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Ten-year Brisbane experience in petrol burns: A preventable health burden

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Abstract

Petrol is one of the most widely used and freely available fuels in use in developed countries today. This study examines the clinical details and demographics of adults with petrol burns over a 10-year period with a view to identifying any trends. The majority of petrol burns were due to human error and thus theoretically preventable. This study determined that the young male (aged 16–25) is most at risk, mainly through the misuse of petrol. The best method of prevention of these burns might be education targeting this group of population. This study provides a basis upon which effective intervention programmes can be designed.

Keywords: Petrol; Burns; Injury; Survival; Mortality

1. Introduction

Petrol burns are a major cause of burns in Australia, however, little attention has been paid to the epidemiology and prevention of petrol burns in this country. Petrol is one of the most widely used and freely available fuels in use in developed countries today. While petrol is intended for use as a motor fuel its widespread availability encourages misuse for other purposes. Petrol is a short-chain hydrocarbon with a high heat of combustion, producing 29.62 MJ/l, which is more than any other common fuel [1]. There are two important physical properties of petrol which explain why it is more hazardous than other flammable liquids found around the home, the first being its flash point and the second its vapour density. The flash point of a liquid is defined as the minimum temperature at which a liquid will give off sufficient vapour to form an ignitable mixture with air. The vapour density is the ratio of the density of a vapour to the density of air. Petrol has both a low flash point 42 °C and a high vapour density of 3–4. Liquids with a vapour density of greater than 1, which is the density of air, are heavy and tend to accumulate in low and enclosed spaces. Petrol fumes are colourless and may travel considerable distances along the ground where they may then be ignited at some distance from the source. This combination of factors makes petrol highly explosive, a fact which is, unfortunately, poorly appreciated by the general community.

There have been articles on the epidemiology of petrol burns in both the UK and USA. Wilson and Bailie [1] in the UK found that 33% of adult burns over their 2-year study period were petrol related, and that the commonest cause was attempting to start or accelerate a bonfire. Barillo et al. [2] in the USA found that petrol was often misused as an accelerant and solvent, leading to burns. In this 18-year retrospective review it was found that 23% of all burns were petrol related, and the use of petrol in 87.1% of these cases was inappropriate or unsafe.

This study examines the clinical details and demographics of adults with petrol burns over a 10-year period with a view to identifying any trends. Although therapeutic management of burns has improved, prevention is still the most effective way of reducing the physical and psychological damage caused by burns, as well as reducing the cost to the community. This information will help to determine where preventive measures should be employed.

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2. Methods

The Royal Brisbane Hospital Burns Unit is the only specialised burns centre for Queensland and receives referrals from the entire state of Queensland and northern New South Wales. The details of all adult patients admitted to the Royal Brisbane Hospital Burns Unit between 1 January 1991 and 31 December 2000 were recorded prospectively for analysis. Patients included in the study were greater than 16 years of age with petrol burns. The data collected were age, gender, burn size, cause of injury, year and duration of admission, predisposing factors, operative intervention, anatomical distribution of burn and outcome. Microsoft Access™ program was customised for the purpose and data was entered using a personal computer.

3. Results

3.1. Admission

During this 10-year period 2016 patients were admitted to the burns unit, of which, 289 (14.3%) were caused by petrol. There was no significant yearly (Fig. 1) or monthly trend (Fig. 2) in the number of patients over the 10-year period.

3.2. Sex and age

Of the patients with petrol burns 256 (88.6%) were males and 33 (11.4%) were females. The male to female ratio for petrol burns was 7.8:1, compared with a ratio of 2.7:1 for all burns during this period. Males aged 16–25 were the highest risk group for suffering a petrol burn injury. Petrol burns in females peaked at 21–30 years (Fig. 3). The trend in age of patients with petrol burns is similar to that of burns from all causes, with the vast majority being young males (Fig. 4).

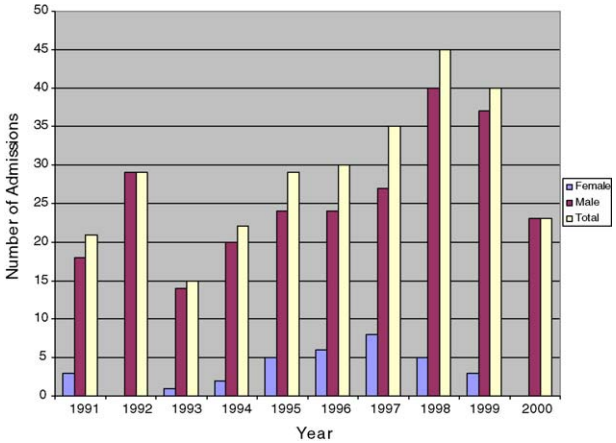

Fig. 1. Petrol burn admission (1991–2000).

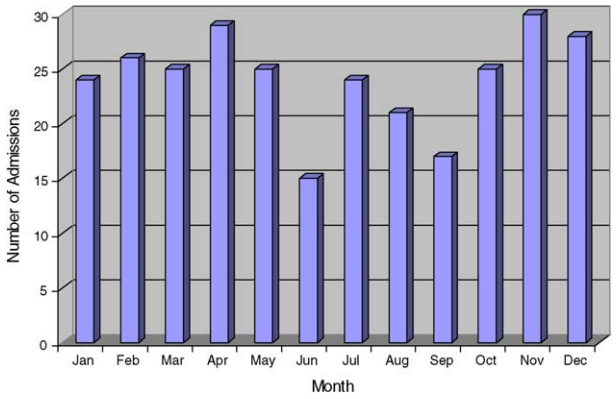

Fig. 2. Monthly trend of petrol burns.

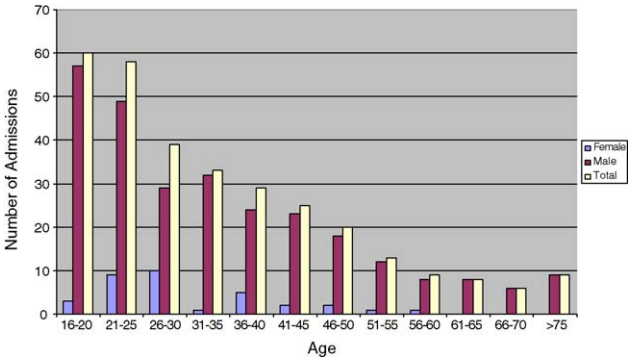

Fig. 3. Age distribution (male vs. female).

3.3. Predisposing factors and causes

Work related burns accounted for 24% of all petrol burns. In the majority of burns there were no predisposing factors, however, for self-inflicted burns psychiatric disorder and alcohol abuse were the two most common predisposing factors. The majority of petrol burns were the result of human error (51%), 28% were attributed to true accidents, 14% were intentional and 7% were of unable to be determined (Fig. 5).

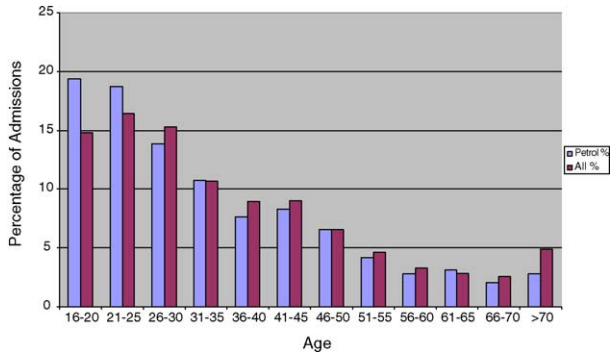

Fig. 4. Age distribution (petrol vs. all burns).

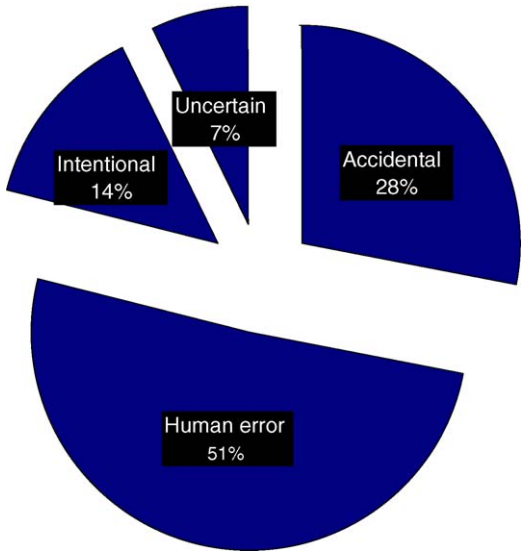

Fig. 5. Nature of petrol burns.

3.4. Extent of burns

The majority of petrol burns were under 20% total body surface area (TBSA), with 40% of the total number of burns being less than 10% TBSA (Fig. 6). Of the self-inflicted burns the majority were in the 11–20% TBSA range. However, the larger surface area burns (>70%) are mostly self-inflicted.

3.5. Site of burns

The location of petrol burns in descending order of frequency was 26% arms, 23% legs, 20% head and neck, 17% trunk, 11% hands, 2% respiratory, 1% genitalia, <1% eyes (Fig. 7).

3.6. Surgery

There was no change in the frequency of surgery over this period, with approximately half of the patients requiring skin grafting.

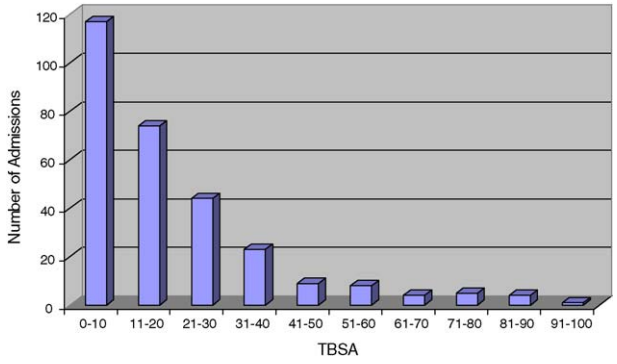

Fig. 6. Total body surface area of petrol burns.

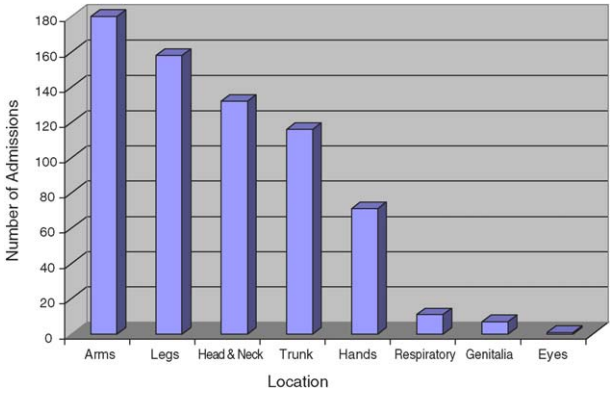

Fig. 7. Location of petrol burns.

3.7. Duration of admission

The average length of stay was 18.7 days for patients with petrol burns, which is significantly longer that of burns patients as a whole. The average length of stay for burns patients during the year 2000 was 9.81 days, as compared to 3.89 days on average for other surgical patients.

3.8. Mortality

Petrol burns were associated with a 4.8% mortality rate (c.f. 3.6% overall mortality from all causes of burns [3]) with 76.9% of deaths from petrol burns being the result of self-immolation.

4. Discussion

This study focuses on the epidemiological pattern of adult burns caused by petrol. Previous studies have reported an incidence of petrol burns varying between 14.5% and 23.3% [1,2,4]. In the 10 years of this study 14.3% of burns admissions were petrol related. The number of patients admitted each year with petrol burns, and their age and sex distribution did not change significantly over the 10-year period. This phenomenon has been noted by other authors in the past [1]. These findings indicate that there has been no change in community awareness of the potential dangers of petrol over the past 10 years.

A significant difference was found between the number of males and females with petrol burns as has been described by other authors [1,2,4]. Males accounted for 88.6% of the patients with petrol burns, compared with 73% of all burns patients. In males the age distribution peaked between 16 and 25 years, accounting for 41% of males with petrol burns. As there was such a preponderance of male subjects the overall age distribution also peaked in this age group. The female age distribution peaked at 21–30 years. The male to female ratio for petrol burns is 7.8:1, however, in the 16–20 age group the ratio is 19:1. Young males are therefore the major risk group.

The causes of petrol burns were categorised into four groups of blame: human error, accidental, intentional and others. The majority of petrol burns were the result of human error (51%), 28% were attributed to true accidents, 14% were intentional and 7% were of unable to be determined. Human error included use of petrol as an accelerant (35%), inappropriate petrol storage (10%) and use of petrol as a solvent (5%). The figure of roughly half of all burns being attributed to inappropriate use of petrol is similar to previous studies [1,2,4]. Burns sustained from refuelling engines were classed as accidental in our study. However, in some cases refuelling a hot engine could be viewed as unsafe. Barillo et al. [2] classified all vehicle associated burns into safe and unsafe practices, and found that 63.4% of 'appropriate' uses of petrol were unsafe. Carburator priming is a practice which has been previously studied as a preventable cause of petrol burns in the USA [5] as have lawnmower related burns [6]. Both inappropriate and unsafe (previously believed to be 'appropriate') causes of petrol burns would be key features of a prevention/education programme. Intentional burns comprised self-inflicted burns (10%) and arson/assault (3%). There was no significant difference in the nature of the petrol burns from year to year over the study period.

Forty-one percent of all patients in the study sustained burns of $\leq$10% TBSA. The mean burn size was 19.9% TBSA, which is less than the 29.8% and 25% reported by Barillo et al. [2] and Williams et al. [4], respectively. There is an element of bias in all these studies, including ours, in that the data only includes inpatients. It is possible that there are greater numbers of minor petrol related burns which are treated in the community or as hospital outpatients. Wilson and Bailie [1] who included outpatients in their study found the average TBSA was 10.5% with over half being 5% or less, and often there was only a superficial flash burn. As in previous studies the larger percentage body surface area burns were accounted for mostly by self-immolation and industrial accidents [1,2].

The sites most commonly affected by petrol burns were the arms, legs, head and neck. This is similar to the distribution found by Williams et al. [4] and is logically explained by the usual mechanism of injury in which the patient is usually bending into the petrol fumes when they ignite, or holding a container of petrol.

The duration of admission for petrol burns was 18.7 days. This is comparable with Williams et al.'s [4] figures of a mean length of stay decreasing from 38 to 17 days during their study period. The average length of hospital stay (1970–1975) for all burns was 22.9 days and the average hospitalisation for all patients in the Royal Brisbane hospital was 8.3 days (for financial year 1972–1973) [7]. The duration of admissions have markedly decreased over the past 20 years with the average length of stay for burns patients during the year 2000 was 9.81 days, and the average stay for a surgical patient was 3.89 days. However, over our 10-year study period the average length of stay remained similar, and was twice the average length of stay for burns patients in general. The fact that patients with petrol burns require longer than usual admissions also makes them an important group to target for prevention. The numbers of patients requiring surgery for debridement and grafting remained roughly half over the study period, and surgery tended to correlate with the larger TBSA burns.

Petrol burns were associated with a 4.8% mortality rate, which was higher than the average burn patient mortality of 3.6%. Mortality was associated with large TBSA burns and 10 of the 13 deaths were the result of self-immolation. Of these deaths eight were due to extensive burns (average 73% TBSA), and two deaths were due to associated carbon monoxide poisoning. Our mortality rate was slightly better than the 6.3% mortality quoted by Williams et al. [4] who found that the mean TBSA of patients who died was 74%.

5. Prevention

Severe burns injuries produce a heavy burden on health care resources, in addition to costs to the community in terms of years of productive life lost. The majority of petrol burns were due to human error and thus theoretically preventable. It is important to identify populations at increased risk in order to focus interventions to decrease the incidence of these injuries. Prevention requires an integrated approach drawing on the resources of government, schools, and the health system. It can be broken down into three aspects: host (person at risk), agent (petrol), and environment using the public health model [8].

This study determined that the young male (aged 16–25) is most at risk, mainly through the misuse of petrol. The best method of prevention of these burns would be education targeting this group of population. However, this age group is one of the most challenging to address as there is an underlying apathy and complacent attitude 'that it will never happen to me'. Young males often have easy access to petrol (i.e. motor vehicle repairs, lawnmowers), and are well known to be a group who engage in risk taking behaviour. Decreasing the accessibility of petrol to this group would likely be an effective, but unfortunately impractical, method of preventing petrol burns. Attempting to change behaviour is one of the most challenging areas in preventative medicine, however, education aimed at school age children may be successful. Such an education programme would need to focus on the appropriate and safe use of petrol (i.e. motor fuel only), as well as it's potential hazards.

Unfortunately, petrol is widely available and there is no restriction on its use. Legislation on the usage of petrol would be impractical. However, warning labels about the danger of petrol and the appropriate use of petrol could be printed on the petrol container. The inclusion of these precautions in a prominent position in clear writing of a different colour should become mandatory. Also, all machineries that use petrol, for example lawnmowers, should similarly have the precautions displayed. Instructions

in refueling of these machineries should be emphasized. Finally, the work place where petrol is used should have routine safety session on the proper handling and use of petrol. Again, warning labels about the danger of petrol should be prominent. Other environments such as camping site, where petrol could be used as an accelerant should also have warning sign in prominent position to discourage the inappropriate use of petrol.

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