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How would you like your tea, vicar?

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ABSTRACT

Introduction: Scald injuries are the commonest cause of paediatric burns leading to hospital admission both in the United Kingdom (National Burn Care Review Committee Report; 2001) and around the world. The cost and significant morbidity resulting from scald injuries reiterates the need for effective prevention campaigns for primary caregivers. The majority of scalds in children occur in the kitchen (49%) at home. Three children a day under the age of 5 (1100/year) are involved in scalds resulting from pulling on a cup of beverage onto themselves. We therefore aim to study the temperature of common beverages made at home and their potential to cause significant thermal injury.

Materials and methods: Common household beverages were formulated to assess the thermal characteristics. Each beverage was made in a standardized environment with constant ambient temperature of 22 °C. Beverages were made in 230 ml ceramic mugs, using boiled water from an electric kettle, instant coffee granules and teabags. Hot milk and hot water were prepared for comparison. Temperature readings were taken from 0 to 10 min. Cooling curves were then plotted.

Results: Milky beverages had the lowest starting temperatures (75–77 °C). Black tea and black coffee remained at temperatures greater than 65 °C despite cooling for 10 min. The addition of sugar did not alter the cooling rate. Similarly there was very little difference in cooling rates for skimmed and full fat milk. Addition of 10 ml rather than 5 ml of milk lowered the starting temperature and increased the cooling rates.

Discussion/conclusion: Hot beverages can cause significant scald injuries especially in the paediatric population. We demonstrated the potential for a full thickness burn despite cooling for 10 min or the addition of cold milk. Thus the complacent attitude surrounding beverages under such conditions should be abolished. Our work also reiterates the need for education amongst caregivers regarding the handling of hot beverages in order to reduce the number of household injuries.

1. Introduction

Scald injuries are the commonest cause of paediatric burns leading to hospital admission in the United Kingdom [1]. 4,675 children under 18 years of age are admitted each year as inpatients to Accident and Emergency (A&E) departments or specialist burns units due to scalds and burns at home. However, the age group at greatest risk is under the age of 5 years, accounting for 75% of all severe child injuries. 3500 pre-school children per year require admission to A&E departments or specialist burns units, many of whom require extensive plastic surgery, sometimes throughout their entire lives [2]. The cost and significant morbidity resulting from scald injuries reiterates the need for effective prevention campaigns for primary caregivers [3–5].

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Table 1 – Showing temperatures of the different beverages.

	Mean starting temperature (°C)	Mean temperature at 10 min (°C)
Black coffee	87.33	64.67
Black coffee + sugar	87.17	64.33
Coffee + 5 ml full fat milk	82.83	63.33
Coffee + 10 ml full fat milk	77.67	60.17
Coffee + 5 ml skimmed milk	83.13	64.67
Coffee + 10 ml skimmed milk	78.17	61.17
Coffee + 5 ml full fat milk + sugar	82.67	63.67
Coffee + 10 ml full fat milk + sugar	81.67	61.5
Black tea	88.67	68.67
Black tea + sugar	88.5	69.17
Tea + 5 ml full fat milk	81.33	61.67
Tea + 10 ml full fat milk	75.33	58.17
Tea + 5 ml skimmed milk	82.17	62.17
Tea + 10 ml skimmed milk	76.17	59.5
Hot water	85.33	64.17
Hot milk	78.33	60.5

Commercial groups have recommended that hot beverages (particularly coffee) are served at high temperatures of around 85 °C [6], although preferred drinking temperatures have been found to be nearer 60 °C [7]. Moritz and Henriques showed that significant burns can be caused by temperatures over 65 °C (an exposure of 2 s can cause a full thickness burn) and higher temperatures can cause burns with shorter exposure. Our burns unit treat significant numbers of children with burns caused by domestic hot beverages. We felt that it was important to study the cooling curves of common beverages to see how long it would take for beverages to be ''drinkable'' as well as less likely to cause significant burn.

2. Materials and methods

Common household beverages were formulated to assess their thermal characteristics. The beverages chosen were the most common causes of scald injuries in the Queen Victoria Hospital Burns Centre. Each beverage was made in a standardized environment with a constant ambient temperature of 22 °C. To imitate real-life household scenarios, each beverage was made in a ceramic mug (230 ml) using boiled water from a 2 l automatic electric kettle, teabags and instant coffee granules. Milk from the refrigerator (at 4 °C) was added to the mug prior to addition of boiled water. At the point when the water boiled, it was added immediately to the mug containing the beverage with a standard calibrated mercury thermometer in situ. For comparison, hot water poured immediately from the electric kettle as it boiled, and hot milk made by boiling 230 ml of milk in a saucepan, were included in the study.

Temperature readings were carried out using the mercury thermometer at 0, 1, 3, 5, 7 and 10 min. The temperature at 0 min was noted when the temperature reading stopped rising and remained stable. Each experiment was carried out three times and the average temperature reading was calculated. The cooling curve for each beverage was then plotted.

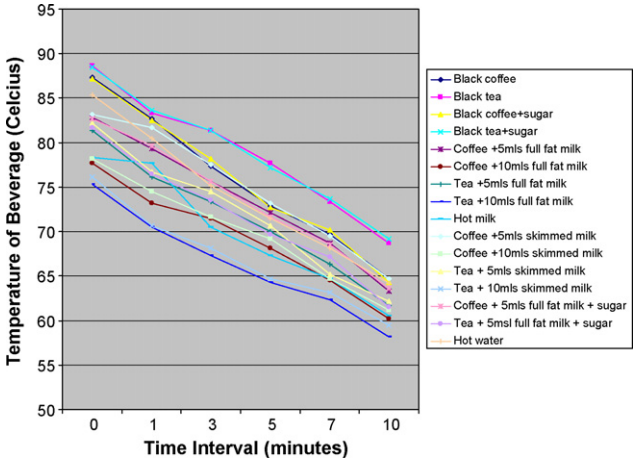

Fig. 1 – Showing the cooling curves of the beverages.

3. Results

Sixteen combinations of household beverages were studied. Table 1 shows the beverages, the mean starting temperatures and temperatures at 10 min. Cooling curves were plotted using the mean temperatures at the different time intervals as shown in Fig. 1.

Of note, black tea with and without sugar showed the highest starting temperature. This is followed by black coffee with and without sugar. The cooling curves are similar for all beverages, showing that a loss of between 17 and 23 °C occurred in 10 min. Black tea and black tea with sugar, however, have a higher endpoint suggesting that the beverage remains very hot at temperatures of 68–69 °C despite 10 min of cooling. The curves for milk tea had the lowest endpoints with temperatures of 58–60 °C.

Milky beverages had the lowest starting temperatures (75–77 °C). The addition of sugar did not alter the cooling rate. Similarly there was very little difference in cooling rates for skimmed and full fat milk. Addition of 10 ml rather than 5 ml of milk lowered the starting temperature and increased the cooling rates.

4. Discussion

This study demonstrates the cooling rates of common household beverages. In a previous review of the literature, Eadie et al. [8] found that up to 67% of scalds occur in children under 2 years of age, with boys being more commonly affected. There was a five-fold increase in numbers of scalds from cups of hot liquid over the 35-year period, in contrast to a decreasing number of scalds from teapots [8]. Herd et al. found that 41% of scalds in children under 2 years old were caused by fluid in teapots, 29% by fluid in kettles and 13% by fluid in cups. This ''toddler peak'' injury is often the result of curiosity in the child [9].

Studies have demonstrated that the addition of milk to beverages shortened the cooling time and thus the time at which a potential full thickness skin burn could occur [10]. These studies also demonstrated that the starting temperature and the volume of liquid are of greater importance in determining the rate of cooling [10], and that the type of container did not affect the rate of cooling [11]. Furthermore, the thermal characteristics of causative agents in scald injuries provide clues as to the likely depth of injury [12]. Moritz and Henriques found that a 2 s exposure to water at a temperature of 65 °C can result in a full thickness skin burn in adult skin. As hot beverages are essentially hot water, full thickness skin burns can result after this time exposure [13].

Adequate clinical management of a scald includes a thorough history to ascertain the type of liquid involved and its temperature. Whilst the exact temperature of the liquid will not be readily available, this study will provide a guide to the temperatures at the time of scalding. If a cut off point is taken at 65 °C, it can be seen from the cooling curves that black tea and black tea with sugar pose a potential threat for full thickness skin burns despite being cooled for 10 min. Full thickness burns following a 2 s exposure to fluids at such temperatures have been shown to occur in adult skin. Children with thinner skin are therefore more susceptible to significant injury with either a shorter duration of exposure or lower temperatures. A complacent attitude amongst caregivers, coupled with curiosity of children make for the perfect setup for scalds at home. Table 2 shows the time period at which a potential threat of a full thickness skin burn can result from the various beverages. Addition of milk significantly reduces the time for a potential scald injury.

The higher recommended serving temperatures for hot beverages means that the potential of significant scald injuries is greater. To try and balance limiting the potential scald burn and maintaining an acceptable perception of adequate beverage warmth, the optimum temperature for serving hot beverages has been studied and found to be approximately 57 °C [7]. To reduce the hazard of scald injuries it is imperative to provide greater education and prevention campaigns targeted to primary caregivers. The Cochrane Review in 2004 concluded that there are a very limited number of research studies allowing conclusions to be drawn about the effectiveness of community-based injury prevention programmes to prevent burns and scalds in children. Thus, there is a pressing need to evaluate high-quality community-based intervention programmes based on efficacious counter-measures to reduce burns and scalds in children [14].

Table 2 – Showing the time period for a potential full thickness burn to occur.

Beverage	Potential time for full thickness skin burn (min)
Black tea/black tea + sugar	10
Black coffee/black coffee + sugar	9
Hot water	9
Hot milk	7
Milky tea/coffee	5

5. Conclusion

This study demonstrates that common household beverages have the potential to cause full thickness burns despite a period of cooling. This period varies from 5 min for milky beverages to 10 min for black tea or black tea with sugar. The concept of the ''danger time'', i.e. the period when there is the potential to cause full thickness burns must be ingrained in parents and primary caregivers. During this ''danger time'', it is imperative that containers of hot beverages, be it mugs or cups in the household, paper or Styrofoam cups outdoors, should be placed well away from the reach of children for the minimum time of 10 min to avoid scalds. Children, in particular toddlers, should be carefully supervised in the presence of any hot liquids and should not be left unattended. Parents and primary caregivers need to realise that a split second of neglect in such circumstances can lead to lifelong morbidity for the child. Furthermore, it is after this ''danger time'' that the temperature of the beverage is allowed to reach the preferred drinking temperature of nearer 60 °C as mentioned earlier.

We have proposed the idea of a ''safety mug'' as a preventative measure that will visually warn people of the high temperatures of its liquid content, subsequently changing its appearance as the liquid cools down. This is being considered by The Children's Fire and Burn Trust (CFBT) in their prevention campaigns. Further studies to compare the efficacy of temperature graduated mugs against the use of caps as prevention against scalds are planned.

Conflict of interest

All authors have no conflict of interest.

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