Pediatric Injury Criteria and Response Research

Matthew Craig, PhD
NHTSA - Vehicle Safety Research

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Contents

1. Pediatric Casualties in Motor Vehicle Crashes
2. NHTSA Child Passenger Safety Group
3. Response Requirements / Injury Criteria Research

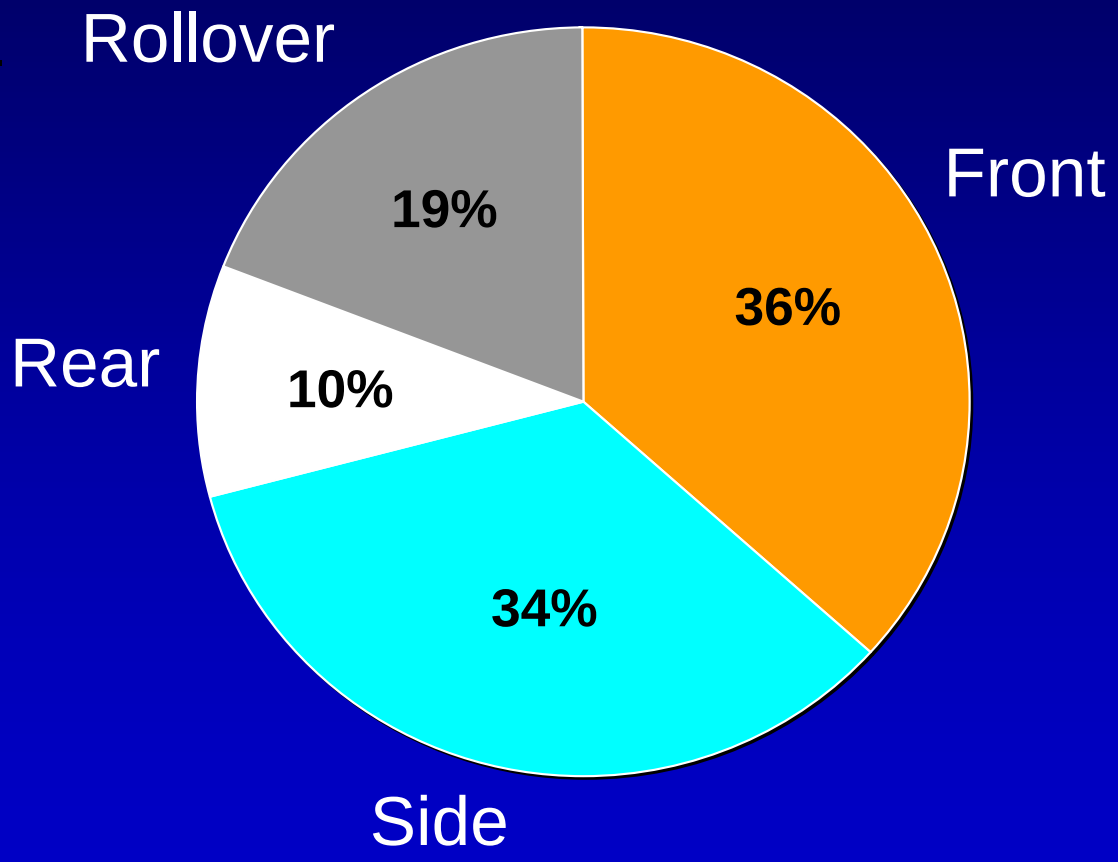
2007 Traffic Fatalities

- 1670 traffic fatalities were children 14 and under in 2007
  - 1248 in-vehicle occupants
  - Motor vehicle crashes are the leading cause of death for ages 3 to 6 and 8 to 14

Source: http://www-nrd.nhtsa.dot.gov/pubs/810987.pdf

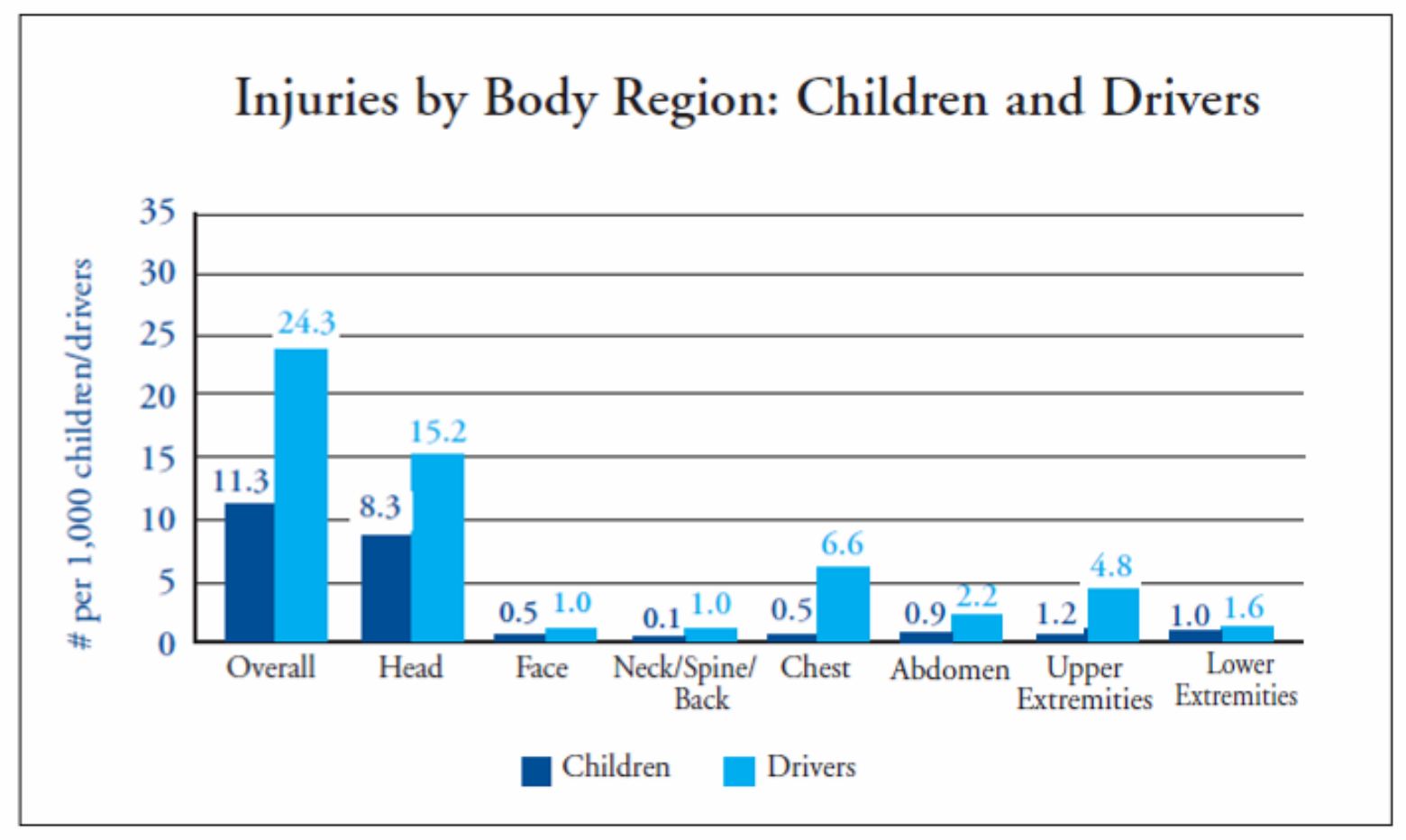
Fatalities by Crash Mode
Child Passengers: Ages 4 – 8 Years

- Roughly 2100 fatalities for rear seated 4 to 8-yr-olds from 1998 to 2007
- 19% of fatal cases involved rollover
- Majority of the remaining 81% of fatal cases involved a major impact to the front or side of the vehicle



Source: FARS – 1998 to 2007

Partners for Child Passenger Safety



Source - http://stokes.chop.edu/programs/injury/files/PCPS_Reports/2008_FT.pdf

AIS 3 – 6 Injuries

Ages 0-8 Years by Seat Position & Restraint Use

Injured Body Region	Front Seat					Second Seat					Total: Front & 2nd Seat
	CSS	Lap and/or Shdlr Belt	None	Other / Unknown	Total: Front Seat	CSS	Lap and/or Shdlr Belt	None	Other / Unknown	Total: 2nd Seat	
Abdomen	271	288	1311	44	1915	1424	301	965	73	2764	4679
Chest	378	509	2757	25	3668	3284	601	2146	196	6226	9894
Head	1552	2444	4747	859	9602	6336	2800	4734	1613	15483	25085
Lower Ext	64	0	1642	25	1731	951	411	438	75	1875	3606
Neck	99	0	32	0	131	450	101	381	0	932	1063
Upper Ext	0	38	1115	0	1154	237	390	1067	5	1699	2853
Unknown	22	0	0	29	51	0	0	0	172	172	223
Total	*2386*	*3279*	*11604*	*983*	*18252*	*12682*	*4603*	*9731*	*2134*	*29150*	*47402*

Source: NASS-CDS: 1991-1996; 1998-2000

- Head, chest and abdomen most commonly injured body regions
- Neck is least frequently injured body region
  - However, biofidelic neck response of an anthropometric test device (ATD) is important for overall head kinematics

Source: Starnes & Eigen, 2002 (NHTSA DOT HS 809 410)

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Child Passenger Safety Group

- NHTSA started group in 2005
- NHTSA's Role
  - Coordinate research related to the documentation of new response requirements and injury criteria appropriate for both 6-yr-old frontal and side impact ATDs
- Participation
  - Children's Hospital of Philadelphia (CHOP), Duke University, Medical College of Wisconsin, Ohio State University, TNO, University of Michigan Transportation Research Institute (UMTRI), University of Virginia (UVA), University of Washington, NHTSA

CPS Group - Objective

- Document response requirements and injury criteria that can potentially be used in efforts to enhance current or develop all-new 6-yr-old frontal and side impact ATDs

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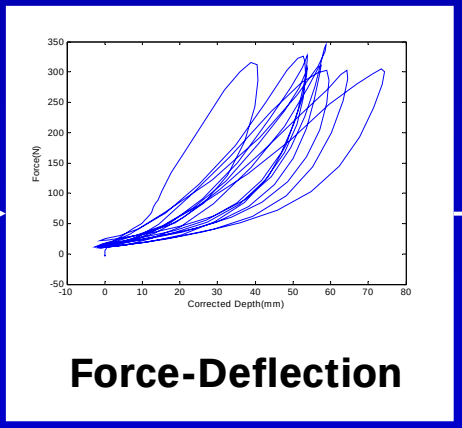
Documenting Pediatric Response

- Existing Response / Biofidelity Requirements & Injury Criteria
  - Current pediatric ATDs developed using biofidelity requirements scaled from adult data
- Current Effort
  - Emphasizing the development of pediatric specific response requirements and injury criteria through a variety of experimental testing and analytical modeling techniques
  - Research focusing on response data that can be applied to a frontal ATD
- Primary body regions being studied are head, neck, thorax, and abdomen
- Data (force-deflection corridors, e.g.) are or will be published in a form that is directly useable in the validation of a 6-yr-old ATD or ATD-based model

Pediatric Response Research

- Head
  - Duke: Head impact response
- Neck
  - Duke & Washington: Neck response (Duke – Stapp 2008)
- Abdomen
  - UVA: Porcine abdominal response and injury criteria (Stapp 2006, 2008)
- Thorax
  - UVA: MADYMO modeling; pediatric thoracic response of surrogate
  - **CHOP: Pediatric CPR (Stapp 2008)**

CPR Event (ED or PICU)

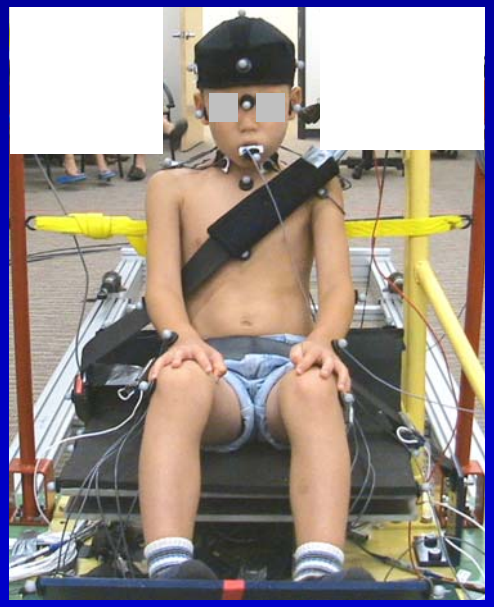


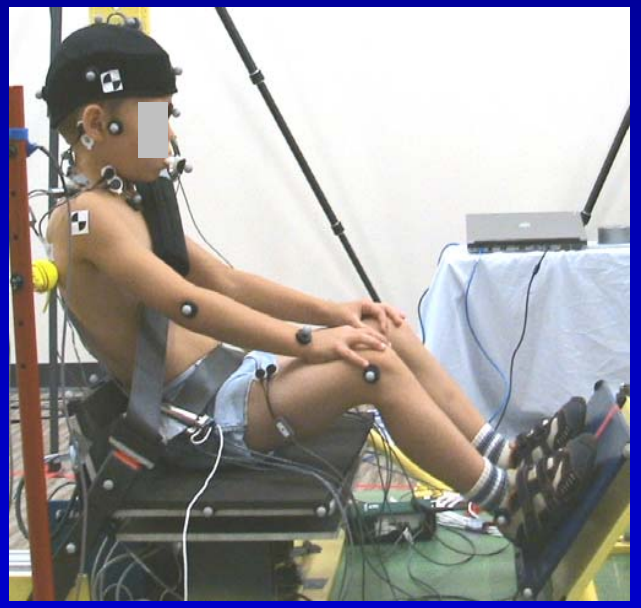
Force-Deflection

Force-deflection Corridor

Pediatric Whole Body Response

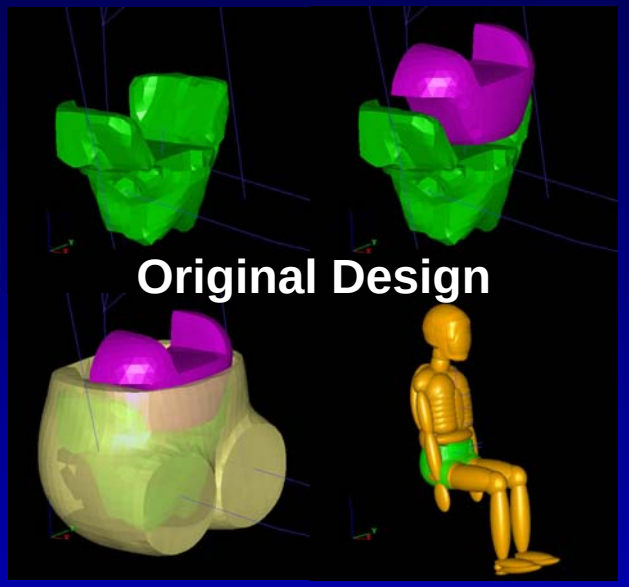
- Sled test reconstruction – UVA
- High-speed sleds w/ surrogate – UVA
- Crash Reconstruction – UVA / TNO
- **Low-speed sleds – CHOP (’08 SAE Gov’t/Industry)**

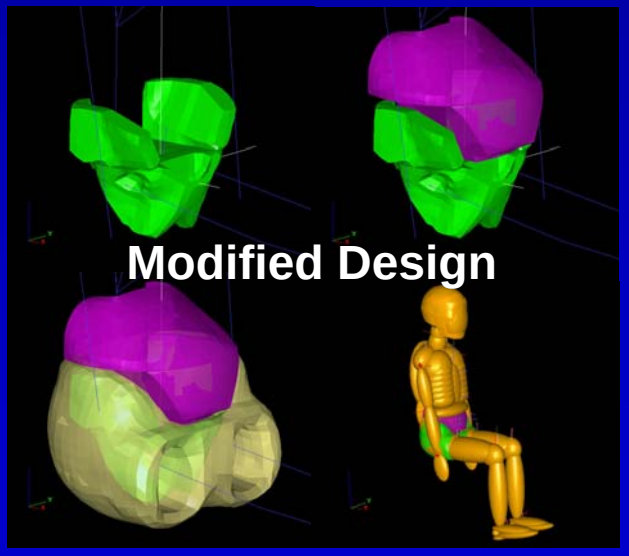




Anthropometry / Range of Motion

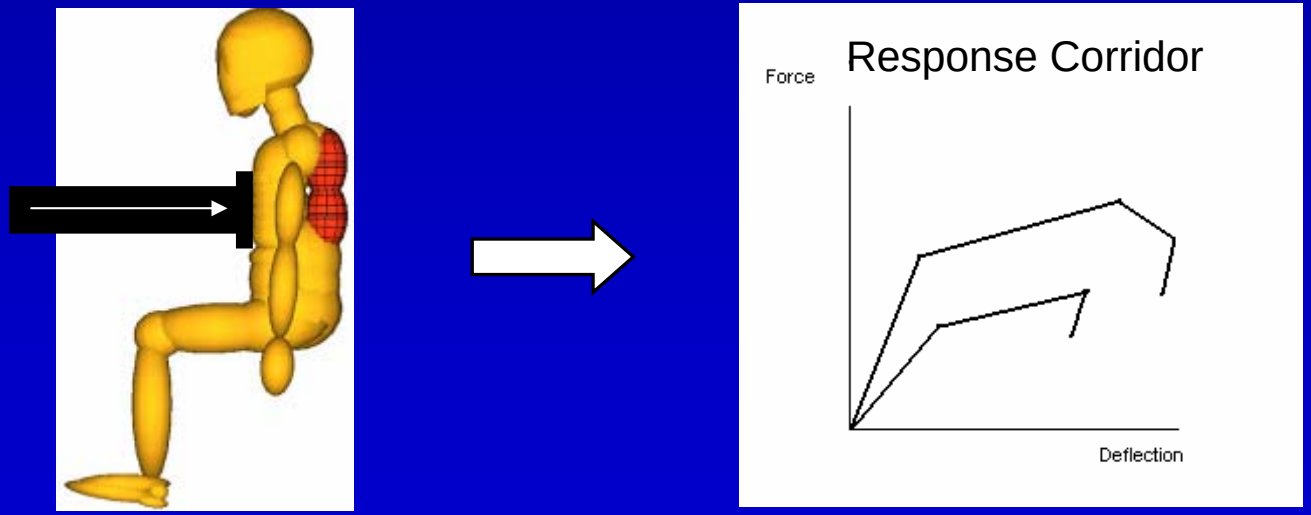
- Thorax
  - UMTRI: Thorax and shoulder anthropometry
  - UMTRI: Spine range of motion
- Neck
  - CHOP: Passive neck flexion (ESV 2009)
- Abdomen / Pelvis
  - **UMTRI: Pediatric abdomen/pelvis for 6-yr-old Hybrid III frontal ATD**





Research / Modeling / Biofidelity Flow

1. Document Biomechanical Response Requirements
2. 6-yr-old Modeling (TNO)
   - Update Hybrid III-based 6-yr-old model (new pelvis/abdomen, e.g.)
   - Complete model sensitivity/optimization using data from #1
3. Document Biofidelity Requirements
   - Directly from biomechanical research
   - **Establish set of simplified biofidelity rqmnts using optimized model (TNO)**



Summary

- Death and serious injury of children in motor vehicle crashes is still a significant public issue
- NHTSA is coordinating both funded and non-NHTSA funded research to develop pediatric response requirements and injury criteria
- Results can potentially be applied in the development of a new or enhanced 6-yr-old frontal ATD
  - New pediatric biomechanical response and injury criteria data could be tailored to other size ATDs (3-yr-old or 10-yr-old, e.g.)

Future Tasks

- Compare biofidelity requirements developed in current effort versus those scaled from adult data
- Assess biofidelity of current ATDs using response requirements developed in current effort
- Expand current effort to include response / injury criteria research that could potentially be used in the development of new child side impact ATDs
  - Would require additional thoracic, abdominal and pelvic response related studies

Questions?

Contact:
Matthew Craig, PhD
matthew.craig@dot.gov
202-366-4720