

Heat related Hyperthermia Injuries in Pediatric and Veterinary Cases

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ABSTRACT

The incidence of heatstroke in children has been reported to be between 29 to 37 children per year from 2018 to present. The incidence is higher in case of animals and pets, with 163 animals in 2023 that succumbed to hyperthermia after being left in the cars. Most hypotheses suggest memory lapse, fatigue, stress, and habit changes could be the underlying cause of such events. It is necessary to examine four types of vehicles commonly used in the United States, and evaluate the internal temperature rise at different times of the day. This sample of increased temperature in these vehicles demonstrates the importance of prevention and proactive planning in car manufacturing. In addition, we will further examine new bills being introduced to prevent child and pet deaths.

Keywords: Hyperthermia; Pediatric; Car; Family pets; Children; Prevention

INTRODUCTION

According to National Weather Service data, the incidence of heat stroke has ranged between 23 to 50 deaths per year in the United States since 1998.^[1] These incidences have risen even more, to approximately 150 deaths per year in case of family pets.^[2] There have been significant attempts by news outlets and social media to reduce the hyperthermia related death. However this has not reduced the risk significantly. The incidence is more common in children younger than 3 years old. It has been shown that the hyperthermia occurs in all seasons although more common in June to August.^[3]

Physiologic response to heat has been evaluated. With rise in temperatures the homeostatic mechanisms cannot balance the internal temperatures to proper physiologic range. Heat reduces the water and minerals necessary to maintain cellular physiologic functions. Heat exhaustion presents as thirst, dizziness, fainting, weakness and finally to confusion, convulsion, coma and eventually death. These studies have revealed that the temperature rise in vehicles is very rapid.^[4] It has been shown that sun rays pass through the windshield and are absorbed by dark surfaces of the car. This absorption leads to infrared light trapped by the interior and leads to rapid increase in temperatures.^[5] Significant work in vehicle materials is being conducted. Studies have shown that certain materials in the interior of new vehicles produce volatile molecules, such as benzene content at 50 milliliter per square feet. This is not harmful to humans or pets however with rise in temperature this concentration may raise to 2000 to 4000 milliliter per square feet. At that

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level, passengers experience headaches, dizziness, drowsiness, confusion and eventually loss of consciousness.^[6] This can lead to convulsions and death. Studies of material used in interiors, which include type of glass, plastic, carbon fiber and other materials, have ramifications in infra-red-light absorption and rise in temperature. The interior temperature can be reduced from 140 degrees to 89 degrees Fahrenheit with use of new material such as Cross-Linked Polyethylene Sheet and vehicle air ventilation designs.^[5] This study aims at looking at temperature rise in four types of vehicles commonly used in the United States namely, large SUV, small SUV, Sedans, and small vehicles. The temperature is evaluated at different times of the day and rise is assessed based on type of vehicle and speed of rise in temperature.

Study design:

Four vehicles with different sizes were selected. These were based on common vehicles seen on the road today. They included a large and small sport utility vehicle, a large sedan and small compact car. The experiment was conducted at 8 AM, 12 PM and 3 PM. The exterior temperature was measured and recorded, and the vehicle doors left open until the interior temperature matched the exterior temperature.

Subsequently the thermometer was placed in the middle of the back seat and measurements were obtained at 0,15,30, 45 and 60 minutes and recorded (Table 1).

Table 1: The temperature and time data for 4 types of vehicles.

	Time Minutes	8AM	12PM	3PM
		External Temp 72.2°F	External Temp 80.0°F	External Temp 82.0°F
Small SUV	15	67.5	87.1	126.3
Small SUV	30	66.4	91.2	131.3
Small SUV	45	66.4	95.2	134.2
Small SUV	60	67.6	100	138.1
Large SUV	15	72	85.1	130.6
Large SUV	30	72	88	134.1
Large SUV	45	72.3	89.4	135.3
Large SUV	60	73	91.2	135.1
Small Sedan	15	68.4	93.4	115.3
Small Sedan	30	68	97.3	120
Small Sedan	45	68.9	116.1	141.3
Small Sedan	60	70.2	130.1	145.6
Large Sedan	15	67.5	87.4	104.7
Large Sedan	30	67.8	90.3	107.7
Large Sedan	45	67.5	96.4	115.2
Large Sedan	60	68.5	116.2	120.5

Data Analysis:

The data suggests that in the morning due to colder temperatures, the temperature inside the cars in general are cooler than outside. There is a noticeable drop in temperature in all cars most likely due to the colder interior of the vehicles

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that regulates the internal temperature. However, by 12PM the average increase in internal temperature is 8,11.7,19.28 and 28.9 degrees Fahrenheit in 15-minute increments. The maximum internal temperature of the car was increased to levels close to 130.1 degrees Fahrenheit in one vehicle. The 3 pm temperature externally started at 820 Fahrenheit however, again the internal temperature rise was more significant at 42.2, 41.3, 49.5 and 53.0-degrees Fahrenheit. The maximum temperature reached at 3 PM in one vehicle was 145.6 degrees in one hour.

DISCUSSION

Deaths from hyperthermia is a preventable tragedy that can be avoided having a good understanding of the etiology and taking proactive steps to prevent it. Various etiologies have been hypothesized as the underlying cause of hyperthermia related deaths. “Forgotten baby syndrome” is one of the major contributors of this event.^[7] It was in the 1990s that airbags became a standard for safety in vehicles. This followed by recommendations to place children in back seats to prevent airbag injuries. The intent of the law was to improve child safety however, a secondary effect was an increase in hyperthermia related deaths.^[8,9] Studies have looked at psychologic factors contributing to Forgotten baby syndrome. Habit being an automatic process has been one contributing factor. Habits in our daily activity are usually being conducted without any input. Our daily routines are mostly automatic functioning and any change in our routine may psychologically be forgotten. This unintentional phenomenon is one of the major contributors to the tragedy. Other conditions such as stress and fatigue could also be contributing to temporary memory impairment.^[10,11] Other possibilities are described as “Capacity-resource theory”. Under this theory, there is decreased attention under stressful conditions. The Habits are not affected by stress and therefore mistakes could occur.^[12] The continued education of the parents is essential in prevention of injuries. Those include every concept, such as always looking at the back seat, leaving toys or diapers in the front seat, asking care providers to call the parents' cells if a child does not arrive on time and never leaving children or pets alone at any time.

Our data suggested that the interior of the small sedan with dark exterior and interior absorbed more heat and temperatures rose the highest at 145.6 degrees Fahrenheit. There are significant studies being done to reduce the heat generated in vehicles by designing better ventilation of vehicles during inactivity and use of better materials to reduce absorption of radiation from sunlight. Studies have shown that using Cross Linked Polyethylene Sheets (XLPE Sheets) reduces interior temperatures from 143.60F to 89.60F.^[13] This study suggests that manufacturers could proactively design interiors with materials that prevent rapid rise in interior temperature.

In addition to parental education, preventive technology exists today that could help reduce infant and pet death today. Companies like Hyundai have taken the lead to create an ultrasound detection mechanism in the car to detect motions in the back seat. This allows the car to alert the drivers and prevent fatal accidents. However, there is a push back by some reporting that only 6 percent of car buyers have infants and young children. The ability of existing technology must become the standard in car manufacturing to prevent such events. This requires us to encourage our legislators to pass laws that require all car manufacturers to proactively use these technologies in all cars. This technology could be simply activated and deactivated as part of software programming if the owners have young children or pets in the car and to address concerns of opposing the technology. Bills such as one introduced by Senator Roger Wicker from

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Mississippi aim at requiring manufacturers introduce systems to prevent hyperthermia related deaths. We should advocate our congress and governors to pass such laws to help curb these tragic incident.

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