Temperatures Achieved During The Heating Of Cooking Oil In Chip-Pans
M Whalan, A Amir, L Spencer, N Solanki, M Wagstaff, J Greenwood

Citation

Abstract
Objectives To investigate aspects of chip-pan design which might lead to hot oil scald injury during cooking. To ascertain whether there is a need for safety information aimed at the general public to encourage primary prevention. Materials and Methods Two previously un-used ‘chip-pans’ were filled with fresh vegetable oil and heated over a gas-heated hotplate. Temperature measurements were taken using an infrared thermometer with laser sight at 1-minute intervals of the cooking oil, the external surface of the pan and the handles of both the pan itself and the inner chip basket. Results Between January 1996 and January 2010, 247 patients were admitted to the Adult Burn Centre of the Royal Adelaide Hospital with burns due to hot oil scalds sustained in the home. Experimentally, the oil temperature reached a plateau of 240-260°C. At this time, the temperature of the long handle of pan 1 ranged from 90-120°C. The shorter ‘alternative’ handle reached temperatures as high as 193°C. The handles of pan 2 ranged from 40-60°C. Conclusions In the absence of a chip-pan fire, pan-handles can become too hot to hold without protection. Attempts to move a blazing chip-pan from the stove-top to outdoors are likely to result in dropping the pan and/or spillage of the oil and severe burn injury (as well as the risk of the fire spreading). Admission numbers mandate public awareness campaigns and the promotion of fire blanket purchase.

INTRODUCTION
Between the start of our Burn-Injury Database in 1996 and January 2010, there were 247 admissions to the Adult Burn Centre at the Royal Adelaide Hospital with injuries caused by hot cooking oil. Whilst a proportion were small injuries from splashes during cooking, a large number are significant injuries sustained whilst trying to move a burning chip-pan from stovetop to outdoors via the kitchen door or worse by trying to extinguish a hot oil fire with cold water.

Epidemiological data surrounding chip pan fires suggests a correlation with lower socioeconomic status, with the majority of these burn injuries occurring in the home environment.

When confronted with flames and fire, the immediate reaction is to move the flaming pan to outside of the house in an attempt to prevent property damage. However, the hazards involved in moving a pan containing flame and smoke at the end of a short wooden or plastic handle are often not realised. Examples of these are: i) the temperature of the oil fire flames (400-700°C) and the constant spitting of hot fat at several hundred degrees, ii) the proximity of the pan handle to the flames will ensure that they are hot and greasy, constantly being spattered with hot oil droplets, iii) the movement of the flame column towards the carrier once forward motion begins, iv) the difficulty of opening the back-door with one hand whilst holding the flaming pan, v) the danger of igniting kitchen fabrics like curtains during the manoeuvre, and vi) the effect of the sudden waft of oxygen-richer air pouring into the air-depleted kitchen fanning the flames once the door has been opened. Unfortunately, once the pan has been dropped, the burning oil spreads out across the kitchen floor igniting combustible materials and forming a hot slippery surface which often leads to further trauma.

Patients from oil-fire 'explosions' are much rarer and tend to be women, who realise the dangers of moving the pan and try 'static' resolving techniques by trying to stop the fire with the application of cold water.

Whilst there is no completely safe method of dealing with chip-pan fires, the ‘safer’ method of dealing with ignited oil involves cutting off the oxygen to the flames by covering the pan with an occlusive material. A purpose-designed ‘fire blanket’ is ideal and readily commercially available. A damp (soaked in water and then well-wrung out) ‘tea-towel’ is
another option when a fire blanket is not available. Trying to replace the pan-lid is often difficult due to the precise fit of the lid and the patient may suffer burns to the hands and forearms from flames coming around the lid or possibly displace the pan in the attempt. Avoiding the consumption of alcohol (often a contributing factor in hot oil burns) while using cooking appliances is also prudent advice which is often ignored.  

OBJECTIVES
An experiment was performed to measure the temperature of canola-blend vegetable cooking oil and cooking pan handles whilst on a heat source to demonstrate that the temperatures reached are sufficient to cause burn injury and attempts to remove the pan from the heat source can result in flame burns, contact burns and/or hot oil scalds.

MATERIALS AND METHODS
Two experiments were performed, several years apart, to assess the temperatures reached whilst heating cooking oil. Two commercially available chip-pans were purchased from stores in metropolitan Adelaide. The first pan was a 'traditional' chip-pan, with an insulated plastic long handle and an insulated plastic short handle diametrically opposite. This pan also was supplied with a lid (Figure 1). The second chip-pan was a more modern design; it had two small, insulated plastic handles on opposite side of the pan and a steel frying 'basket' with a long metallic handle. This pan was not supplied with a lid (Figure 2). Commercial edible canola (rapeseed) oil was used.

The two pans were heated separately in an identical manner, over a gas-heated hotplate, with serial measurements taken every minute of the temperatures of the oil, pan and all panhandles. Since the first pan had a long handle, we divided it into thirds (taking measurements from each third as well as its underside). We also measured the temperature of its short handle and the contained oil. With the second pan, measurements were taken from the short handles, the base of the frying basket handle and the contained oil. Temperatures were measured using a Testo 830-T1 Infrared Thermometer with laser sighting (Testo AG, Lenkirch, Germany). The results were analysed using Microsoft Excel® software.

Retrospective data of inpatients admitted to the Royal Adelaide Hospital Burns Unit from January 1996 to January 2010 was collected. Patients who sustained hot oil burns during home use were included. Occupational injuries were not included since this study was concerned with the domestic risk of chip-pan burns and oil fires, and the potential need for education to the general public.

RESULTS

PAN 1
The experiment ran for 105 minutes. Oil temperature rose steadily until reaching a plateau at 238°C after 60-70 minutes of heating. By 30 minutes, the temperature of the long handle ranged from 51.0°C at the distal end to 59.5°C at the base. At 60 minutes, the temperature of the main handle ranged from 58.5°C at the distal end to 90.5°C at the base. At 90 minutes, the temperature of the main handle ranged from 71.5°C at the distal end to 135.0°C at the base. The short handle on the opposite side reached 193°C by the conclusion of the study.
Temperatures Achieved During The Heating Of Cooking Oil In Chip-Pans

Figure 3
Table 1 Experiment 1; time and temperature range

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>Temperature Range (°C)</th>
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<tbody>
<tr>
<td></td>
<td>Handle Base</td>
</tr>
<tr>
<td>0-10</td>
<td>27.0-41.5</td>
</tr>
<tr>
<td>11-20</td>
<td>40.0-51.5</td>
</tr>
<tr>
<td>21-30</td>
<td>49.5-56.5</td>
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<td>107.5-122</td>
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<tr>
<td>101-110</td>
<td>113.5-125</td>
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</tbody>
</table>

Figure 4
Figure 3 Measured temperatures of oil and pan 1 over time

PAN 2

After steadily rising, an oil temperature plateau of 256°C was reached at 60-70 minutes. At 30 minutes, the temperature of the small handles reached 66°C on the left and 59.5°C on the right. After 30 minutes, the temperature of the handle was constantly above 50°C on the left. The temperature of the base of the silver handle remained greater than 100°C after 30 minutes, reaching a maximum, 158°C, at 44 minutes.

Figure 5
Table 2 Experiment 2; time and temperature range

<table>
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<tr>
<th>Time (min)</th>
<th>Temperature Range (°C)</th>
</tr>
</thead>
<tbody>
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<td>Pan left handle</td>
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<tr>
<td>0-10</td>
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<td>54.0-61.5</td>
</tr>
<tr>
<td>81-90</td>
<td>55.0-60.0</td>
</tr>
</tbody>
</table>

Figure 6
Figure 4 Measured temperatures of oil and pan 2 over time

RETROSPECTIVE DATA

Between January 1996 and January 2010, 247 patients were admitted to the Adult Burn Centre of the Royal Adelaide Hospital with hot oil burns/scalds sustained in the home. Seventeen injuries resulted from cooking oil that had ignited and caused an oil fire.

DISCUSSION

The depth of a thermal scald burn is determined by the temperature of the liquid and the duration of contact. Thermal injury occurs with temperatures in excess of 46°C and above 60°C a full thickness burn occurs after contact duration of only 1 second\(^4\). The duration of contact of a liquid is related to its viscosity with more viscous liquids remaining in contact with the skin for longer periods of time\(^5\). The higher viscosity of oil and its higher temperature when heated often leads to deep dermal or full thickness injuries after scolding occurs.
The experiments demonstrate that the handle of a chip-pan can rapidly reach temperatures well above 46˚C, even in the absence of the oil igniting. The pan itself and the oil reached higher temperatures. This highlights how important correct handling of the pan is in order to avoid accidental burn injury. In both experiments, the flash point of the oil (the temperature at which oil will burn if an external flame source is applied) was not reached and we were unable to assess the radiant heat generated by flames over burning oil.

Educational programs have been employed in the United Kingdom, spread mainly through mainstream media campaigns. A television publicity campaign together with home visits from local fire officers run in England from 1976-1977, which educated the public on the correct action in the event of a chip pan fire, successfully reduced the number of chip pan fire injuries by 30%. Our unit produced a Community Service Announcement (CSA) in 2009, which has been regularly aired on one of the main television networks in South Australia. After this, the incidence of hot oil burns declined in the following 12 months. Adequate product safe-use guidelines should accompany all cookware items designed to heat or contain cooking oil. Fire blankets are widely available at many hardware outlets, such as Bunnings Warehouse (an Australian-owned chain) who stock fire blankets of varying size for customer purchase.

Like all burn injuries, morbidity and the financial cost to the patient and state (in terms of time off work and loss of productivity) and to healthcare institutions, can be reduced by effective prevention and enhanced safety measures.

CONCLUSION

Hot cooking oil, whether ignited or not, is a frequent and often serious cause of burn injury amongst Australians. Our studies demonstrate that the temperatures of chip pan handles quickly become hot enough to cause contact burns. In the event of oil fire, attempts to move the burning pan are often met with failure and severe burn injury. Preventative strategies to reduce the risk to the public must be implemented and maintained, particularly education about ‘safe’ methods of extinguishing oil fires and the promotion of fire blanket acquisition.

ACKNOWLEDGEMENTS

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References
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