where's baby?
Look before you lock.
Objectives

- Understand the pathophysiology of heat stress on the pediatric patient
- Be familiar with current laws and policies regarding leaving children alone in vehicles
- Describe interventions and educational resources available to prevent accidental deaths from heat stress
Case 1: M.S.

19 month old female

July 9, 1973
1:00pm

Near Chesapeake Bay
How often is the quick ten-minute visit to the supermarket converted to 30 or 45 minutes?
Case 1: M.S.

- Mom running errands, child fell asleep
- Left in front seat with back windows open, front window down 4 inches
- 2:00pm
Case 1: M.S.

- Mother returns to car
  - Unresponsive
  - White foam exuding from mouth
- Local ER
  - Rectal temperature 42.2°C (108°F)
Case 1: M.S.

- Rapid cooling
- IVF
- Hydrocortisone
- Antibiotics
  - Anuric
  - Hypotensive
  - Pupils non-reactive
- Transfer to Johns Hopkins Hospital
Case 1: M.S.

- Blood
- Plasmanate
- Aqueous electrolyte solutions
- Hydrocortisone and antibiotics continued
Case 1: M.S.

- Mechanical respiratory assistance required
- Child bled profusely from puncture sites and into GI tract
- Progressive deterioration of nervous system function
  - Areflexia, lack of response to caloric stimulation
- 12 hours after transfer, EEG and physical exam consistent with brain death
Case 2: S.K.

"If she just would have made a peep..."
Case 2: S.K.

- 7 month old female
- August 23, 2007
- St. Louis, Missouri
- Mother is a pediatrician at St. Louis Children’s Hospital
Case 2: S.K.

- S.K. in rear-facing car seat
- Husband drives to work instead of to daycare center
- Does not remember baby in back seat
Case 2: S.K.

- High temperature = 95°F
- Estimated car interior temperature = 140°F
- S.K. in car from 8:30am until passer-by breaks window at 12:30pm
- Time of death within 1 hour
Case 3: C.H.

- 22 month old male
- June 18, 2014
- Atlanta, Georgia
Case 3: C.H.

- 9:00am
  - Father goes to work and leaves C.H. in the back of their SUV
- 4:58pm
  - C.H. pronounced dead
- 10:00pm
  - Father arrested and charged with murder
Fatal Mistakes.

National Heatstroke Prevention Day, July 31
The Automobile and Heat Stress

- Study 1
- Late September 1975
- 38 Chevrolet automobiles
  - 18 cars facing the sun, alternating
    - 2 front windows open halfway
    - 2 front windows cracked open 2 inches
  - 20 cars facing away from sun, partially shaded
    - 2 front windows open halfway
    - 2 front windows cracked open 2 inches
The Automobile and Heat Stress

- Temperatures measured using Taylor Dairy Thermometers

- Front seat cushion - bulb 6 inches above
- Recording 0, 15, 30, 45 minutes
### TABLE I

**THE FOUR GROUPS OF AUTOMOBILES**

<table>
<thead>
<tr>
<th>Group</th>
<th>Direct Sun (Front Seat)</th>
<th>Front Windows Open</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Yes</td>
<td>2 inches</td>
<td>9</td>
</tr>
<tr>
<td>2</td>
<td>Yes</td>
<td>Halfway</td>
<td>9</td>
</tr>
<tr>
<td>3</td>
<td>No</td>
<td>2 inches</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>No</td>
<td>Halfway</td>
<td>10</td>
</tr>
</tbody>
</table>

### II

**MEAN TEMPERATURE RECORDINGS IN THE FOUR GROUPS OF AUTOMOBILES**

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>0</th>
<th>15</th>
<th>30</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>1</td>
<td>84</td>
<td>1.8</td>
<td>110</td>
<td>1.5</td>
</tr>
<tr>
<td>2</td>
<td>83</td>
<td>1.8</td>
<td>102</td>
<td>2.7</td>
</tr>
<tr>
<td>3</td>
<td>82</td>
<td>1.5</td>
<td>93</td>
<td>1.7</td>
</tr>
<tr>
<td>4</td>
<td>82</td>
<td>1.5</td>
<td>86</td>
<td>2.1</td>
</tr>
</tbody>
</table>
Fig. 1. Mean temperature recordings in cars grouped by exposure to direct sunlight and degree of ventilation.
The Automobile and Heat Stress

- Study 2
  - Urban and suburban shopping centers
  - 50 mothers with infants less than 2 years of age
    - Frequency left infants in car
    - Degree of ventilation provided
The Automobile and Heat Stress

- Study 2 results
  - 2 out of 50 admitted to leaving infants in parked car
  - 10 did so on “rare occasions”
  - 38 said never
- Provisions
  - Windows open more than “a crack”
  - One third said fully open or halfway
- Concern of theft
Discussion

- Temperature rise greatest in first 15 minutes
  - Inadequate ventilation and direct sun additive effects
- Burden of prolonged environmental heat
  - Circulatory collapse of heat pyrexia due to high-output cardiac failure
Why does this happen so quickly?
Physics 101

- Evaporation
- Conduction
- Convection
- Radiation
Heat Dissipation

- **Evaporation**: Infant clothed and bounded on two sides by seat cushion and seat back, only head as evaporative surface.
- **Conduction**: Infant received heat from seat cushions and back.
- **Convection**: Location of infant below window level.
- **Radiation**: Greenhouse effect of vehicle.
Heat Stress in Motor Vehicles

1981

Two deaths discussed:

1. Car originally in the shade
2. Parents evicted from home, child left in car

- Circulatory failure, DIC, generalized convulsions, assisted ventilation, death after 70 hours
Heat Stress in Motor Vehicles

- Australian automobiles
  - Interior temperatures measured with electronic thermometer
  - Humidity measured with bulb hygrometer
  - Measurements between 11am and 1pm
    - Q5 minutes for the first 30 minutes, then Q15 for additional 60 minutes
Heat Stress in Motor Vehicles

Results

- 75% maximum stabilized temperature reached within 5 minutes of closing doors
- Highest interior temperatures: Large dark sedans
- Lowest interior temperatures: Large light station wagons
- White colored vehicles 6.5 C cooler
Heat Stress in Motor Vehicles

Key point

Despite effects of color and size on internal temperature, all vehicles produced an environment incompatible with sustaining life.
Phases of Heat Illness

- **Heat stress**
  - Physical discomfort and physiological strain
- **Heat exhaustion**
  - Dehydration and core temperature 37°C-40°C
    - Thirst, weakness, anxiety, dizziness, syncope, headache
- **Heat stroke**
  - Elevated core temperature 40°C
  - CNS dysfunction, delirium, convulsions, coma, death
Heat Illness in the Child

- Despite increased body surface area to mass ratio, children have less effective thermoregulation compared to adults.
Heat Stress in Motor Vehicles

- Fluid loss
  - At 12 months of age, loss 1 to 1.2 mL/kg/hr
  - Adult data in extreme heat exposure suggests maximum loss 10-20mL/kg/hr
  - 10kg child
    - 800mL fluid loss or 8% dehydrated in 4 hours
    - Sweat gland exhaustion
    - Cerebral manifestations of heat stroke
Epidemiology

- 1991-2011
  - Child vehicular heat stroke deaths: at least 613
  - 2010 Child vehicular heat stroke deaths: 49 (highest number of fatalities in one year--ever)
  - Average number of child vehicular heat stroke deaths per year since 1998: 38 (one every 9 days)
U.S. Child Vehicular Heat Stroke Fatalities

97% of incidents occurred between 1990 and 2010

These data should be considered the absolute lower boundary of actual fatalities. This chart represents the incidents KidsAndCars.org has been able to uncover and document involving children less than 15.

www.KidsAndCars.org
Why does this happen?
Contributing Factors

- Distraction
- Change in routine
- Lack of sleep
- Stress
- Poor communication
- Leaving the windows cracked
- Thinking only gone for a few minutes
- Sleeping baby is a quiet baby
Child Vehicular Heat Stroke VS. Child Front Seat Passenger Deaths

The chart below illustrates as we reduced airbag deaths, the number of children dying in hot cars has continued to grow.

This in no way implies children should be placed in the front seat; they are MUCH safer in the back seat. Children should always be properly restrained in the back seat.

There were 184 children killed by over-powered airbags in the front passenger seat from 1990-2010; while during those same years at least 586 children died in vehicles due to heat stroke. Today it appears children are suffering from the totally unintended consequence of moving them to the back seat.

Airbag deaths: January 1, 2009, National Center for Statistics and Analysis, Special Crash Investigations, Children Fatally Injured by Passenger Air Bags (PAB)
Heat Stroke deaths: KidsAndCars.org national database

KIDS AND CARS.ORG
LOVE THEM, PROTECT THEM
www.KidsAndCars.org
Ages

Children who have died from vehicular hyperthermia in the United States (1998-2010) have ranged in age from 5 days to 14 years.

31% of hyperthermia deaths involve children under the age 1

87% of children who have died from vehicular heat stroke are age 3 and younger
Education

- Dissemination of information through general practice and media in order to prevent further human tragedies

- When the outside temperature is 80 degrees, the inside of a car will reach nearly 110 degrees (a potentially fatal temperature) in 20 minutes and be greater than 120 degrees in 60 minutes.
Prevention

- DO NOT LEAVE CHILDREN IN THE CAR

- It has happened to a teacher, pediatrician, dentist, postal clerk, social worker, police officer, nurse, clergyman, electrician, accountant, soldier, assistant principal, and even a rocket scientist.

- The most dangerous mistake a parent or caregiver can make is thinking it will not happen to them or their family.
Safety Tips

- Put something you'll need like your cell phone, handbag, employee ID or brief case, etc., on the floor board in the back seat.

- Keep a large stuffed animal in the child's car seat when it's not occupied. When the child is placed in the seat, put the stuffed animal in the front passenger seat as a reminder that anytime the stuffed animal is up front you know the child is in the back seat.
Recent Local Campaigns

- National Highway Traffic and Safety Administration
- Louisiana State Police
- Safe Kids Worldwide
- Where’s baby? Look before you Lock
Heatstroke: Get Involved

Clouds or no clouds, the heat of the sun can be deadly.

Kids in Hot Cars

While the full scope of the fatalities of children due to heatstroke in vehicles is not fully known, NHTSA and other safety advocates and academic institutions have recognized the safety threat heatstroke poses for young children left in hot cars. Together, the Federal Government, automakers, car seat manufacturers, health and safety advocates, consumer groups, and others are working together to tackle this important safety issue.
Law
United States: 20 states with existing laws
Leaving children unattended and unsupervised in motor vehicles; prohibition; penalties:

A. It is unlawful for any driver or operator to leave a child or children **under the age of six years** unattended and unsupervised in a motor vehicle.
B. 1) The term “unattended” as used in this Section means a child who has been left in a motor vehicle when the driver or operator of the vehicle is more than ten feet from the vehicle and unable to continuously observe the child.

(2) The term “unsupervised” as used in this Section means an unattended child when a person ten years of age or older is not physically present in the motor vehicle.
C. (1) A law enforcement officer who observes a child left unattended and unsupervised for a period in excess of ten minutes in violation of the provisions of this Section shall use whatever means are reasonably necessary to protect the child and remove the child from the motor vehicle.

(2) If the child is removed from the immediate area by a law enforcement officer pursuant to the provisions of this Section, the law enforcement officer shall place notification on the motor vehicle. The law enforcement officer shall hold the child until the parent or guardian returns.
D. Whoever violates this Section shall be fined not more than five hundred dollars, or imprisoned for not more than six months, or both. For each second or subsequent offense, the defendant shall be subject to imprisonment, with or without hard labor, of not less than one year nor more than two years and a fine of not less than one thousand dollars nor more than two thousand dollars, or both.

E. Any law enforcement officer acting in good faith pursuant to the provisions of this Section shall have immunity from any civil liability that otherwise might be incurred or imposed.
Amazing Safety Inventions

- The Hot Seat
  - One child too many...
Thank you!

- Mr. Andrew Pelham
- Dr. Costa Dimitriades
References


- [http://www.kidsandcars.org](http://www.kidsandcars.org)


Questions?