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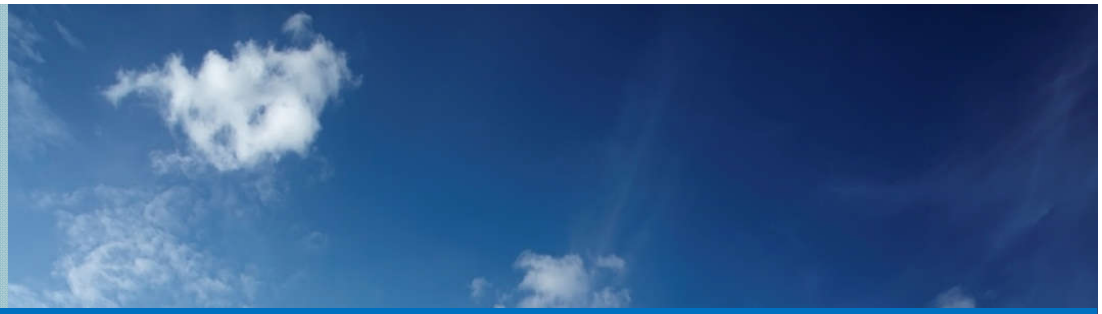

Child Occupant Protection: Latest Knowledge and Future Opportunities

Kristy Arbogast, Ph.D.
Center for Injury Research and Prevention
The Children's Hospital of Philadelphia

September 20, 2017

Problem Facing our Youth
Leading Causes of Death by Age Group

< 1year	1-4 years	5-14 years	15-29 years
Preterm birth complications	Malaria	Road Injury	Road Injury
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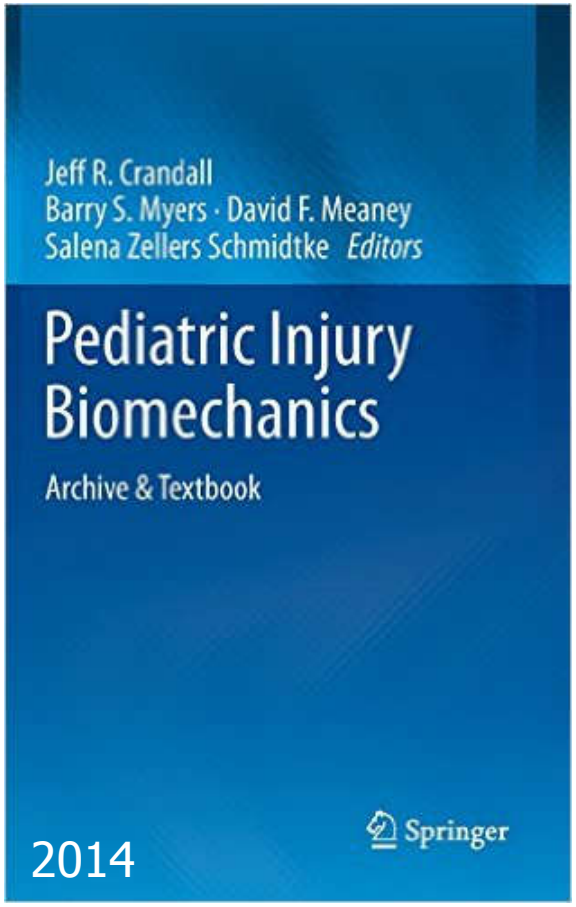
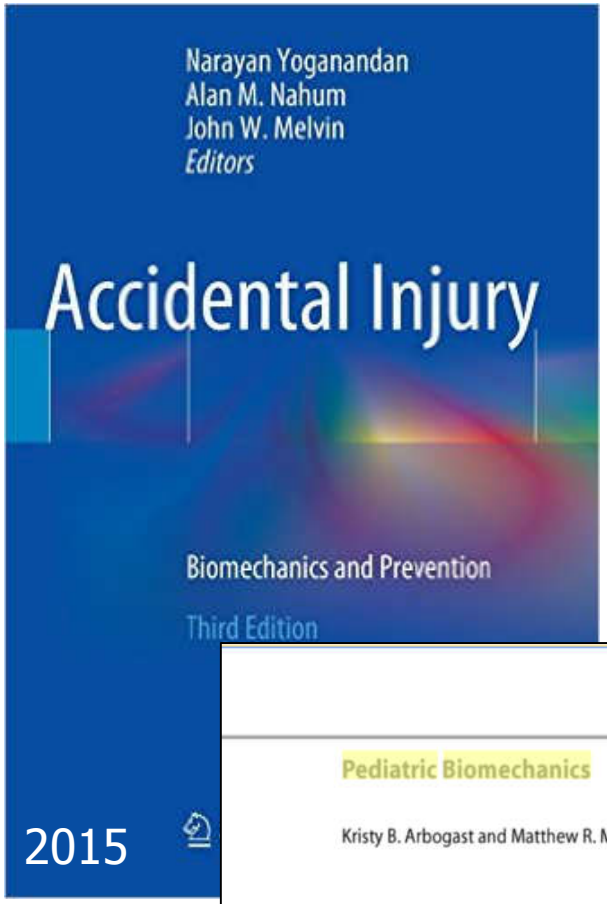
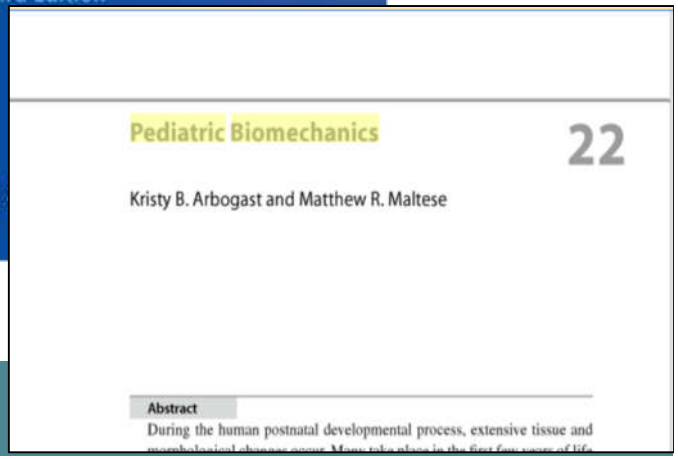
Malnutrition	Measles	Congenital anomalies	Mechanical forces
Syphilis	Fire	Forces of nature	Diarrheal diseases

World Bank, Transport for Health: The Global Burden of Disease from Motorized Transport, 2014

Quantify Fundamental Mechanics of Children







Develop Pediatric Specific Tools

Annals of Biomedical Engineering, Vol. 41, No. 12, December 2013 (© 2013) pp. 2538–2552
DOI: 10.1007/s10439-013-0858-7

BMES BIOMEDICAL ENGINEERING SOCIETY™ www.bmes.org

Development and Validation of a 10-Year-Old Child Ligamentous Cervical Spine Finite Element Model

LIQIANG DONG,[1,2] GUANGYAO LI,[1] HAOJIE MAO,[2] STANLEY MAREK,[2] and KING H. YANG[2]

INJURY SIMULATION OF REAR SEAT CHILD OCCUPANT IN OFFSET DEFORMABLE BARRIER FRONTAL IMPACT

Tomoshi Takahashi
Satoshi Fukushima
Yuichi Kitagawa
Tsuyoshi Yasuki
Toyota Motor Corporation
Japan

IRC-15-73 *IRCOBI Conference 2015*

Development and a Limited Validation of a Whole-Body Finite Element Pedestrian and Occupant Models of a 10-Year-Old Child

Ming Shen[1], Feng Zhu, Binhui Jiang, Vikas Sanghavi, Haonan Fan, Yun Cai, Zhenguang Wang, Anil Kalra, Xin Jin, Clifford C. Chou, King H. Yang

IRC-15-74

Development of an Active 6-Year-Old Child Human Body Model for Simulation of Emergency Events

Karin Brolin[1], Isabelle Stockman[1], Hariharan Subramanian[2], Laure-Lise Gras[1], Jonas Östh[1]

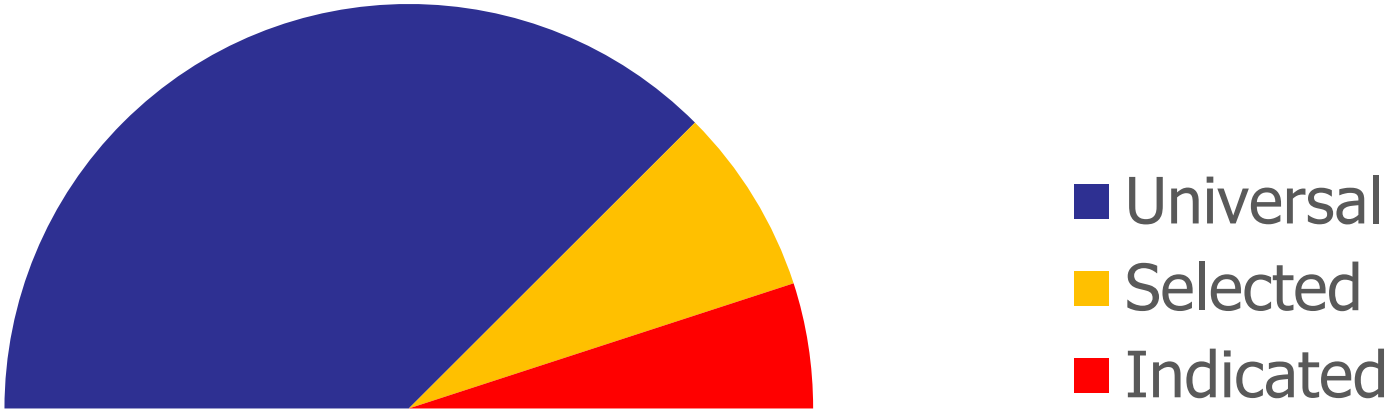
[1.] Chalmers University of Technology, Gothenburg, Sweden. [2.] Indian Institute of Technology, Delhi, India.

Stimulate development of engineering strategies for rear seat protection

From latest EuroNCAP news release…

"*Almost all new cars in this release … have incorporated more advanced restraint technology on the rear seats to cope with the newest full-width frontal crash test.*"

"Precision Prevention" – tiered risk



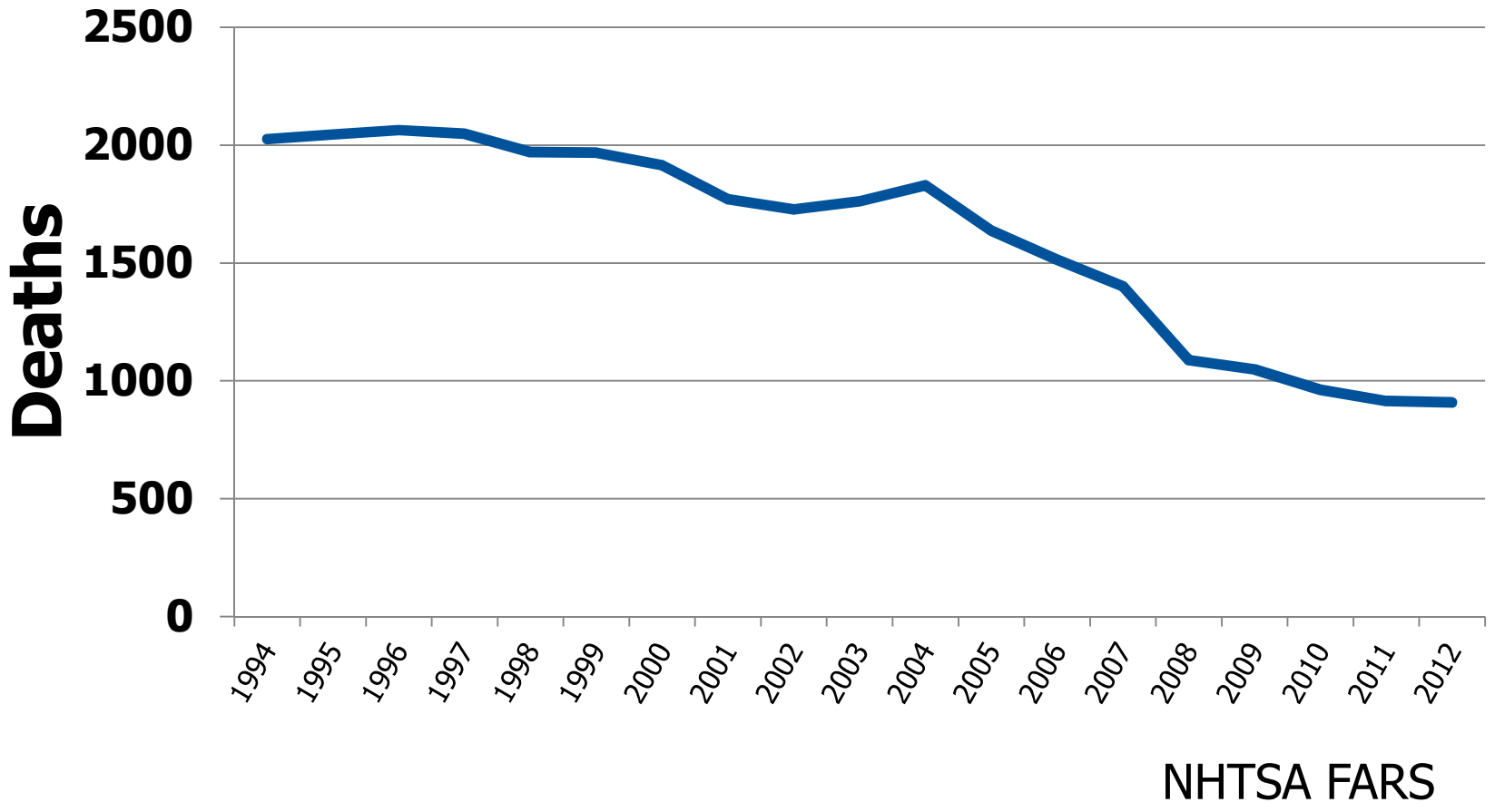
UNIVERSAL	SELECTED	INDICATED
Typical risk Tailored to population	Individual with known risk factors	Individual with unsafe behaviors or crashes

right STRATEGY
right PERSON
right TIME
right CIRCUMSTANCE

Best Practice Recommendations Based on Biomechanical Principles

UNIVERSAL	SELECTED	INDICATED
Typical risk Tailored to population	Individual with known risk factors	Individual with unsafe behaviors or crashes

Impact: Crash Fatalities
>50% reduction in deaths to children < 16



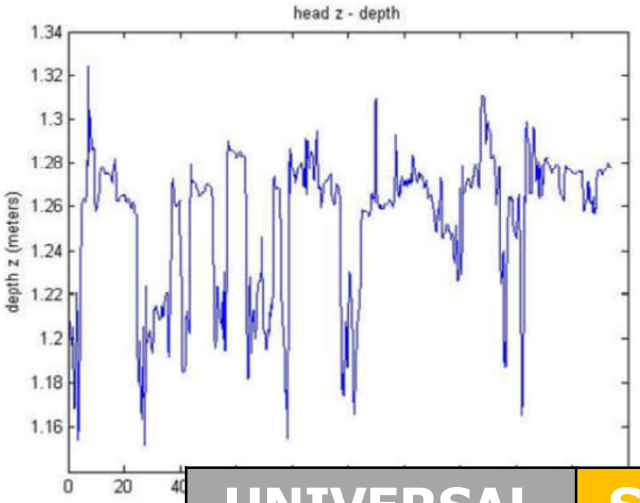
NHTSA FARS

Define realistic postures and positions

Charlton et al with US & Swedish colleagues

- Large naturalistic driving study rear row occupants (42 families, 690 hrs of data)
- Head position tracked via Kinect motion tracking

- Depth of head motion quantified



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Charlton et al with US & Swedish colleagues

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- Head pos

IRC-13-105 IRCOBI Conference 2013

Older Children's Sitting Postures, Behaviour and Comfort Experience during Ride – A Comparison between an Integrated Booster Cushion and a High-Back Booster

Anna-Lisa Osvalder, Ida Hansson, Isabelle Stockman, Anna Carlsson, Katarina Bohman, Lotta Jakobsson

Traffic Injury Prevention (2014) **15**, 866–874

ISSN: 1538-9588 print / 1538-957X online
DOI: 10.1080/15389588.2014.890720

Taylor & Francis
Taylor & Francis Group

Kinematics of Pediatric Crash Dummies Seated on Vehicle Seats with Realistic Belt Geometry

KATHLEEN D. KLINICH[1], MATT

UNIVERSAL	SELECTED	INDICATED
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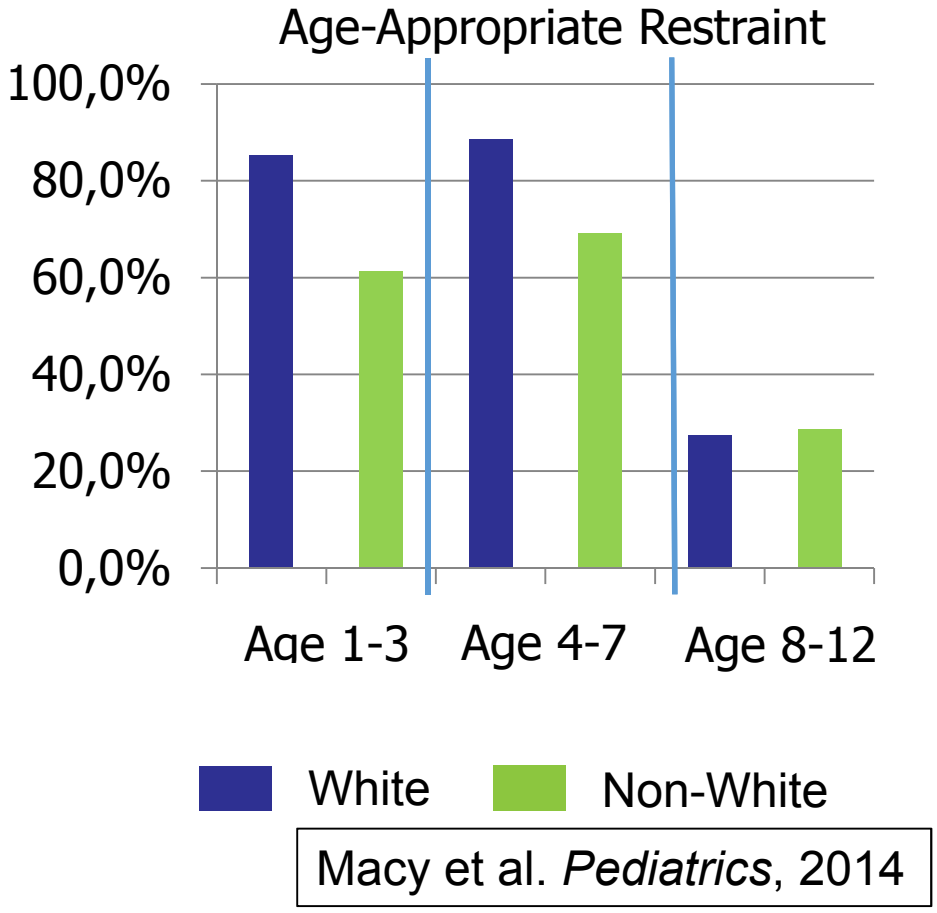
Need NEW Approach for Targeted Populations

White parents had higher adjusted odds of reported age-appropriate restraint for their children

OR 3.86, 95% CI 2.27–6.57*

*controlling for education, income, information sources, and site



Macy et al. *Pediatrics*, 2014

UNIVERSAL	SELECTED	INDICATED
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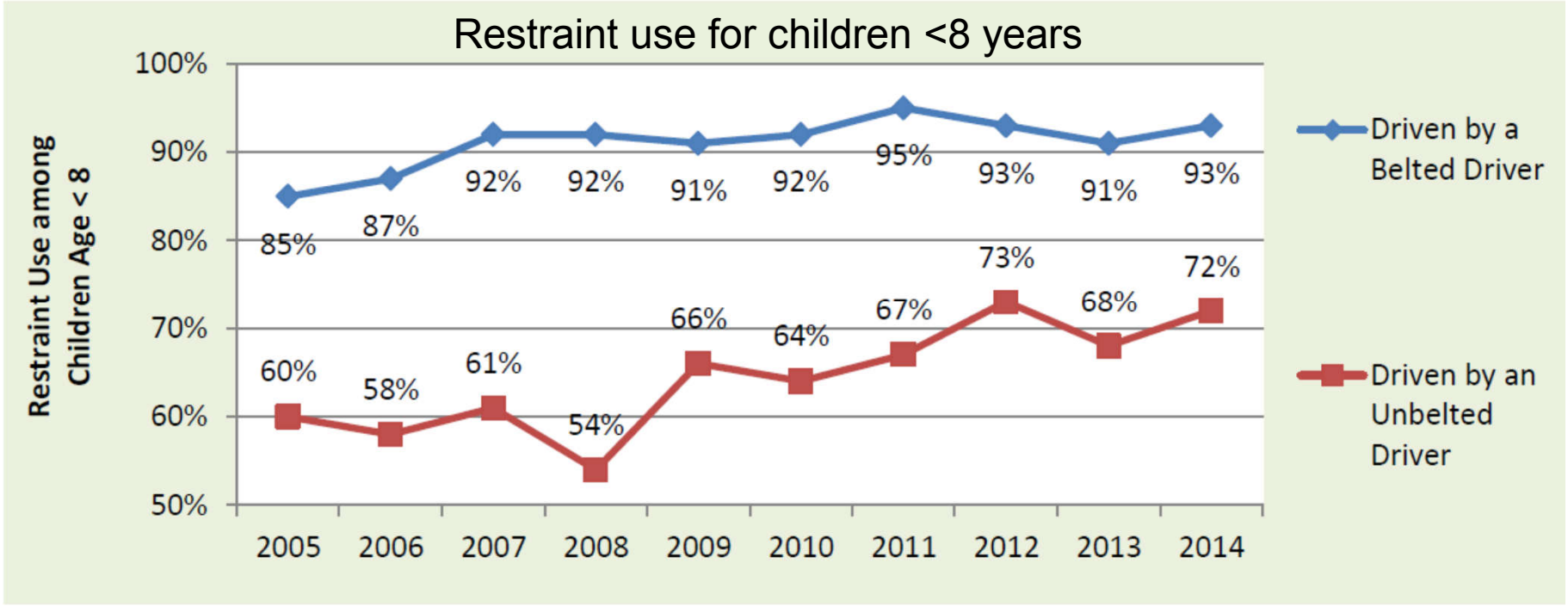
Restrained drivers lead to restrained children – increase adult restraint use



DOT HS 812 244

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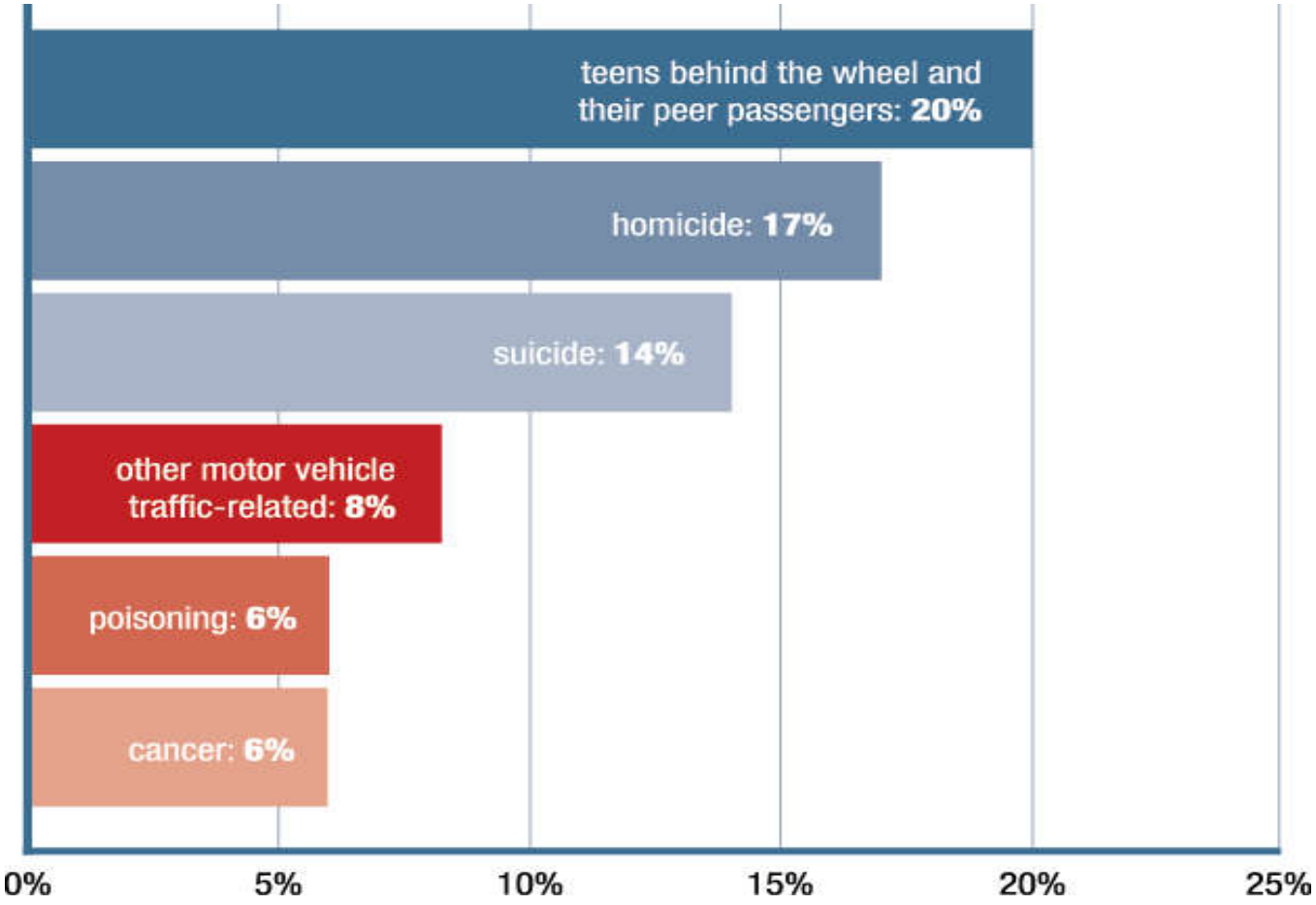
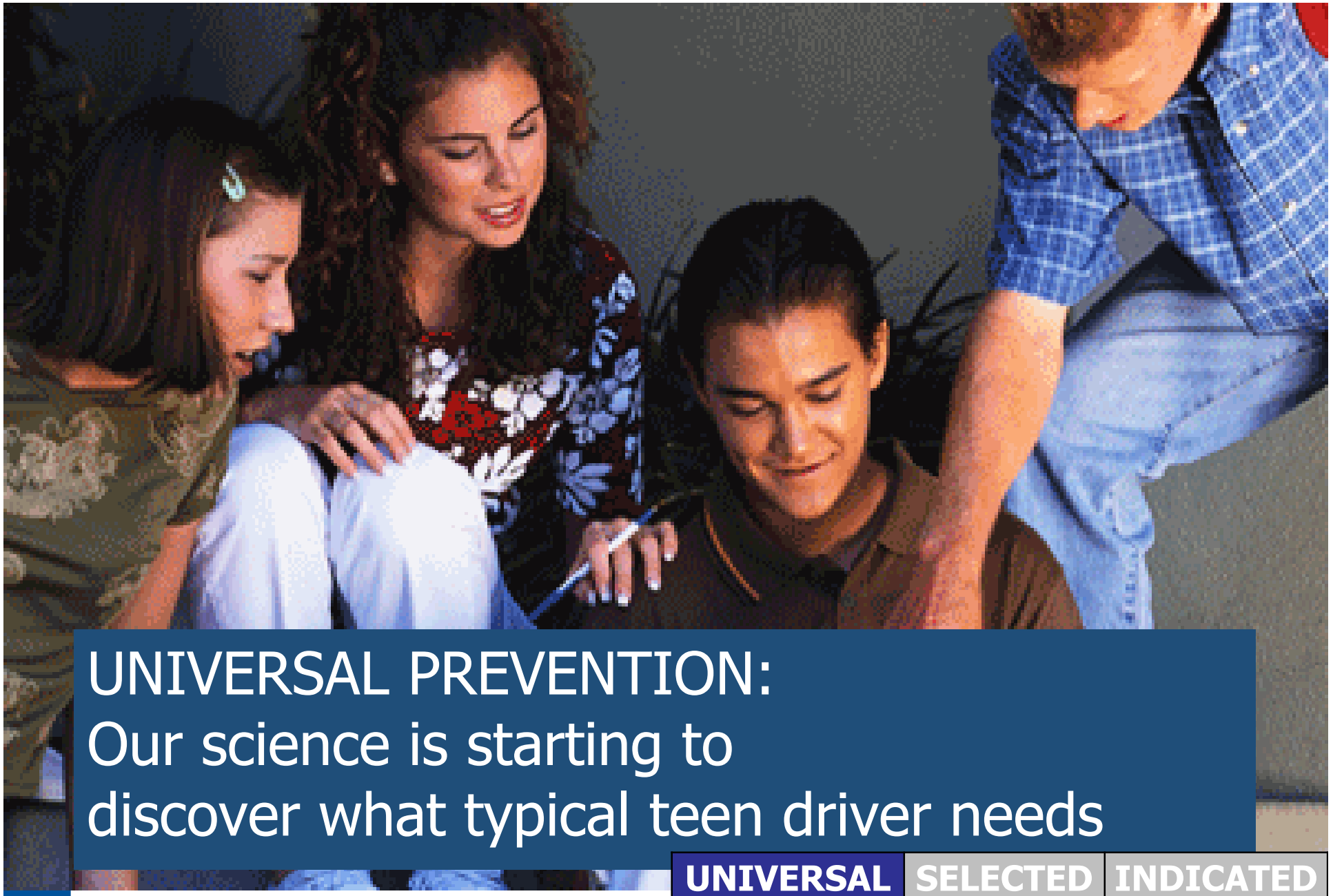
Motor Vehicle Crashes – Leading Cause of Death for Teens



Source: Miles to Go , CHOP, 2012.

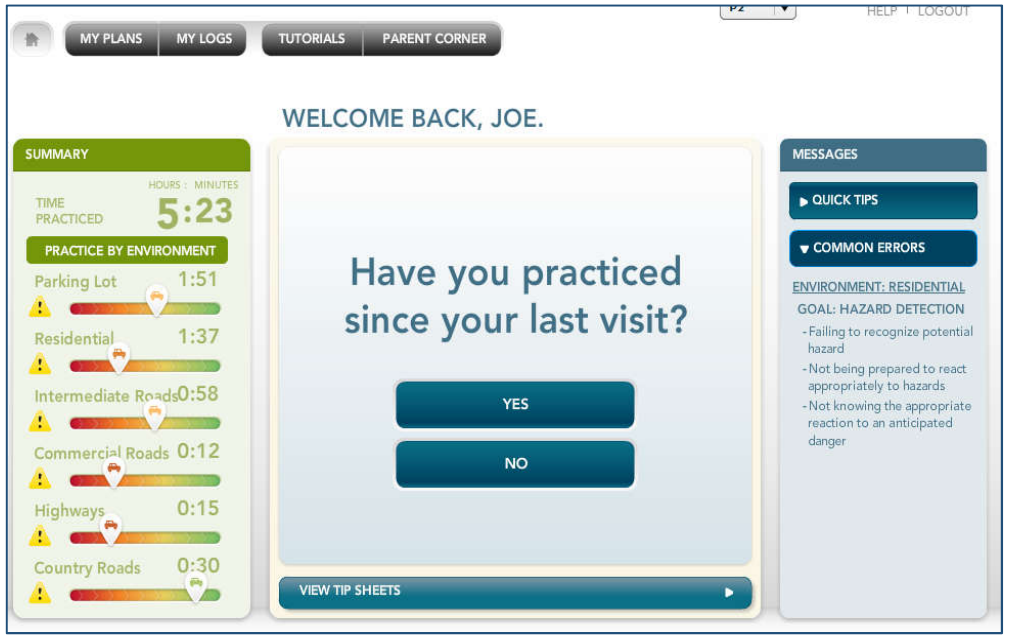


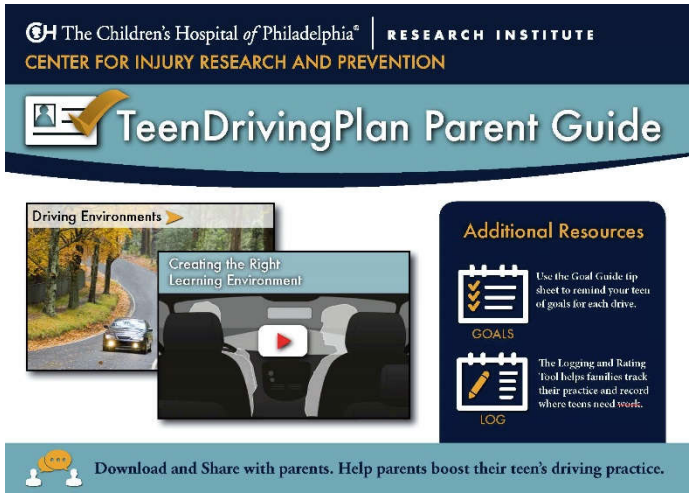
UNIVERSAL PREVENTION: Our science is starting to discover what typical teen driver needs

UNIVERSAL	SELECTED	INDICATED
Typical risk Tailored to population	Individual with known risk factors	Individual with unsafe behaviors or crashes

Universal:
Ensure quantity & variety of practice

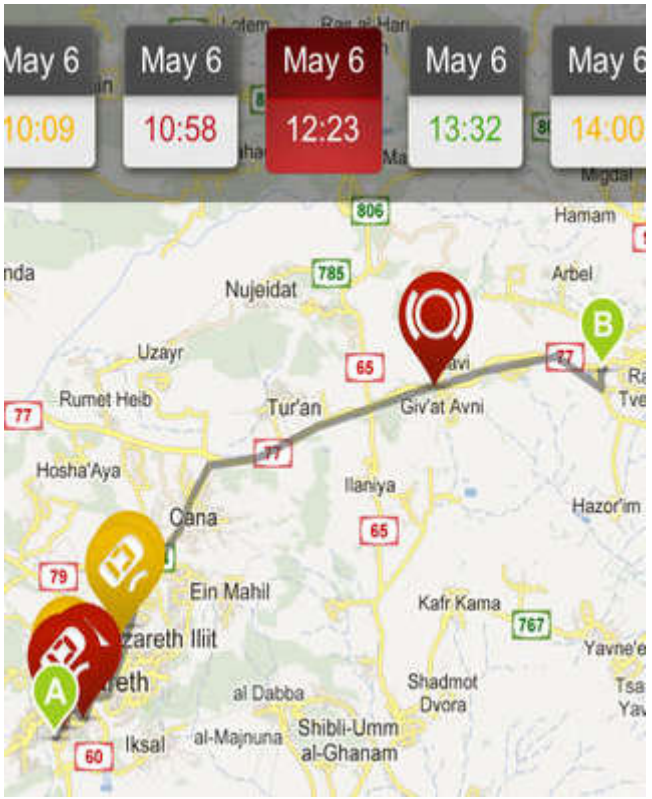
Teen Driving Plan: CHOP-Developed Intervention





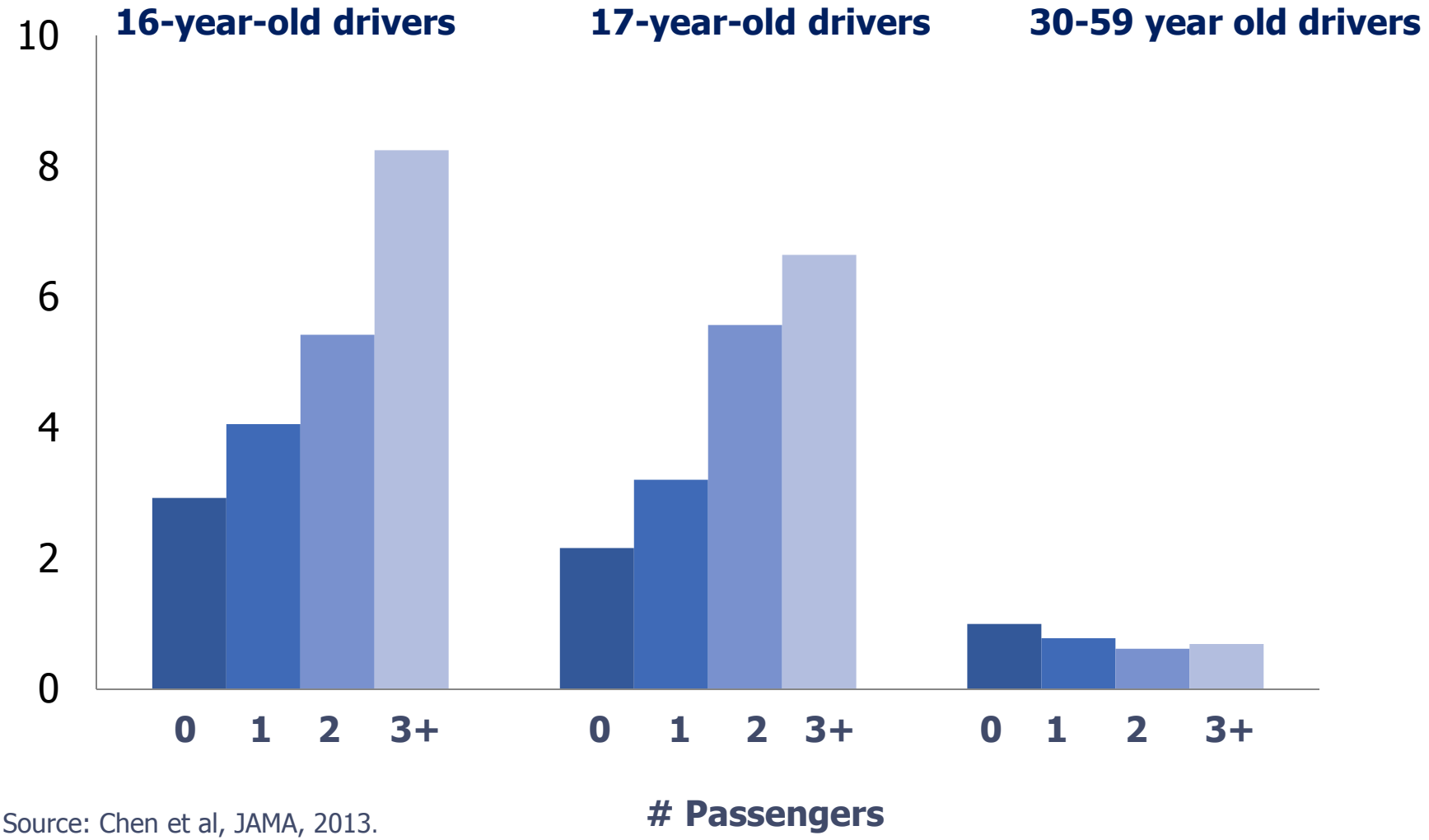
https://www.teendriversource.org/tools/for_parents/detail/244

Universal: Decals/parents/monitoring



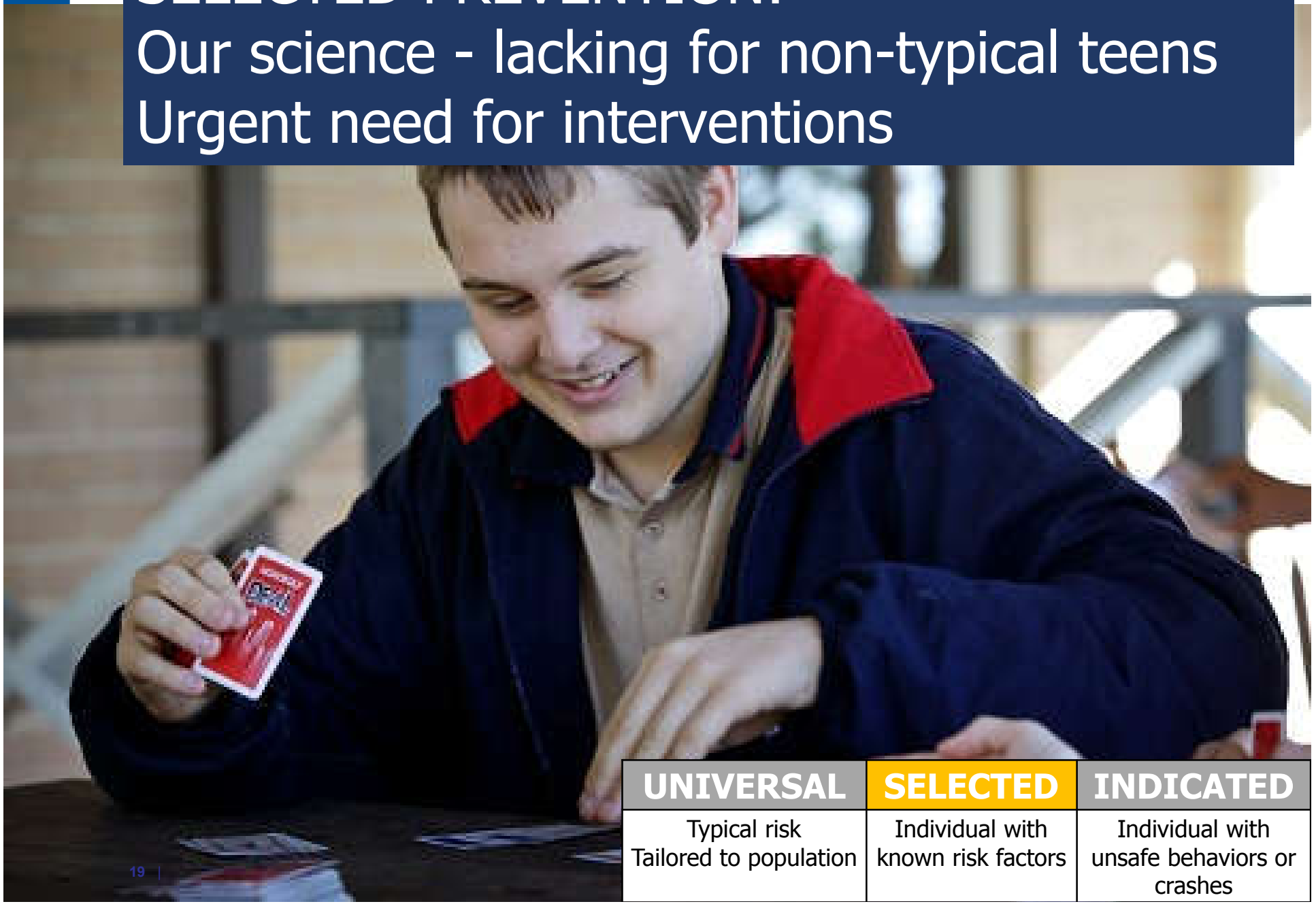
Universal: GDL limits on passengers

Crashes per 10,000 Trips, by # of Passengers



Source: Chen et al, JAMA, 2013.

SELECTED PREVENTION:
Our science - lacking for non-typical teens
Urgent need for interventions



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Selected Prevention – Novice Drivers

Move from protection of the typical to include the protection of "edge cases"

- People's characteristics and states intersect with the limits of automotive technology

Safe transition from manned to autonomous driving to advance accessible mobility for all people, including those with disabilities

- Autonomous driving features open up opportunities for mobility for those that traditionally didn't have it – how do we protect them – human factors/accessibility/passive safety
- The vehicle will expect the driver to respond as a typical driver would

Likely requires broadening of traditional engineering to user-centered, participatory design and human factors research that optimizes technology

INDICATED PREVENTION:
Our science is lacking: What do we do after unsafe behavior/ crash?

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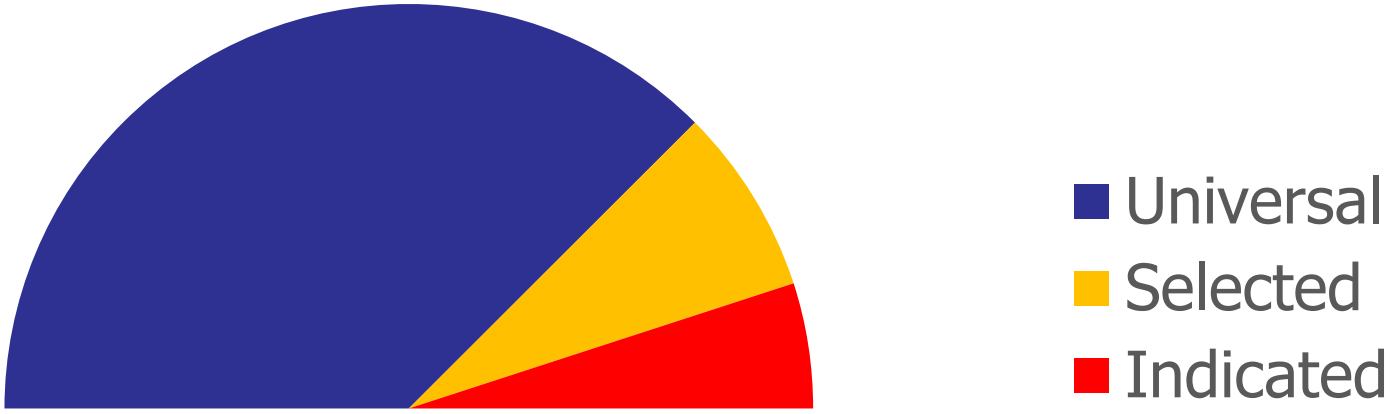
“Precision Prevention” – tiered risk



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