

Pediatric Vehicular Heatstroke: The Solution

A Technologically Simple New Standard
Will Prevent Children From Dying in Hot Cars

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Contents

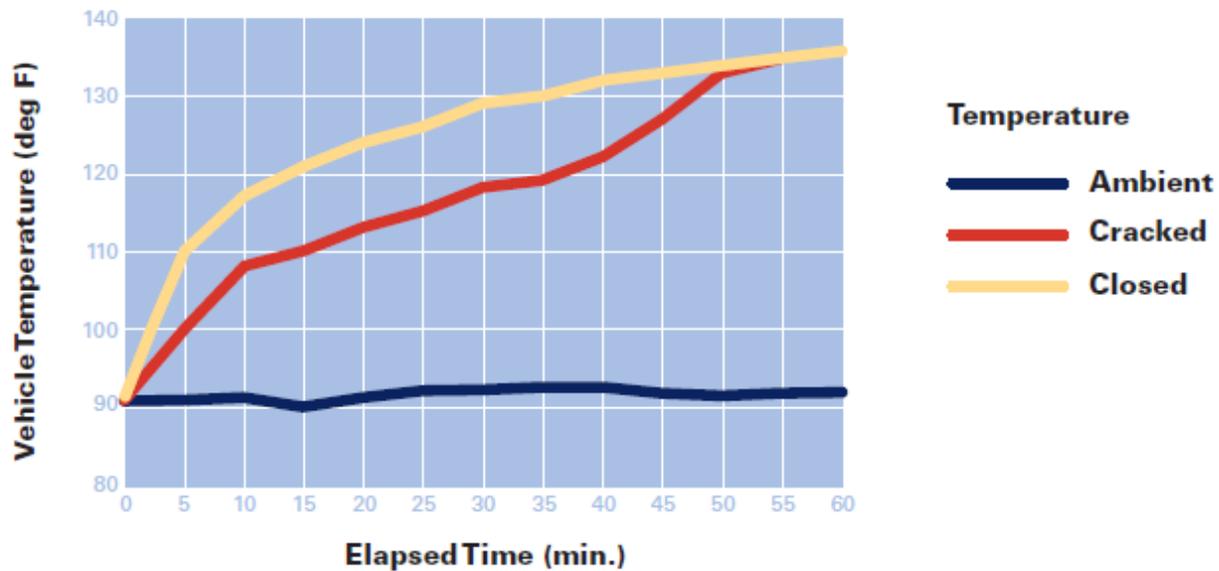
1	Abstract
2	The Problem: Children are Dying Preventable Deaths in Cars
2	Even the Government Wants to Help. But so far, no luck
3	What Areas Aren't Being Serviced?
3	The Solution: A Key Fob in the Car Seat
4	Principles of Operation
6	What Modifications are Required to the Child Car Seat?
6	Must Car Company(s) Be Involved?
7	Car Seat / Fob Interface
7	Two Fob Sockets per Car Seat
7	How Does Three Rs Get Off The Ground?
8	Can a Car Company Do it Alone?
8	Trapped in Vehicle Outside Car Seat
8	About L-Squared Technologies
9	References
10	Dr. Robert Lyons
10	Eric Lupton

Abstract

PEDIATRIC VEHICULAR HEATSTROKE IS PREVENTABLE.

Education can only go so far in preventing something inherently accidental. The technological solutions so far have been primarily reminders, and while everyone needs a reminder, a reminder alone is never enough to effect dramatic change. A complete safety solution requires a layered approach: reminding the driver, reversing and preventing temperature rise, and initiating rescue. Widely adopted, our “Three Rs” strategy will all but eliminate pediatric vehicular heatstroke fatalities. The technology to support the Three Rs already exists in vehicles. A simple change to the child car seat standard would ensure universal adoption of the Three Rs. On the other hand, there is compelling evidence that a car seat manufacturer introducing the Three Rs will address today’s concern of parents.

Interior Vehicle Temperature Over Time: Closed Versus Cracked Windows²



The Problem: Children are Dying Preventable Deaths in Cars

Since 1990, more than 1,000 children have died from hyper/hypothermia after being left in a car. While over half these children were forgotten in the car accidentally¹, the rest were abandoned intentionally by parents who underestimated the risk of their actions.²

Anyone charged with watching a young child should remember: overheating in a car is deadly, and happens faster than most of us think. On a clear and sunny 85° day, the temperature in a vehicle that is parked in the sun can reach 100° in only 10 minutes.

"Heatstroke occurs when a person's temperature exceeds 104° and their thermoregulatory mechanism is overwhelmed. A core body temperature of 107° is considered lethal as cells are damaged and internal organs shut down. Small children's thermoregulatory systems are not as efficient as an adult's and their body temperatures rise at a rate 3 to 5 times faster than an adult's."³

This means that a child can suffer from heatstroke in a matter of minutes.

Even the Government Wants to Help. But so far, no luck

Everyone realizes that there is a problem. Even the government has attempted to introduce legislation to protect the children^{2,4}, but unfortunately, there is still not a viable, enforceable solution.

- Recently, the U.S. House of Representatives introduced and passed the Hot Cars Act of 2017. This bill requires that all new passenger vehicles sold must be equipped with technology that will provide an alert when a child or unattended passenger remains in the rear seat after the vehicle's motor has been deactivated. Sadly, this has not been as all-encompassing as many would hope. An exact version of the House Hot Cars Act was also introduced in the Senate, but was not taken up.
- The Hot Cars Act has been introduced in both chambers in the 117th Congress.

Most significantly, these complex reminder solutions may well be less than satisfactory in addressing pediatric vehicular heatstroke. "Safety belt reminders are a lesson in how easy it is to ignore activators."⁵

Furthermore, exiting a vehicle without the ignition key and windows closed frequently results in drivers locked out of their vehicle. The security system, working as intended or defectively, acts autonomously to lock the vehicle. If a child is left “trapped” inside with rising temperature, the driver’s only rapid response is to bash in a window.⁶ Our “Three Rs” solution unlocks doors and opens the windows immediately.

What Areas Aren’t Being Serviced?

These governmental actions are a step forward, but they are not enough. What is needed is a sweeping industry-wide solution.

- Car seat manufacturers and car companies need an easy-to-use technology that works seamlessly.
- It shouldn’t be expensive or require major alteration to a vehicle.

Unfortunately, most of the ideas proposed or implemented are not as comprehensive as they can or should be.

A few minutes can mean the difference between life and death. The answer is hiding in plain sight. We just have to get past the notion that opening car windows endangers the child inside without exception.

The Solution: A Key Fob in the Car Seat

We believe that the public is underserved by the powerful computer technology embedded in modern vehicles. Security, a valid concern, is the main obstacle. But consider this – an enabled car seat fob plugged into a car seat can reliably remind the driver a “baby is on board”, open the windows to prevent heat stroke, and honk an SOS for rescue. Vehicles come equipped to do all this. Only the child car seat maker need adapt.

Recognizing the limitations of humans and hardware, safety professionals advocate layers of protection to reduce risk. We adopt a layers of protection philosophy in our “Three Rs” solution to pediatric vehicular heatstroke.

- **REMINDE** the Driver ... if Child is on Board

The first layer of protection is a reminder that a child is in the car seat when the driver turns off the ignition. The reminder does not occur when a child is not on board.

- **REVERSE** the Temperature Rise ... if Child has Been Left Behind

If the temperature rises fast or reaches a critical limit with the child present, the vehicle rolls down all of the windows. Radiated heating in the car is reduced while circulating air brings inside temperature toward the outside ambient. This buys time, improving the chances of first aid, i.e., immersing child in cold water, that will prove therapeutic. Given the rate at which cars heat, there is no alternative to opening windows. Starting the car and turning on air conditioning cools too slowly, while exposing the child to a real danger.⁷ Air conditioning may be viable for electric cars.

- **RESCUE** the Child

The final step is the most important. Many critical rescues of endangered children abandoned in vehicles have been performed by bystanders who break into the vehicle to perform the rescue. At the same moment the windows are lowered, the system will unlock the car doors and initiate the car alarm. The alarm needn’t be deafening for the child. One beep every 5-10 seconds should be sufficient to alert nearby bystanders that a child is in need of rescue. Attracting attention has the side benefit of discouraging vandalism.

“An automatic reminder system activated at the time the driver exits the car will work in all cases in which kids are forgotten in cars. When parents intentionally leave children in cars, and unexpectedly the interior of the car becomes dangerously hot, then an automatic temperature detection system which opens windows and sounds an alarm can save children’s lives.”

David M. Diamond, Ph.D., Dept. of Psychology, University of South Florida, author of reference 1

Principles Of Operation

1

Car seat manufactured with plug-in car seat FOB

Car seat FOB: Front and Back

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2

The FOB is enabled with a one time coding procedure using the vehicle's on board diagnostic port. This is not required if the car seat FOB comes with vehicle.

Alternatively, a FOB locksmith can perform this procedure.

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3

Outside air temperature 75°C

An audible warning will occur if one of the buckles is not properly attached.

FOB presumes that the seat is occupied ONLY when ALL buckles are properly attached.

At start of journey the child is safely buckled into car seat.

75°F

Air temperature inside car

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4

Parent and child drive to their destination

75°F

Air temperature inside car

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5

At the end of the journey the parent turns off the ignition

engine off 0 mins.

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6

Don't forget me

The car seat FOB reminds the parent that the child is still in the car seat

engine off 10 seconds

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7

NORMAL SCENARIO

Parent removes the child from the car seat at end of journey

engine off
1 min.

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8

BUT
If a child is LEFT in the car with windows closed

5 mins. in car

82°C

Air temperature rises inside car

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9

10 mins. in car

88°C

Air temperature rises inside car

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10

FOB opens windows, unlocks doors and triggers car alarm to emit one beep every 5 seconds

FOB can open and close all windows of most vehicle models. Some, (eg. VW, Nissan, Honda), require vehicle software enabling, readily performed by dealer.

Electric vehicles will turn on air conditioner.

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Cooler outside air enters car

30 mins. in car

76°C

Air temperature falls inside car

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120	127	133	149	167
115	122	128	144	162
110	117	123	139	157
105	112	118	134	152
100	107	113	129	147
95	102	108	124	142
90	97	103	119	137
85	92	98	114	132
80	87	93	109	127
75	82	88	104	122
70	77	83	99	117
	5	10	15	20
		30	45	60

Initial Temperature (°F)

Time (minutes)

www.tempsensornews.com/automobile-temperature-table

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Our system addresses hypothermia as well as heat stroke risk if child is left in vehicle.

Prolonged exposure to extreme cold will trigger car alarm and unlock doors.

In an electric vehicle the heater is turned on.

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What Modifications are Required to the Child Car Seat?

The Three Rs solution is easily incorporated into new car seat designs. There may be practical ways of adding the Three Rs to an existing car seat. Technical details of alternative solutions are provided in US patent 10,991,225. Here is one implementation.



The car seat is fitted with a car seat fob socket as shown. Each of the car seat buckles is wired as cold contact leads to a pin pair in the socket. The wiring can be a loop through the buckle [conductive contact] or loop back from one side of the buckle [magnetic contact].



The removable car seat fob contains all the electronics with a battery. Electrically the car seat fob is an enhanced two way key fob, including:

- Lock/unlock buttons (for programming and testing)
- Three normally open [conductive] or closed [magnetic] cold contact inputs
- Temperature sensor
- Elapsed time clock
- Receiver to remote monitor ignition status from OBD2 port [may not be required]

This "intelligent" car seat fob controls the vehicle to achieve the Three Rs.

If a car company decides to fully embrace the Three Rs it can enhance its performance in many ways, while relegating one simple function to the car seat fob, sense and report buckle status. This is the "dumb" fob alternative, or more exactly, a vehicle sensor solution. In the meantime, car companies can facilitate the introduction of intelligent car seat fobs as follows.

Must Car Company(s) be Involved?

The short answer is probably yes. Consider the scenarios with and without car company cooperation:

Car Seat Maker Goes it Alone

- Instructions on self programming the fob to all vehicle types must be provided
- Consumer may need car locksmith to complete the setup
- Consumer may need car dealer to swap software to enable fob window open
- New vehicle models may be increasingly restrictive on self programming fobs.

While the benefits and appeal to its customers are immense, would a car seat maker engineer and promote a solution in the face of these headwinds? What percentage of owners would complete the setup to activate the Three Rs in their vehicle(s)?

One final point: unless a two way fob can derive ignition status from all vehicle types, an OBD2 plug in must be provided with the car seat fob, another piece of the setup.

Car company support, however, makes launching a Three Rs car seat an easy decision for all car seat makers.

Vehicles Come with Car Seat Fobs

- Car seat makers know the future of the Three Rs
- Car dealers / locksmiths provide car seat fobs standard to their aftermarket
- No vehicle software incompatibility
- A majority of parents will want and benefit from a Three Rs car seat
- Pediatric vehicular heatstroke is virtually eliminated – lives are saved

The car maker need only take two simple steps:

- Select software that enables fob to open windows and receive ignition status
- Allow dealers to program and sell car seat fobs [aftermarket]

We're not talking airbags here! The analogy is more like Apple allowing a 3rd party app.

Which car company will set this new standard for child safety and carry the banner for the entire industry in advance of regulations that are surely coming?

Car Seat / Fob Interface

Fob(s) that come with a vehicle must work with any Three Rs car seat on the market. A plug standard is therefore required to achieve 100 % interoperability with third party fobs. Slide 2 below presumes an OBD plug type, allowing a self-programmable fob to directly access the vehicle's OBD port during programming.

Two Fob Sockets per Car Seat

The car seat should have two fob receptacles so the car seat can be moved between two vehicles without replacing a fob. The car seat will likely come equipped with only single self-programmable fob, since multiple vehicles can be programmed to recognize it.

How Does Three Rs Get Off The Ground?

A regulation requiring that new child car seats include fob port(s), supported by vehicle manufacturers agreeing to be a source of car seat fobs, is one path. Car companies individually or collectively motivating car seat makers to add fob ports is another. So is a single car seat manufacturer acting as a first mover to offer Three Rs to customers willing to program the included fob to their vehicle(s).

A "smart car seat fob / dumb car" combination narrows the gap as follows between what car makers might be willing to do and what regulators want, shortening the time frame for meaningful change:

- Compatible with all vehicles on the road
- No change to current vehicle design
- Minimal liability to car maker

Can a Car Company Do it Alone?

A car company can implement the Three Rs by surveilling the back seat(s) to detect the occupancy of any installed car seat. This involves significant design and production investment, and cost.

This "car of the future" solution is many years away. A car company would not initiate nor regulators require retrofitting Three R protection in existing vehicles.

Doesn't the same "car seat of the future" argument apply to the car seat job solution? Actually no, child car seats and safety regulations turn over quickly compared to vehicles. Car seats have expiration dates. And wiring a vehicle for back seat surveillance is an order of magnitude more costly than wiring a car seat for buckle detection.

Legislated standards specify the requirement, not how to achieve it. There are two long term paths, each with advantages and disadvantages. In the end, one path will be followed. Isn't a contact closure technology cheaper and more reliable than AI? What can go wrong for the car company and the consumer with another AI safety solution?

Trapped in Vehicle Outside Car Seat

The scenario of child NOT in car seat has historically also been a big contributor to vehicular pediatric hyperthermia deaths and injuries. The victim is typically a 1 - 5 year old who opens the car door from the outside, closes it from the inside then does not open it to escape.

The door in question is nearly always a rear door, where they normally enter, and where not coincidentally manual rear door child lock may be enabled.

Separate death and hospitalization statistics are available for children who were in car seats versus not. However, there seems to be no data on whether the rear door lock enabled manually played a role in latter cases. This is unfortunate and should

be corrected going forward.

The introduction of auto lock by the vehicle makers, that locks all doors a few seconds after ignition and unlocks them when the driver turns off ignition. has reduced the need for manual rear door child lock, but this feature is still mandated. Note that the rear door must be OPEN to disable manual child lock, so even an adult can be "entrapped".

Hyperthermia is just one (albeit the worst) bad outcome when a child is trapped in a car. Such occurrences are probably preventable simply by correcting an outdated vehicle standard*:

49 CFR § 571.206 - Standard No. 206; Door locks and door retention components, specifically

S4.3.1 Rear side doors

S4.3.2 Back doors

and possibly limiting Door handles.

- *What additional security is provided by a manual lock that is not released by a child or adult entering the back seat, who otherwise will be "locked in"?*

About L-Squared Technologies

L-Squared Technologies was founded by Dr. Robert Lyons and Eric Lupton specifically to develop a solution that would prevent the many tragic infant heatstroke deaths in vehicles each year. For the last two decades, Lyons and Lupton have, through their separate companies (Safety Turtle and Life Saver Pool Fence Systems, respectively), invented, manufactured, and distributed pool safety solutions for children, all aimed at preventing drownings. After focusing on water safety for so long, they were struck with the similarities between pediatric vehicular heatstroke and drowning, so they challenged themselves to help save even more lives by creating a solution to this very real problem.

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Dr. Robert Lyons

Co-Founder

Bob received his Ph.D. in Electrical Engineering from Carleton University, Ottawa, Canada in 1971. He is co-founder of SkyWave Electronics Ltd. and Square Peg Communications (www.squarepeg.ca).

Square Peg manufactures mobile satellite and aeronautical terminal communications equipment and test systems.

Bob started Terrapin Communications (www.safetyturtle.com) in October 1998 to market a new product he conceived to break the silence of drowning, Safety Turtle®. In 2004 he won the Manning Innovation Award, sponsored by Noranda Inc. [Canada], for his safety innovation. Terrapin sold the Safety Turtle business in 2012.

In addition to managing Terrapin, he has been an advocate of technology to help reduce backyard pool drowning of young children. He was a member of the ASTM Committee that drafted the Standard for Pool Alarms, and has written articles and given seminars on aquatic alarms and layers of protection for backyard pools.



Eric Lupton

Co-Founder

Eric Lupton is the President of Life Saver Pool Fence System, Inc., the world's largest pool fence company, according to Forbes. He has been featured as a business, entrepreneurship, marketing expert in two *New York Times* Best Sellers, the *Wall*

Street Journal, *Forbes*, *Huffington Post*, *BuzzFeed*, and *USA Today*, and is highly sought after by the media for interviews as an expert on child safety.

Eric was born with cerebral palsy, requiring him to use a power wheelchair full-time. He served on the board of the National Drowning Prevention Alliance, the country's largest water safety non-profit, and was eventually elected to become its Vice President.