Confessions of a Car Seat Junkie
What Every Pediatrician Must Know About Child Passenger Safety

Benjamin Hoffman, MD, FAAP, CPST-I
Child Passenger Safety Technician Instructor
Oregon Health and Science University
Disclaimers & Disclosures

- The presenter has no relevant financial relationships with the manufacturer(s) of any commercial product(s) and/or provider of commercial services discussed in this presentation.

- The presenter does not intend to discuss an unapproved/investigative use of a commercial product/device in this presentation.

- Statements and opinions expressed are those of the presenter and not necessarily those of the American Academy of Pediatrics.

- Mead Johnson sponsors programs such as this to give healthcare professionals access to scientific and educational information provided by experts. The presenter has complete and independent control over the planning and content of the presentation, and is not receiving any compensation from Mead Johnson for this presentation. The presenter’s comments and opinions are not necessarily those of Mead Johnson. In the event that the presentation contains statements about uses of drugs that are not within the drugs’ approved indications, Mead Johnson does not promote the use of any drug for indications outside the FDA-approved product label.
Objectives

By the end of this talk, you should be able to:

1. Discuss **basic principles** of child passenger safety (CPS) science, including:
   - Epidemiology
   - Physics
   - Anatomy and physiology of children
   - Crash dynamics

2. List **5 ways** car safety seats help prevent injury to children.

3. Discuss **best practice** recommendations for appropriate child passenger restraint.

4. **Identify and access** CPS resources in your community, including for children with special health care needs.
Car Crashes Kill More Kids Than Any Other Cause

Source: Centers for Disease Control and Prevention.
5 children per day
“If a disease were killing our children in the proportions that injuries are, people would be outraged and demand that this killer be stopped.”

C. Everett Koop, MD
Former U.S. Surgeon General
Car Safety Seats Work!

Belt-positioning booster (BPB) seats are effective for children through at least age 7. Using a BPB with a seat belt instead of a seat belt alone reduces a child's risk of injury by 59 percent. Once a child has outgrown her child safety seat with harness, she should be restrained in a belt-positioning booster seat until she reaches a height at which an adult seat belt fits properly, usually around 4'9".

Not All Kids Ride Restrained

Restraint Use Rates Have Not Improved

Child Restraint Use Among Children Under Age 8, 2002–2011

Restraint Use Rates Have DECREASED
2013–2015

Car Safety Seats Are Hard To Use Correctly

Critical Misuse by Restraint Type

- RF Infant: 84
- RF Convertible: 84
- FF Convertible: 82
- FF Only: 79
- Booster: 40

Almost Every Caregiver of Newborns Makes Errors!


THERE IS GOOD NEWS!

Source: Safe Kids Worldwide.
But...
The laws of physics **ALWAYS** trump the law of the land.

Would you catch a 10-pound bowling ball dropped from a 3rd story window?

F = MA

Force = 10 lb x (32 feet/sec)/(.94 sec)

330 lb of momentum
A car traveling at 30 MPH hits a tree...

10-pound child

Stops in 1 second

Acceleration = 45 feet/sec/sec

Momentum = 10 lb (45 feet/sec/sec) = 450 lb
It is ALL about The Force
More About Force

1. A body in motion stays in motion until some opposing force causes it to stop.

2. Energy is preserved.

Human Tissue + Energy = Injury

Portrait of Isaac Newton circa 1689. Public domain via Wikimedia Commons.
Video
We must learn to control the force!

\[ F = MA \]

\[ F = (\text{kg})(\text{m/s/s}) \]
More About Force

1. Force per unit of area is key.

2. Minimize acceleration into the impact.
5 Ways Restraints Prevent Injury

- Prevent ejection.
- Allow body to “ride down” with vehicle.
- Contact the strongest body parts.
- Distribute force over most extensive area.
- Protect the head, neck, and spinal cord.
Kids Are Not Little Adults

Proportion of total

Birth 2

1/8

3/8

1/4

1/2

ULTHOOD
Why are kids different?
Kids lack anterior superior iliac spines.
Submarining
Abdominal Organs

Source: Graph Diagram. Available at http://graphdiagram.com/male-anatomy-pictures/

Seat Belt Syndrome

- Intra-abdominal injuries
- Contusions
- Spinal injuries
Cervical Spine

~40% of all C-spine injuries in children
Why are kids different?

Vehicle belt systems are designed for adults!
Basics of Best Practice

1. **Location**
   - Rear seat is best until 13 years

2. **Direction**
   - Rear-facing vs. forward-facing

3. **Selection**
   - Pick the best method/device for a child
   - Manufacturer limits

4. **Installation**
   - Know the basics
   - Know the resources in your community
   - Follow specific manufacturer instructions
There are three kinds of lies: lies, damned lies, and statistics.

— Benjamin Disraeli

Expression of concern: car safety seats for children: rear facing for best protection


The manuscript ‘Car safety seats for children: rear facing for best protection’ was published in *Injury Prevention* in 2007, after peer review. The paper used US data from the National Automotive Sampling System Crashworthiness Data System to conclude that children 0-23 months were less likely to be severely injured when using a rear-facing car seat than a front-facing car seat. This result, along with similar data from Swedish experience and biomechanical studies, has been used as the basis for public education and policy recommendations that favor a rear-facing position for children under age two in car seats.

In 2016, the journal was contacted by a biostatistician employed as an expert witness in a court case involving a car seat manufacturer. She indicated that she was unable to replicate the results of the analysis reported in the Henry et al paper. Despite requests from the editor, she did not provide details of her analysis nor did she submit a manuscript describing her analysis, her results, or their implications.

The same letter was also forwarded to authors of the Henry et al study. They, and colleagues, have communicated to the journal that their attempts to replicate the analysis also fell short. Specifically, they believe that survey weights were improperly handled in the initial analysis, which caused the apparently sample size to be larger than the actual sample size. This resulted in inflated statistical significance. It is important to stress—the authors there is no evidence that current recommendations are harmful. However, these field data are inadequate to statistically support the safety benefit of rear facing seats.

The journal has asked the authors to provide a reanalysis, correcting the analysis and results. We anticipate receiving this soon. We have also offered to publish updated analyses based on more recent data. In the meantime, we are releasing this statement of concern to alert readers and policymakers to uncertainty about the weight and significance of the findings reported herein.
Rear-facing versus forward-facing child restraints: an updated assessment

Conclusions Non-US field data and laboratory tests support the recommendation that children be kept in RFCRS for as long as possible, but the US NASS-CDS field Injury Severity Score of at least 9. Both 0-year-old and 1-year-old children in RFCRS had lower rates of injury than children in FFCRS, but the available sample size was too small for reasonable statistical power or to allow meaningful regression controlling for covariates.

Conclusions Non-US field data and laboratory tests support the recommendation that children be kept in RFCRS for as long as possible, but the US NASS-CDS field data are too limited to serve as a strong statistical basis for these recommendations.

Child passenger safety has dramatically evolved over the past decade; however, motor vehicle crashes continue to be the leading cause of death for children 4 years and older. This policy statement provides 4 evidence-based recommendations for best practices in the choice of a child restraint system to optimize safety in passenger vehicles for children from birth through adolescence: (1) rear-facing car safety seats as long as possible; (2) forward-facing car safety seats from the time they outgrow rear-facing seats for most children through at least 4 years of age; (3) belt-positioning booster seats from the time they outgrow forward-facing seats for most children through at least 8 years of age; and (4) lap and shoulder seat belts for all who have outgrown booster seats. In addition, a fifth evidence-based recommendation is for all children younger than 13 years to ride in the rear seats of vehicles. It is important to note that every transition is associated with some decrease in protection; therefore, parents should be encouraged to delay these transitions for as long as possible. These recommendations are presented in the form of an algorithm that is intended to facilitate implementation of the recommendations by pediatricians to their patients and families and should cover most situations that pediatricians will encounter in practice. The American Academy of Pediatrics urges all pediatricians to know and promote these recommendations as part of child passenger safety anticipatory guidance at every health supervision visit.
Algorithm to Guide Implementation of Best Practice Recommendations for Optimal Child Passenger Safety

Pediatric patient at health supervision visit
Assess age, weight, height, and presence of special health needs.

Does the child have significant special health needs?
Yes
Consult complementary AAP Policy and other resources for best practice recommendations

No

What is the child’s age?

< 4 years

What type of CSS is the child using?

Rear-facing-only CSS
Convertible CSS

< 4 years

Has child outgrown weight or height limit for seat?
Yes
1) Best practice recommendation
Rear-facing-only or convertible CSS used rear facing

No

What type of CSS is the child using?

< 4 years

Rear-facing-only CSS
Convertible CSS

4–8 years

Is weight or height less than the rear-facing limit for convertible or combination CSS?
Yes
2) Best practice recommendation
Convertible or combination CSS used forward facing

No

Is weight or height less than the forward-facing limit for convertible or combination CSS?
Yes
3) Best practice recommendation
Belt-positioning booster seat

No

Does the child fit properly in the vehicle seat belt, usually around 4’ 9” in height?
Yes
4) Best practice recommendation
Lap and shoulder vehicle seat belt

No

Age

> 8 years

Does the child have significant special health needs?
Yes
Consult complementary AAP Policy and other resources for best practice recommendations

No

What is the child’s age?

> 8 years

What type of CSS is the child using?

Rear-facing-only CSS
Convertible CSS

> 8 years

Has child outgrown weight or height limit for seat?
Yes
1) Best practice recommendation
Rear-facing-only or convertible CSS used rear facing

No

What type of CSS is the child using?

> 8 years

Rear-facing-only CSS
Convertible CSS

> 8 years

Is weight or height less than the rear-facing limit for convertible or combination CSS?
Yes
2) Best practice recommendation
Convertible or combination CSS used forward facing

No

Is weight or height less than the forward-facing limit for convertible or combination CSS?
Yes
3) Best practice recommendation
Belt-positioning booster seat

No

Does the child fit properly in the vehicle seat belt, usually around 4’ 9” in height?
Yes
4) Best practice recommendation
Lap and shoulder vehicle seat belt

No

Age

All Children under 13 years of age should be restrained in the rear seats of vehicles for optimal protection.
2019 Best Practices

- No more 5X safer to age 2
- No data specifying age 2

Using the correct car seat or booster seat can be a lifesaver: make sure your child is always buckled in an age- and size-appropriate car seat or booster seat.

- **Rear-Facing Car Seat**
  - Birth up to Age 2:
    - Buckle children in a rear-facing seat until age 2 or when they reach the upper weight or height limit of that seat.

- **Forward-Facing Car Seat**
  - Age 2 up to at least age 5:
    - When children outgrow their rear-facing seat, they should be buckled in a forward-facing car seat until at least age 5 or when they reach the upper weight or height limit of that seat.

- **Booster Seat**
  - Age 5 up until seat belts fit properly:
    - Once children outgrow their forward-facing seat, they should be buckled in a booster seat until seat belts fit properly. The recommended height for proper seat belt fit is 57 inches tall.

- **Seat Belt**
  - Once seat belts fit properly without a booster seat:
    - Children no longer need to use a booster seat once seat belts fit them properly. Seat belts fit properly when the lap belt lays across the upper thighs (not the stomach) and the shoulder belt lays across the chest (not the neck).

Keep children ages 12 and under in the back seat. Never place a rear-facing car seat in front of an active air bag.

*Recommended age ranges for each seat type vary to account for differences in child growth and height/weight limits of car seats and booster seats. Use the car seat or booster seat owner’s manual to check installation and the seat height/weight limits, and proper seat use.

## Rear-Facing Seats

<table>
<thead>
<tr>
<th>Type</th>
<th>Direction</th>
<th>Lower Weight Limit (lb)</th>
<th>Weight Limit (lb)</th>
<th>Length Limit (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infant Carrier</td>
<td>Rear Only</td>
<td>3, 4, 5</td>
<td>22–35</td>
<td>29–35</td>
</tr>
<tr>
<td>Convertible</td>
<td>Rear Then</td>
<td>3, 4, 5</td>
<td>30–50</td>
<td>43–49</td>
</tr>
<tr>
<td></td>
<td>Forward</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Most infants will outgrow rear-facing only seats by length, not weight!

Growth chart developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000). Modified 4/20/01. https://www.cdc.gov/growthcharts
Birth to 36 months: Boys
Length-for-age and Weight-for-age percentiles

Growth chart developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000). Modified 4/20/01. https://www.cdc.gov/growthcharts
Why Rear-Facing?
This photo illustrates how a rear-facing car safety seat can cocoon and protect a child, compared to a forward-facing seat, in a crash.
What about the legs?

3 yr, 32 lb, 36 in
Arms and Legs Are Safer Rear-Facing!

National Automotive Sampling System Crashworthiness Data System
Rear-Facing Take Home

Best Practice:
Rear-facing as long as possible, up to the limit of the seat

Key Time Points:
Birth, 6, 9, and 12–24 months
## Forward-Facing Seats

<table>
<thead>
<tr>
<th>Type</th>
<th>Direction</th>
<th>Lower Weight (lb)</th>
<th>Higher Weight (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convertible</td>
<td>Rear then Forward</td>
<td>20</td>
<td>40, 50, 65, 80+</td>
</tr>
<tr>
<td>Combination</td>
<td>Forward only (Booster)</td>
<td>20</td>
<td>40, 50, 65, 80+</td>
</tr>
<tr>
<td>3-1</td>
<td>Rear/Forward/Booster</td>
<td>20</td>
<td>40, 50, 65</td>
</tr>
</tbody>
</table>
When Do Kids Exceed Limits?

Growth chart developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000). Modified 4/20/01. https://www.cdc.gov/growthcharts
Forward-Facing Take Home

Best Practice:
Forward-facing harness as long as possible, up to the limits of the seat

AT A MINIMUM:
4–8 years

Key Time Points:
4–10 years
# Belt Positioning Booster Seat

<table>
<thead>
<tr>
<th>Type</th>
<th>Lower Weight Limit (lb)</th>
<th>Higher Weight Limit (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belt Positioning Booster</td>
<td>30, 40</td>
<td>80–105</td>
</tr>
<tr>
<td>Combination/3-1</td>
<td>30, 40</td>
<td>80, 100, 120</td>
</tr>
</tbody>
</table>
Belt Positioning Booster Seat
4’9” Is The Magic Number!

Until Then, Kids Need A Booster Seat

visit www.boosterseat.gov
Is There a Time That Belts Fit?

Growth chart developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000). Modified 4/20/01. https://www.cdc.gov/growthcharts
Step 4 – Seat Belt
It’s All About the Fit!
Misused Seat Belt
Correct Seat Belt

1. Sitting upright
   - Back against vehicle seat
2. Legs bend comfortably
3. Shoulder belt across clavicle and sternum
4. Lap belt low across hips
   - Not resting on abdomen
5. Child can sit that way the entire ride
Booster/Seat Belt Take Home

Best Practice:
Booster until seat belt fits correctly

AT A MINIMUM:
8–12 years/4’9”

Key Time Points:
8–?
The Best Seat

- Fits the child
- Fits the car
- Can be used correctly every ride
Installation
Installation

**How a Seat Belt Retractor Works**

**Lower Anchors & Tethers for Children System (LATCH)**

- Located in rear filler panel of passenger cars
- Located in cargo floor of station wagons/vans
FIND EXPERT RESOURCES IN YOUR COMMUNITY!
Bring your car seats in to ensure they are correctly and properly installed

Parents and caregivers are encouraged to have their children's car seats checked. Certified child passenger safety technicians are available to work individually with families to provide installation education and support, at no cost.

Car seat safety checks at OHSU Doernbecher Children’s Hospital

Hours: Monday - Friday, by appointment only
To make your appointment, call 903 494-3735 leave us a message with your contact information at safety@ohsu.edu.
Address: OHSU Doernbecher Children's Hospital, Garage F, Level 4. Tom Sargent Safety Center - Inspection Station.
700 S.W. Campus Drive, Portland OR. 97239

Car seat safety checks in Oregon

Please visit our Community Partner - Oregon Impact, to learn about free car-seat check-up events around the state.

Safety resources

View printable safety tips in both English and Spanish.
You can easily find **Certified Child Passenger Safety Technicians** in your community.

www.seatcheck.org
www.nhtsa.gov
www.safekids.org
1-866-Seat-Check

AAP Car Seat Guide
THE TAKE HOME MESSAGE:

Just because you can, doesn’t mean you should...

Delay car safety seat transitions as long as possible!
Questions?
Take Home Messages

- Best practice based on real world physics
- Delay transitions
  - Lose relative protection every step
- Rear-facing to weight/height limit of seat
  - Rear-facing until at least 2 years
- Forward-facing until weight/height limit of seat
  - Forward-facing in a harness until at least age 4
- Belt positioning booster seat until seat belt fits correctly
  - Generally 4 years to 8–12 years
    - Depends on child and vehicle
- Rear seat until at least 13 years of age
Share the latest AAP car safety seat guidelines, including new recommendations for rear-facing riders, with the families in your care. *Car Safety Seats: 2019 Guide for Families* helps parents make informed decisions about car safety seat selection and use.

Included in this 49-page, annually updated brochure, is information on the various types of car safety seats (installation tips and common questions), LATCH attachment system, airbags, and lap and shoulder seat belts, plus feature comparisons of more than 225 car safety seats, belt-positioning booster seats, and travel vests!

Available for purchase at:
Visit Pediatric Care Online today for additional information on this and other topics.

pediatriccare.solutions.aap.org

Pediatric Care Online is a convenient electronic resource for immediate expert help with virtually every pediatric clinical information need with must-have resources that are included in a comprehensive reference library and time-saving clinical tools.

Don’t have a subscription to PCO?
Then take advantage of a free trial today!
Call Mead Johnson Nutrition at 888/363-2362
or, for more information, go to www.aap.org/pcotrial