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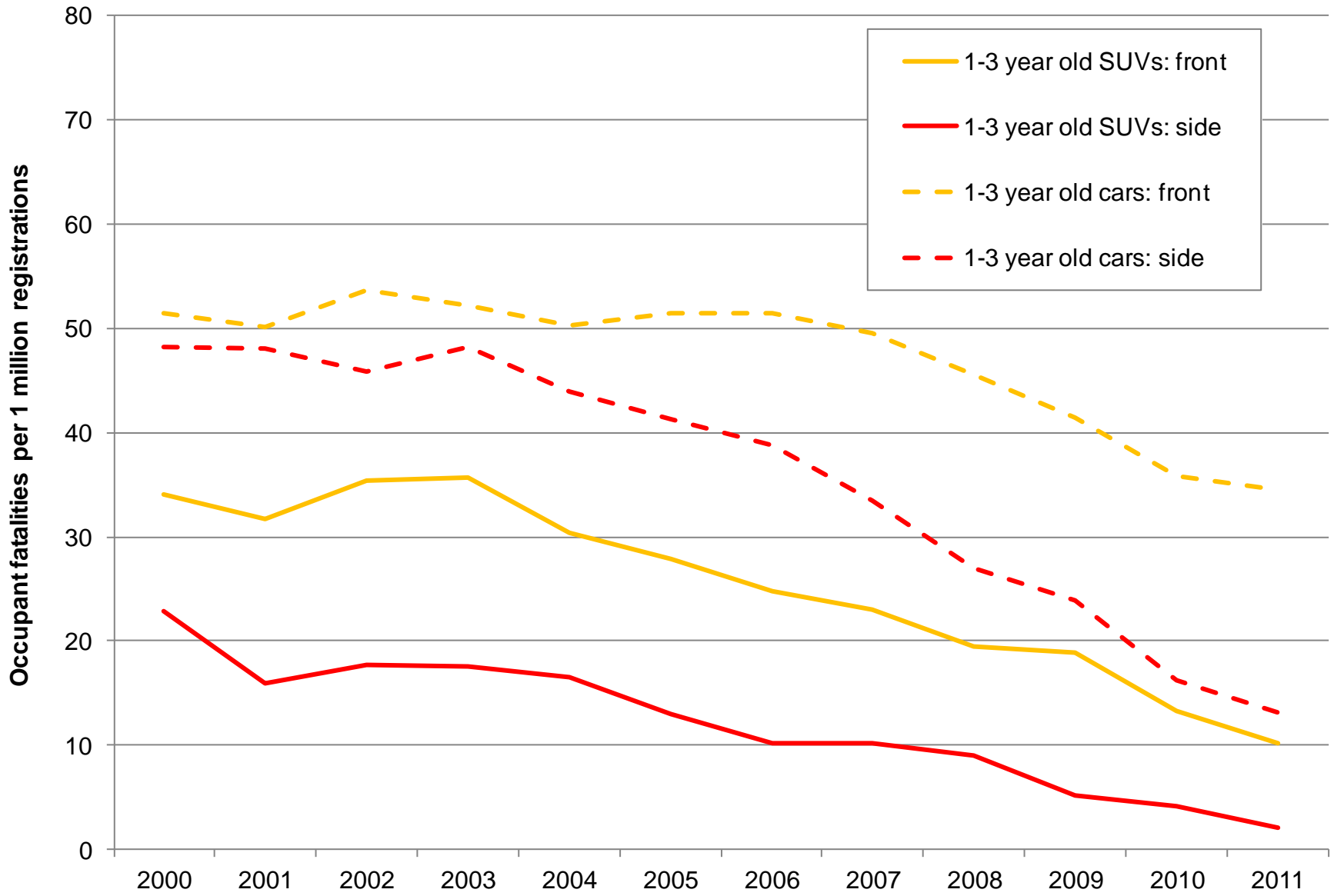
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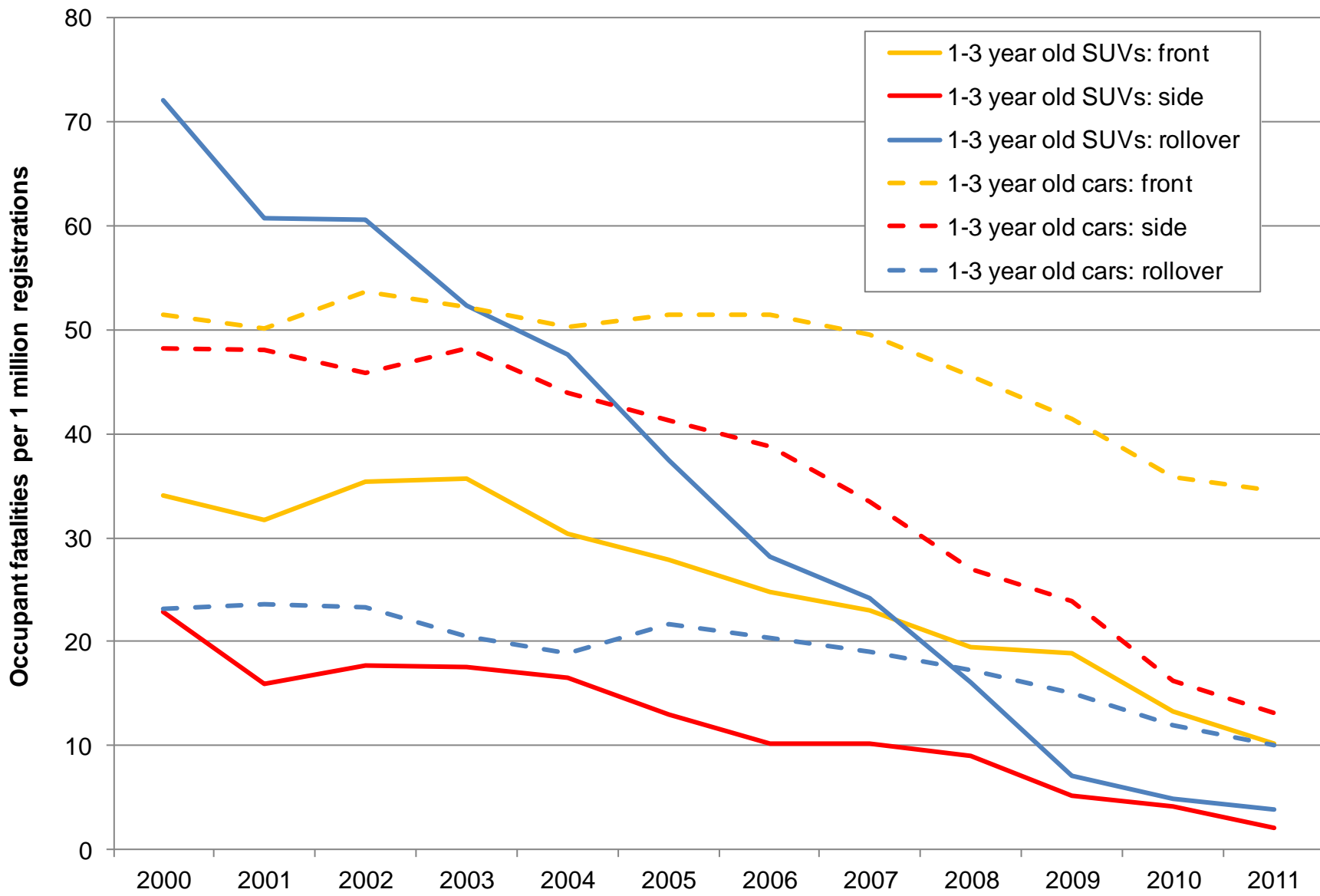
Rollovers of the future: strong roofs, ESC, and curtain airbags

Matthew Brumbelow
SAE Government / Industry Meeting
30 January 2013

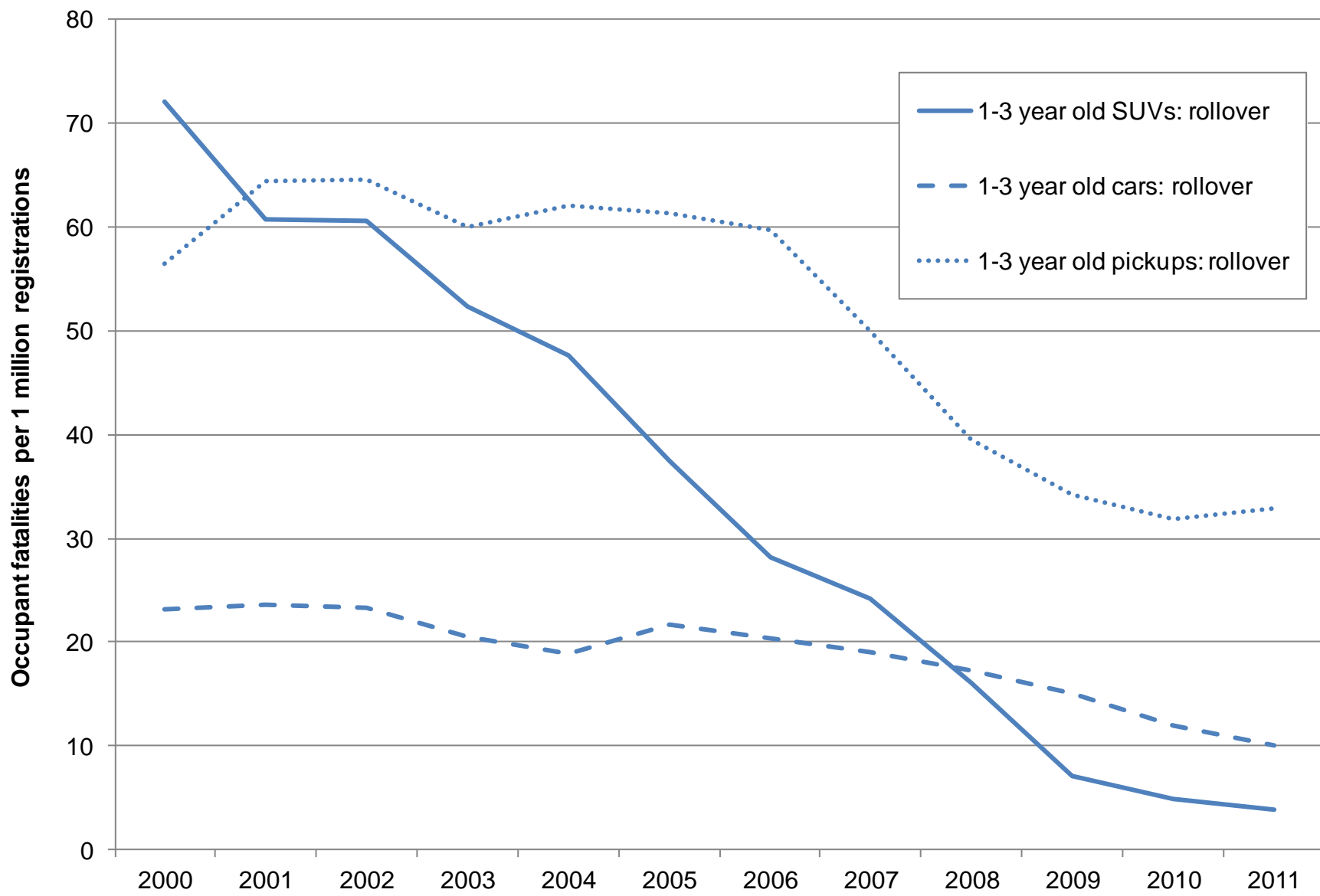
Fatality rates in 1-3 year old SUVs and cars



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Rollover fatality rates in 1-3 year old pass. vehicles

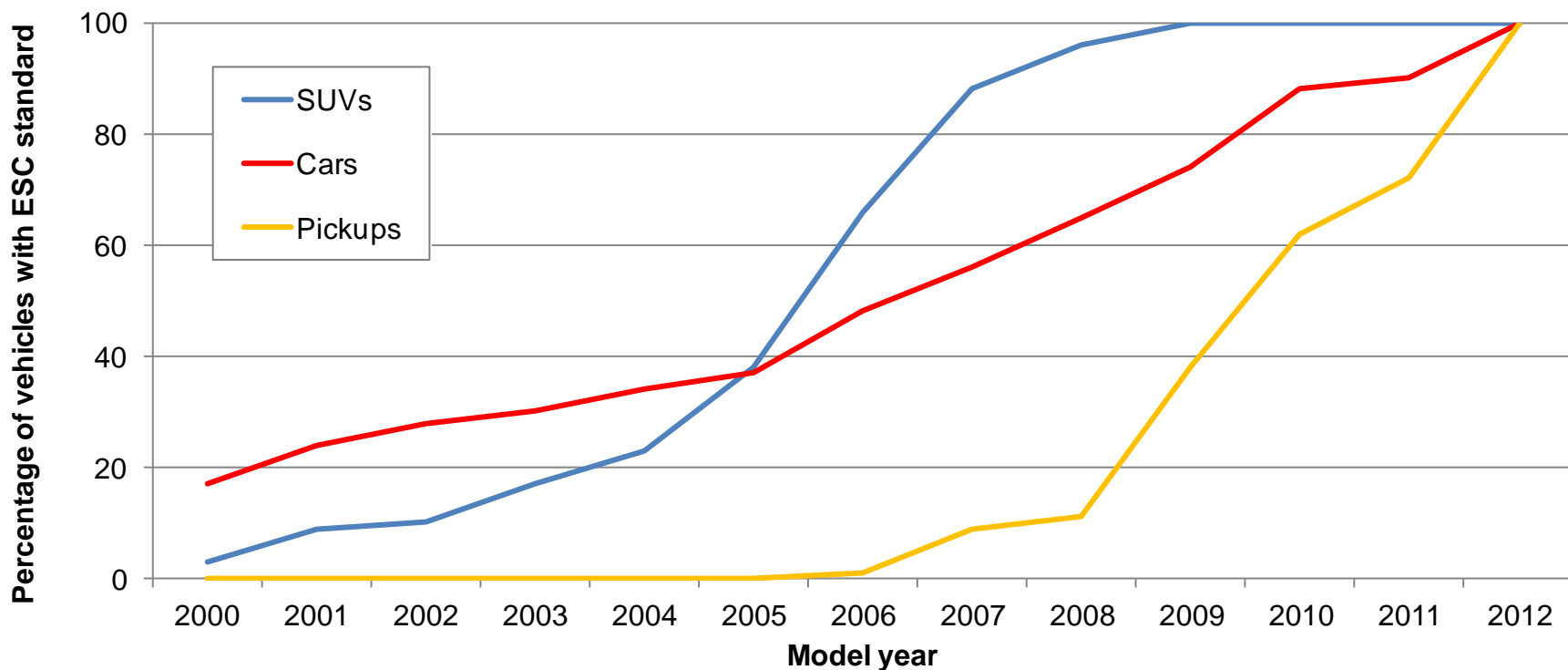


Many factors are likely contributing to reduced rollover fatality rate

- Impact of economic recession
- Improvements in static stability factor (especially SUVs)
- Increased belt use rates
- Increased ESC fitment rates
- Increased side curtain airbag fitment rates
- Increased roof strength

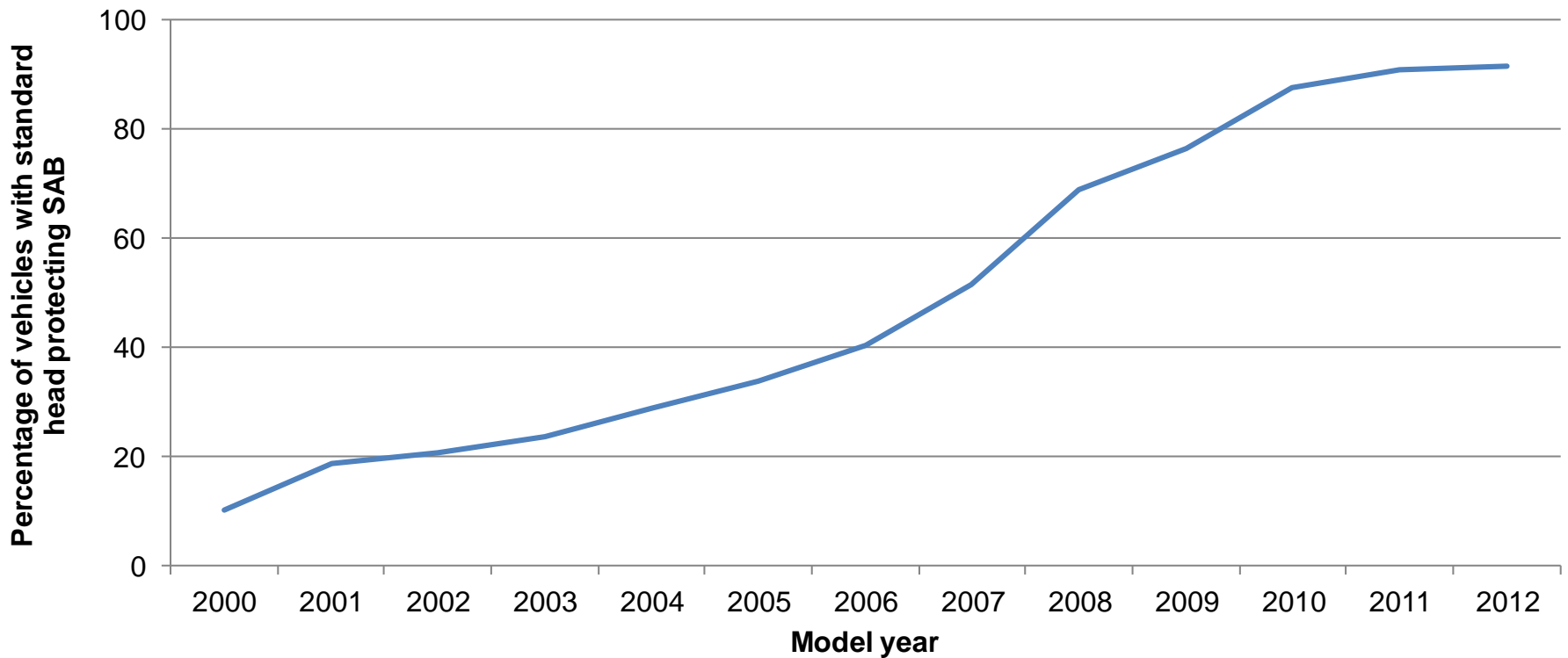
Electronic stability control

- Estimated 73 percent reduction in fatal single-vehicle rollover crash rates due to ESC (Farmer 2010)
- FMVSS 126 issued in 2007, required complete phase-in for 2012 model year
- SUV fitment rates were far ahead of FMVSS requirements



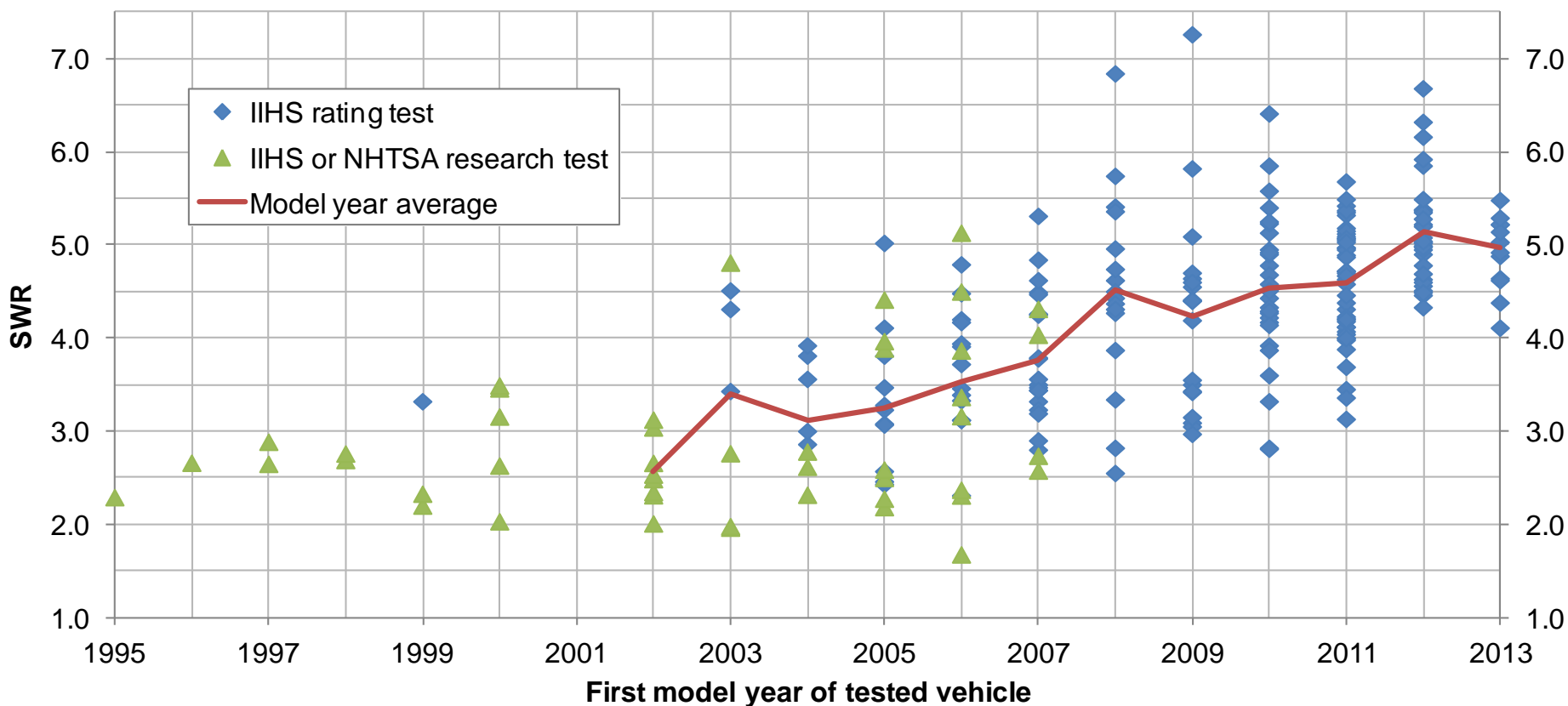
Curtain airbags

- Side impact protection has driven fitment of airbags
- Many curtain airbags have not been linked to roll sensors (especially in cars)
- FMVSS 226 will phase-in over 2014-2017 model years



Roof strength

- Estimated 23 percent reduction in fatal/incapacitating injury risk for a 1.0 unit SWR increase (Brumbelow and Teoh, 2009)
- IIHS rating system began in 2009; FMVSS 216 upgrade will phase-in over 2013-2017 model years



How will future rollovers be different?

- Will ESC presence shift the average crash severity?
 - “Unsuccessful” ESC interventions could still reduce speed entering roll
 - Rollovers which ESC is unable to prevent may be more severe or otherwise initiated differently
- Will curtain airbags and stronger roofs produce a shift in the relative prevalence of injury types?
- Does the amount/type of vehicle deformation change with higher roof strength (as measured in FMVSS 216 configuration)?
- Questions like these should inform current research efforts

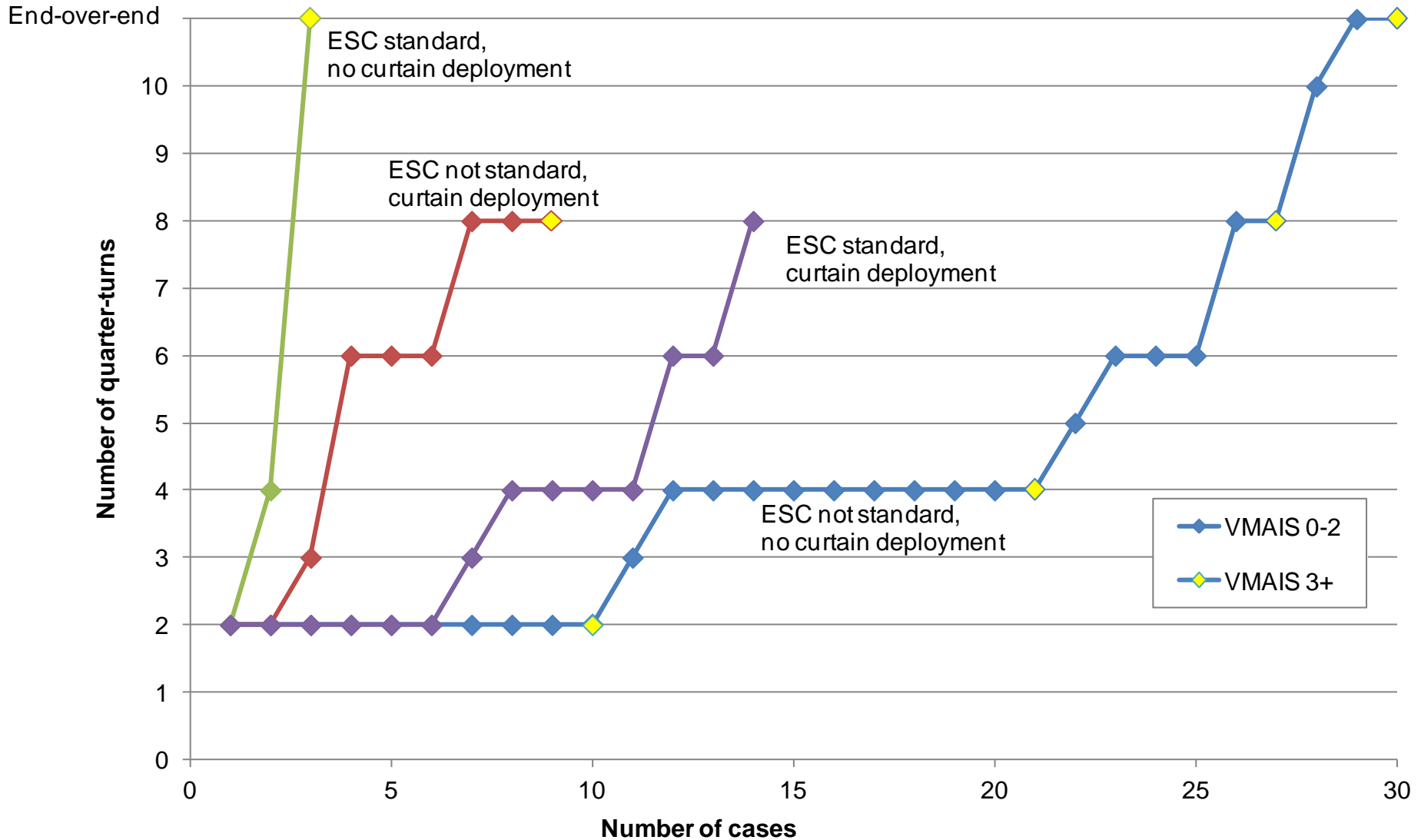
NASS-CDS query

- Vehicles with Good IIHS roof strength ratings ($SWR \geq 4.0$)
- Calendar years 2003-2011
- Two or more quarter-turns

Total cases	61
With standard ESC	19
With curtain SAB linked to roll sensor (all had ESC)	12
With other inflated curtain SAB	12
<hr/>	
Total VMAIS ≥ 3	8
In lateral rolls (n=58)	6
In end-over-end rolls (n=3)	2
In vehicles with both curtains deployed (n=18)	0 (1 unk due to fire)
In vehicles with one curtain deployed (n=5)	1

Rollovers by quarter-turns and ESC/curtain status

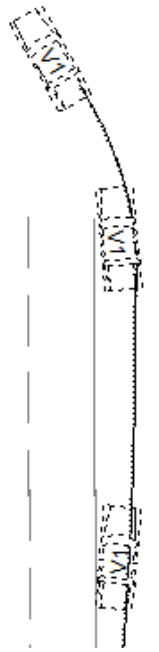
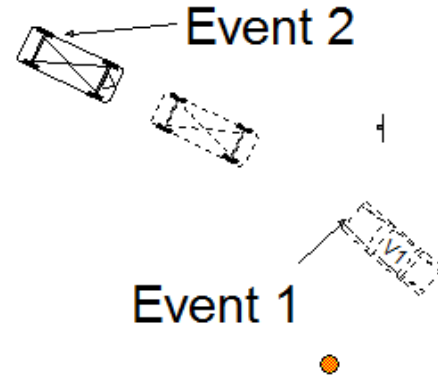
Excluding 5 cases with unknown MAIS or countermeasure



2011-12-051

ESC, no curtains

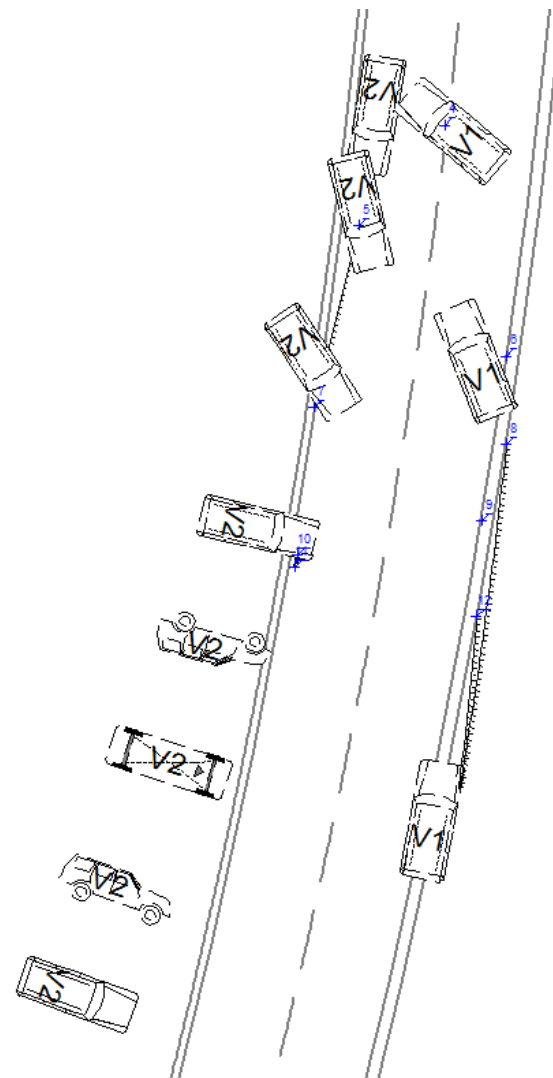
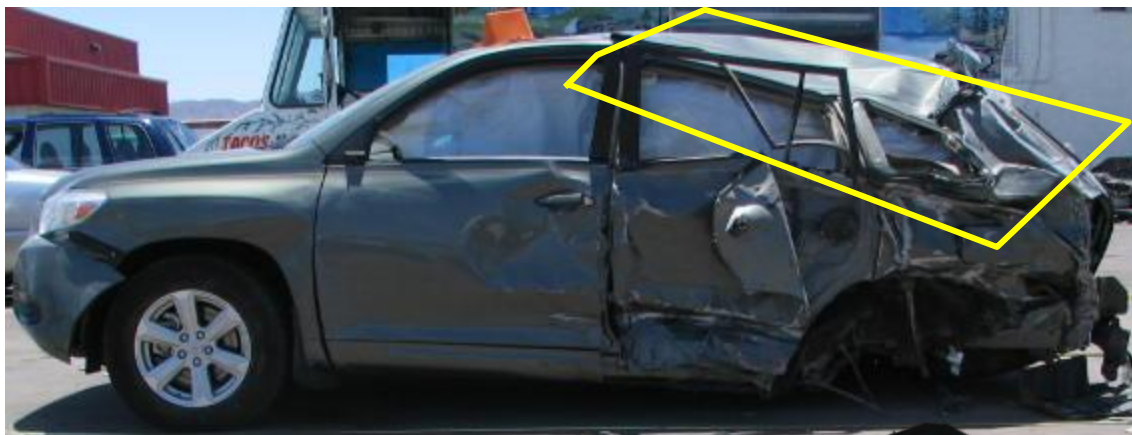
No obvious control loss, drove off road, hit ditch and flipped forward onto roof. Unbelted driver had AIS3 spinal cord contusion, lumbar spine burst fracture.



2009-76-073

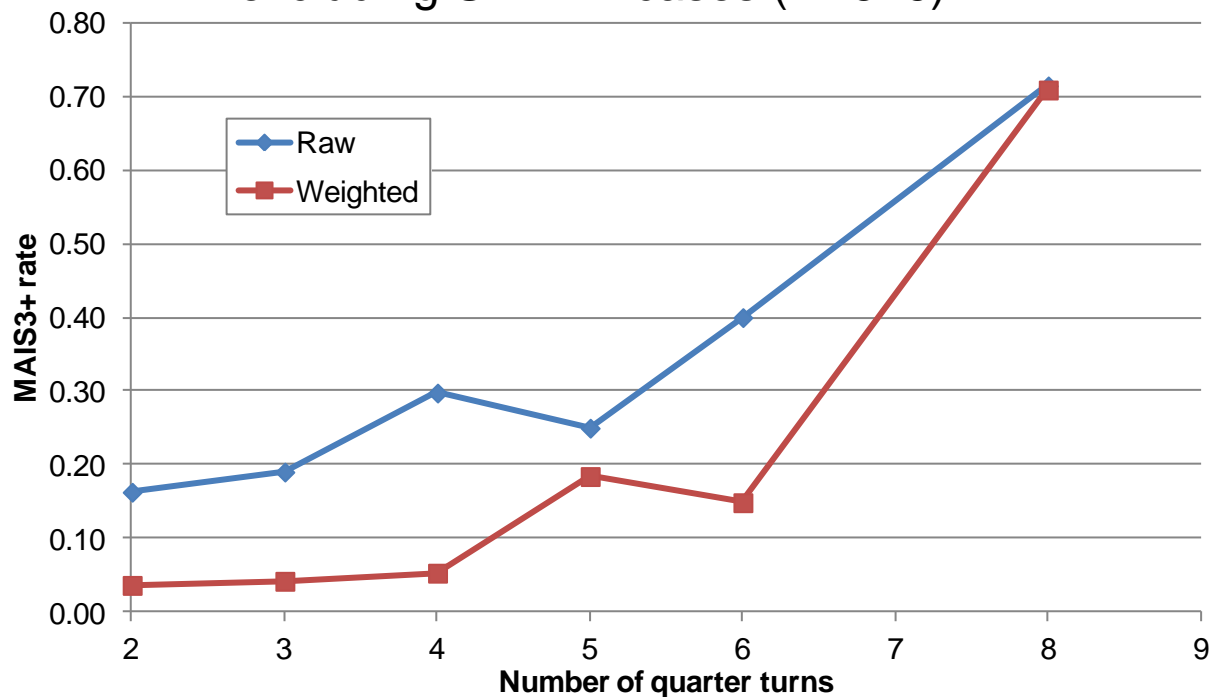
ESC+curtains

Case vehicle struck in left rear by oncoming vehicle, rotated CCW, rolled right 4 quarter-turns. Appears to have landed on back left corner of roof. Belted 69 year-old driver had AIS 1 leg strain, skin injuries. Belted 96 year-old front passenger had AIS 1 facial skin injuries. Both curtains, left torso SAB deployed.



Injury severity compared to SWR<4 vehicles

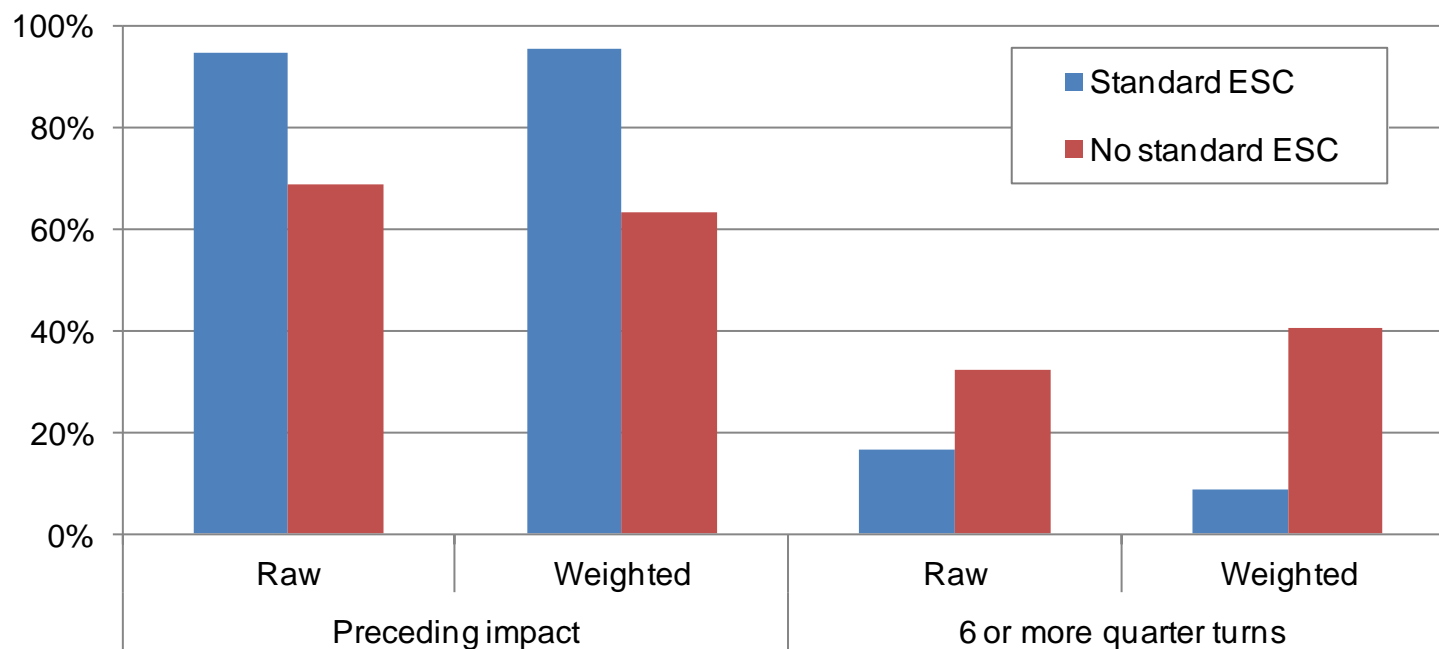
Lateral rollovers with 2-8 quarter turns for all 2007+ MY, excluding SWR>4 cases (N=316)



SWR≥4 cases	Raw	Weighted
Expected MAIS3+	17.2	1548
Actual	6	682
Rate Ratio	0.35	0.44

Roll initiation and duration by ESC presence

		Raw	Weighted			Raw	Weighted
Std ESC	Preceding impact	18	3190	6+ quarter-turns	3	287	
	Total	19	3337	Total lateral R/O	18	3210	
	Rate	95%	96%	Rate	17%	9%	
No std ESC	Preceding impact	29	4278	6+ quarter-turns	13	2726	
	Total	42	6750	Total lateral R/O	40	6678	
	Rate	69%	63%	Rate	33%	41%	



Observations

- Rollover fatalities likely will continue falling as proportion of vehicles in fleet with ESC/curtains/high-SWR increases
- Still very few relevant NASS-CDS cases
 - No known case of AIS \geq 3 injury in a vehicle with ESC, roll-activated curtains and SWR \geq 4 (n=12)
 - Likely that an increased proportion of future rollovers will be preceded by other impacts based on available data
 - Likely that average roll duration (quarter-turns) will be reduced based on available data

Future work

- Continued need to better understand effect of current countermeasures
 - Previous analyses of NASS-CDS rollovers (e.g. prevalence of various injury types/mechanisms, occupant positioning for dynamic testing) could be misleading when evaluating current priorities
- IIHS will continue to monitor NASS-CDS for relevant cases; important that NASS continues to provide source of crashworthiness data after NHTSA's "Data Modernization" effort
- IIHS continues monitoring state crash databases for sufficient data
 - Could allow individual injury risk effect estimates for ESC, curtains, and SWR values beyond 4.0



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