.37	0.14
Head rel. T1 y-rot. (extension)	0.35	0.53
N_{km}	0.33	0.38
T8 x-acceleration	0.28	0.29
T8 z-acceleration	0.22	0.07
U. N. F_x (head r.w.)	0.19	0.23
L. N. F_x (head f.w.)	0.17	0.22
L. N. M_y (negative)	0.16	0.20
T1 x-acceleration	0.15	0.40

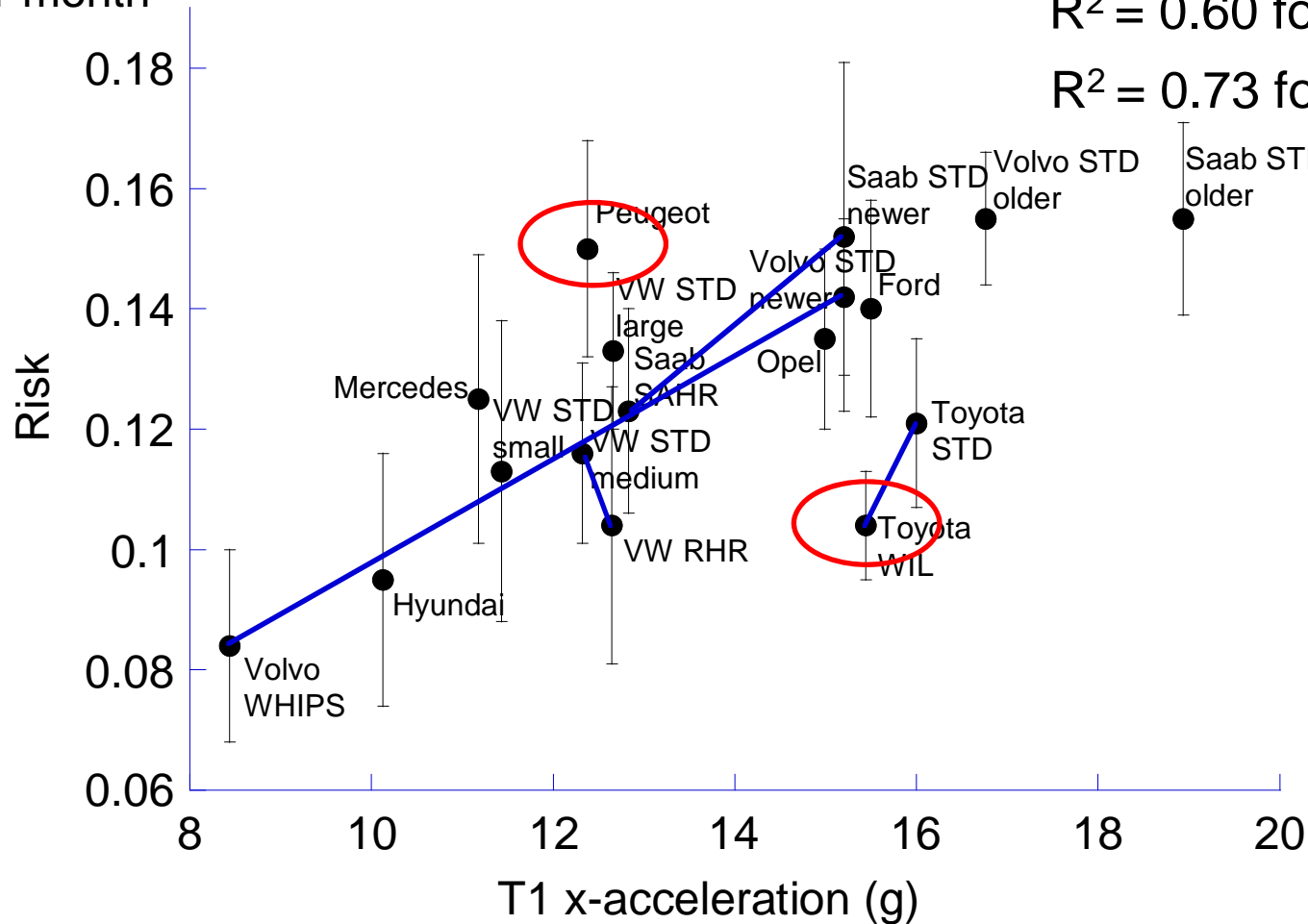
Discussion: Effect of outliers

Risk of symptoms
>1 month

$R^2 = 0.40$ for 17 datasets

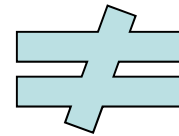
$R^2 = 0.60$ for 16 datasets

$R^2 = 0.73$ for 15 datasets



Discussion 2: Injury risk measures

Risk of long term symptoms and impairments given the occupant had initial symptoms following a rear-end impact



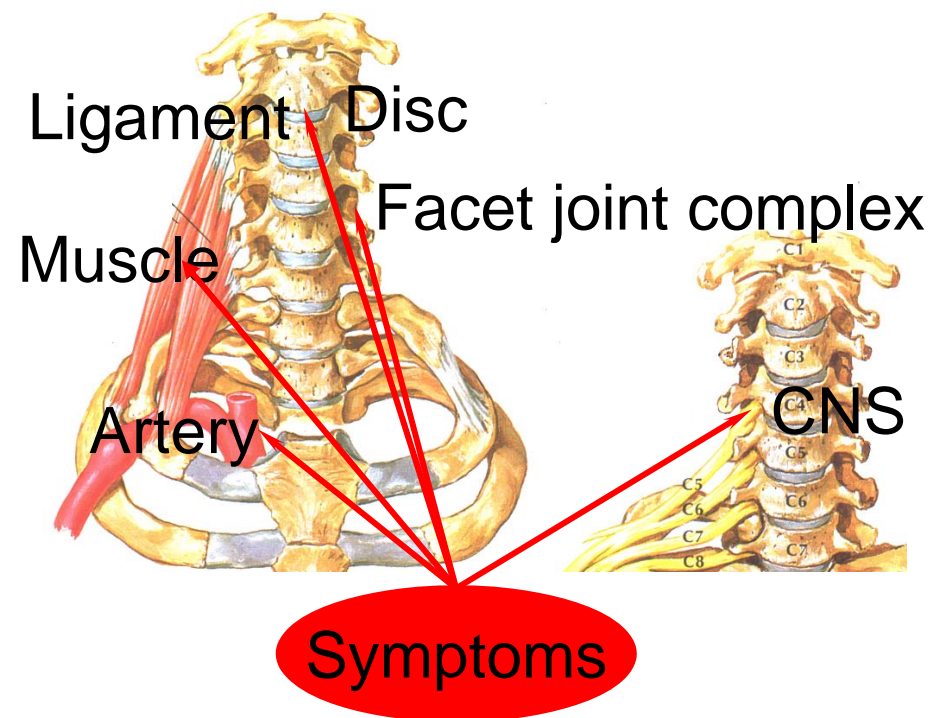
Risk of long term symptoms and impairments given the occupant were in a rear-end impact

Discussion: Dummy tests

- Since the BioRID tests were carried out:
 - Test procedures updated
 - Dummy calibration routines changed
 - Dummy build level updated
- Single sled pulse was used
 - Evaluate injury predictability of the complete sled test method

Discussion: Correlation coefficient

- R^2 coefficients were below 0.72



Conclusions

- NIC, Occipital condyles relative T1 x-displacement and L1-acceleration correlate with long term injury risk:
- Neck extension and T1 x-acceleration may be candidates but appear to be sensitive to set model inclusion
- These findings are in partial agreement with other studies on this
- Additional parameters may predict PMI and long term symptoms

End!

Many thanks to Thatcham and Autoliv for
providing BioRID seat test data!