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Properties of Matter matter in assessment of scald injuries

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ABSTRACT

Gathering information on the thermal characteristics of the causative agent in scald injuries provides clues as to the likely depth of injury. We theorize that viscosity and thermal capacity may have important roles to play when we view scalds as contact burns due to a liquid.

From a 4-year review of our scald patients, we found that scalds due to thick food/drinks such as congee (a porridge made from rice) were associated with a higher rate of surgery. We determined the rate of cooling of seven common food/drinks and found little difference between water, tea, coffee and noodles, other than the starting temperatures. However, the rate of cooling of congee was significantly slower indicating a greater thermal capacity. A ''drip'' model found that a skin substitute exposed to congee cooled significantly more slowly compared to other food/drinks, suggesting that its greater viscosity plays a role. This supports the theory that the viscosity of food/drink is important.

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1. Introduction

The commonest type of burn leading to hospital admission is the scald [1]. The scald is generally regarded to be an evolving injury that takes about 48 h to ''declare'' itself in terms of its depth of injury. The depth is a critical factor in the management of the patient as this will largely determine whether a conservative or surgical approach is taken [2]. Clinical assessment of burn depth remains a central feature of the acute management, even though the ''objectivity'' of the scanning laser Doppler [3] offers significant advantages over ''subjectivity'' of clinical assessment. When considering the scald injury, essential points from the history can assist in the clinical evaluation of the wound such as the type of liquid involved and its temperature, the clothing worn at the time of injury, the type and timing of the first aid provided. Whilst the exact temperature of the liquid will not be readily available, asking appropriate questions will allow an educated guess—hot water from a dispenser (popular in our locality) is generally lower than water boiled in a kettle, a time interval between heating and the injury will allow cooling to occur and the addition of cold milk to tea or coffee will lower the temperature further.

Scald can be viewed as a ''contact burn due to a liquid'' and as such the contact time with the skin and the thermal capacity of the liquid will be important. The duration of contact is usually brief but the implication can be appreciated in terms of the variable depth of burn when, for example, spilt liquid has been retained by clothing and that area of burn is significantly deeper than exposed skin. It is in this context we hypothesize that viscosity and thermal capacity may be important factors in potentially prolonging the exposure of the skin to the harmful agent.

2. Materials and methods

All patients admitted with food or drink related scald injuries over a 4-year period were identified from our computer database. Charts were then reviewed to identity specific

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Table 1 – Summary of data of foodstuff scalds from 2000 to 2003 in PWH burns unit

	2000	2001	2002	2003	Total
Total number	122	99	101	76	398
Males	62	43	58	45	208
Females	60	56	43	31	190
Children (≤16)	68	48	56	54	226
Adult (>16)	54	51	45	22	172
Types of food					
Water	65	54	58	46	223
Chinese soup	21	13	17	18	69
Oil	11	9	4	4	28
Cup noodles	4	7	5	3	19
Chinese tea	5	5	4	1	15
Congee	1	7	5	0	13
Herbal medicine	1	0	2	0	3
Milk drinks	1	2	1	1	4
Soya sauce	0	0	1	1	2
Boiled cola	1	0	0	0	1
Boiled ginger juice	0	1	0	0	1
Oat meal	0	0	0	1	1
Unspecified	12	1	4	1	18

Milk drinks includes milky tea, coffee and chocolate milk. Admissions were slightly down in 2003 due to closure of the unit for 3 months during the SARS crisis.

details of the agents involved and also the subsequent management of the patients.

The seven most common agents causing scalds were then subject to further study examining their cooling and viscosity characterstics. All food and drinks involved in this study were obtained from ''commercial'' sources (to mimic real life situations) and tested within a standardized environment with constant ambient temperature and humidity.

Standard cooling curves were performed using both paper and foam containers. Measurements of the temperature were recorded using a Raytek®, non-contact, infra-red food thermometer every minute after stirring for 5 s.

To assess the effect of food/drink viscosity, pieces of Allevyn® foam dressing (Smith & Nephew Medical Limited, Hull, England) were equilibrated in a water bath at 37 °C for 10 min and then positioned at 30° to the horizontal. Food/drink was poured onto the outer surface of the dressing and allowed to drip away by gravity. The temperature of the Allevyn at the contact point was recorded every 10 s with the Raytek® non-contact thermometer.

Table 2 – Summary of the number of patients requiring surgery various categories of foodstuff injuries

Foodstuff	Number of patients	Number requiring surgery	Percentage requiring surgery
Congee	13	4	31
Soup	69	11	16
Water	223	32	14

The exact nature of surgery, e.g. extent of debridement, area grafted and number of operations, is not considered.

Table 3 – Comparison starting temperature of food/drink and the first measurement (10 s) of the skin substitute after exposure

Food/drink	Mean starting temperature (°C)	Temperature of skin substitute at 10 s (°C)
Water	73	44
Chinese tea	72	44
Milk tea	62	41
Coffee	59	41
Chinese soup	66	48
Noodles	59	46
Congee	49	47

3. Results

Three hundred and ninety eight patients were admitted to our unit with food and drink related scalds from 2000 to 2003. The demographic details and the specific agents involved are detailed in Table 1. Table 2 indicates the number and percentage of patients requiring surgery when considering scalds from congee, soup and water.

Cooling curves for the studied agents are shown in Fig. 1 for paper cups and Fig. 2 for foam cups. These demonstrate that the cooling curves for water, tea, coffee and soup are similar while congee shows a flatter curve, i.e. a slower rate of cooling. One point of interest was the difference in starting temperatures (''serving temperatures'') of the various liquids with water and Chinese tea being around 72–73 °C, milk tea, coffee and noodles 60 °C and congee being the coolest at approximately 50 °C. We found that foam cups kept the food/drink consistently warmer but the difference was small, ranging from 2.8 to 0.2 °C.

The results of the ''drip model'' are shown in Fig. 3. The temperature of the skin substitute would reflect how much heat had been transferred from the hot food/drink, which in turn would be influenced by the temperature of the food/drink at the time of contact, the length of contact, the thermal capacity, the viscosity and the effectiveness of heat transfer. For example, when we poured water at an average temperature of 73 °C onto the skin substitute, the temperature of the skin substitute was 44 °C by the time of the first measurement at 10 s. If we pour congee at 49 °C, then the temperature at 10 s was 47 °C (Table 3). This suggests that the heat transfer by

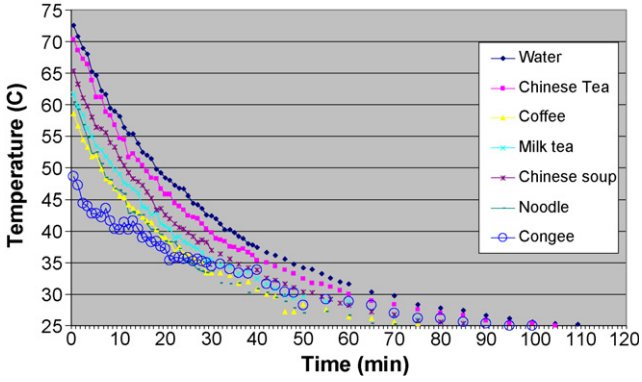

Fig. 1 – Cooling curve of different foodstuffs in paper cup.

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