Review Article

Burns Caused by Hand Sanitisers: The Trail of a Collateral Damage Left Behind by the Covid Pandemic

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ABSTRACT

Background: The current COVID-19 pandemic has changed human lifestyle to follow COVID-19 Appropriate Behaviours (CAB) and that includes social distancing, and the use of masks and sanitiser for hand hygiene. With increased use of sanitiser; the incidence of burns due to sanitiser has been reportedly on the rise. The study analysed the reported burn incidences due to sanitiser, found the relation between sanitiser and the aetiology of burn and formulated guidelines for its safe use. The authors also suggested Do's and Don'ts to prevent and manage sanitiser burns.

Methodology: An online search was made to search the articles related to sanitiser burn targeting the words 'sanitiser', 'hand sanitiser', and 'burns and burns injury'. A general Google search was also made to look for any news reported in electronic media for sanitiser burns.

Result: A total number of 10 scholarly articles mentioning 95 cases were found satisfactory to fulfil the inclusion criteria. Most of the cases were flame burns due to the ignition of alcohol-based sanitiser (n=92, 98%) either by mistake or while lighting the flame for cooking or cigarette for smoking. In all cases, it was found that alcohol-based sanitiser was the agent causing burns which were more due to gel form. 61 patients were managed on an outpatient basis whereas 33 patients required admission.

Conclusion: Increasing use of sanitisers can be related to increased incidence of burns. Its safe use is warranted with proper guidelines.

KEYWORDS
Alcohol based sanitizer burn; Hand sanitizer; Burn injury; Sanitizer burn; Burn prevention

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INTRODUCTION

The recent pandemic of Covid-19 has changed the lives as well as lifestyles of all of us across the globe. We learnt slowly but surely the importance of social distancing, maintaining proper hand hygiene and wearing masks for our own protection as well as for that of others. Pharmaceutical products, like hand sanitisers, which were so far being used in hospitals and clinics by healthcare professionals, suddenly became a common daily consumable to the population.
While sanitisers had been an effective mechanism of breaking the cycle of transmission, and we are slowly recovering from the aftermath of the

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pandemic, as we go through the reports we come across another entity which increased significantly as collateral damage- sanitiser-related burn injuries. Even now as we are coming out of the trauma of the pandemic, new strains of the deadly virus emerging and news of isolated pockets of outbreaks are being reported intermittently from across the world. It appears that the use of hand rubs and hand sanitisers is likely to be a part of our lives for the days to come. Apart from efficacy, the safety of such solutions is now brought into question with a rising number of incidents reporting chemical burns due to sanitiser solutions as well as fire incidents due to alcohol-based sanitisers catching fire. Therefore, the safe use of hand sanitiser is mandatory and a guideline, in order to prevent burns due to sanitiser is laid down by FDA[1]. The authors also aimed to describe the Do's and Don'ts after sustaining burns due to hand sanitiser based on the analysis.

METHODS

An online search was made on PubMed, Google Scholar, and ScienceDirect with targeted search words "sanitiser", "hand sanitiser", "alcohol sanitiser burns", "Burns" and "Burn injury" to look for any scholarly article on this subject. A General Google search was made to look for any related news reports or articles in the online media and news portals. However, for analysis, only the scholarly articles were included. The news articles were tabulated in a separate table and not included in the analysis due to the non-reliability of such mass-media articles. All the data were analysed with the aim to find out any correlation between using specific sanitiser and the risk of burns, assessing the flammable properties of different hand sanitisers and formulation of guidelines for their safe use and to avoid such burns.

Inclusion criteria

All cases reported with the above search words were read and analysed and relevant cases were recorded and tabulated in a table.
Cases with chemical burns due to sanitiser or its components were also included.
Accidental burns or chemical burns due to wrong labelling or mixing of other chemicals with hand sanitiser were also included.

Exclusion criteria

Articles that contained the word "burning sensation" "burning pain" or "burning"; that on analysis were found to be due to skin irritation rather than clinical burns, were excluded. The following conditions were excluded from the present analysis-

- Skin hypersensitivity due to sanitiser or its components
- Irritant contact dermatitis due to sanitiser
- Incidents due to ingestion of hand sanitisers

Also, articles that were in any language other than English were excluded.
Newspaper reports, although tabulated, were excluded from the final analysis.
All the cases reported in scholarly articles were tabulated in a consolidated table (Table 1). Newspaper articles reporting hand sanitiser burns injuries or fire accidents were tabulated separately (Table 2). The basic demography and pattern of injury were studied. The age distribution and sex predilection were noted. The nature of injury (chemical burn/flame burn due to ignition of the flammable contents of hand sanitiser) was analysed and severity (degree of burns) was noted if reported. The percentage of burns, wherever available, was noted down. Fatal events (death, loss of vision, loss of hearing or loss of body parts) were tabulated and requirements of hospital admission, need for intensive care and duration of hospital stay were analysed wherever reported.
The type of sanitiser was analysed according to the composition (components, percentage of alcohol) and we tried to find if there is any correlation between any particular component and percentage of alcohol to the severity of the injury.
The contact time of the sanitiser, if mentioned, was also noted and analysed to find any correlation with the severity of the injury, especially in cases with chemical burns.

RESULTS

A total of 10 articles reporting 95 cases were found to fulfil the inclusion criteria. Of these, 3 cases occurred in the pre-Covid era and 92 cases in the Covid and post-Covid eras. The majority (n=92, 96.8%) were flame burns and only 3 cases reported were chemical burns. Of the total 95 cases, 63 were

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Table 1: Epidemiology of hand sanitizer burns (scholarly articles)

Sr. no.	Authors	Place	No. of cases	Pre/post covid	Type of burn	Age/sex	%TBSA burn	Fatal/ grave events	Hospital stay	Type of sanitizer
1	Amjadi et al	Australia	1	Pre	Flame	33/m	>2% 2nd & 3rd degree	Debridement under GA	Yes, 4 days	Gel sanitizer, 66% methanol
2	O'Leary et al.	UK	1	Pre	Flame	40/f	Approx. >2%, 1st degree		No	Alcohol gel sanitizer
3	Hohl et al.	Brazil	6	1 pre, 5 post	Flame	Unknown	9- 40%	Debridement & STSG in 3 cases	Yes	
4	Sunny Au	Hong Kong	1	Post	Chemical	32/f	Ocular injury	Temporary vision loss		Alcohol gel sanitizer
5	Rodriguez et al.	Spain	1	Post	Chemical	3/m	Ocular injury	Temporary visual loss		62% alcohol gel sanitizer
6	Lee et al.	Korea	1	Post	Chemical	5/f	Ocular injury	Corneal injury, symblepharon	Yes. 3 weeks	Gel sanitizer
7	Dahmardehei et al.	Iran	76	Post	Flame	2-87 75% male	4%-36%	3rd degree burn in 15.8%	Yes. 2-37 days	-
8	Swaminathan et al.	India	3	Post	Flame	34-53 2 Males, 1 female	28%-60%	Inhalational burn in 2 cases	10 days	-
9	Gupta et al.	India	4	Post	Flame	10-30 1 Male, 3 females	25%-70%	1 death, 2 cases needed debridement and STSG	Yes.	-
10	Murphy	USA	1	Post	Flame	23/m	62.5%	Multiple surgeries	Yes. 41 days	-

Male, 26 were female and gender was not mentioned in 6 cases. The age of the victims ranged from 2 years to 87 years (mean= 28) with age not mentioned in 6 cases.

Only one burn injury was mentioned to be of 1st degree. Burn depth was not mentioned in other cases. The percentage of flame burns ranged from about 2% to 70%. Most of the cases (n=92, 98%) involved flame burns due to the ignition of alcohol-based hand sanitiser, either inadvertent or intentional. 3 burns were ocular chemical burns.

The reported fatal events were death in one case, temporary loss of vision was reported in two cases with corneal injury due to a chemical burn recovered with treatment, and persistent symblepharon in one case. The inhalational injury was reported in 2 cases. Sixty-one cases were mentioned to be managed on an outpatient basis without hospitalisation, 33 cases required hospitalisation, and in one case it was not mentioned whether the patient was admitted or managed on an outpatient basis. Of the admitted patients with flame burns, 21 patients required surgery in the form of Debridement with or without skin grafting. This amounts to 22% of the total patients. Of them, one patient is mentioned to have undergone multiple (total 5 procedures) surgeries. The hospital stays ranged from 2-41 days. (hospital stay duration not mentioned in 4 cases)

In all the cases it was clearly mentioned that the sanitiser was alcohol based. However, the exact composition was not mentioned. Five incidents involved the gel form of the sanitiser. In all 3 cases of chemical burns, gel sanitisers were implicated. In all other cases, the exact form of sanitiser was not mentioned. The compositions mentioned in the reports were 66% methanol in one case, and 62-70% ethanol in 3 cases. There was no mention of the exact contact time in any of the incidents reported.

DISCUSSION

The last few years have been a trying time for mankind. With the pandemic wreaking havoc on the populace, there is fear and panic among the people trying to steer clear of the disease. The three basic rules of hand hygiene, social distancing and proper masking are widely advised and accepted norms in the prevention of covid infection. The first and most important step in prevention is hand hygiene. While thorough hand washing up to the elbow maintaining the six steps of surgical hand-washing using a soap solution was traditionally considered the best and most effective measure, WHO guidelines have recommended adopting alcohol-based hand rubs as the gold standard for hand hygiene in health care way back in 2009 [2].

Hand sanitisers are more popular due to ease of application, lesser time was taken than formal hand-washing and comparable efficacy in surface sanitization.

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Table 2: News articles with hand sanitizer-associated burns/ fire accidents

Sr. no.	Place	Year	No. of cases	Pre/ post covid	Age/sex	Type of Burn	% TBSA	Fatal events	Hospital stay	Type of sanitizer
1	Oregon, USA	2012	1	Pre	11/f	Flame	Approx 15%	-	Already hospitalised pt	Ava Gard-D,
2	Boston, USA	2017	1	Pre	8/m	Flame	15%		Yes	62% ethyl alcohol
3	Haryana, India	2020	1	Post	44/m	Flame	35%		Yes	62% ethyl alcohol
4	Singapore	2020	1	Post	-/f	Flame	Approx 10%			
5	Connecticut, USA	2020	1	Post	50/m	Inhalational injury		Death	No	
6	New Jersey, USA	2020	4	Post	Around 10 years/ all male	Chemical injury			Yes (one boy)	Spray sanitizer
7	Netherlands	2020	8	Post	Unknown	Chemical injury (inadvertent mixing of unknown cleaning fluid with disinfectant)	Approx 4%		No	
8	Texas, USA	2020	1	Post	-/f	Flame (attempted to light a candle after rubbing hand sanitizer)	18%, 2nd & 3rd degree	ICU admission	Yes	62% alcohol
9	Maritime journal of UK, Netherlands & Switzerland	2020	1	Post	-/m	Flame (touching metal surface with gel sanitizer on hand- build up of static electricity- invisible flame	4%, 2nd & 3rd degree			Gel sanitizer
10	Millis, USA	2020	1	Post	-/m	Flame (hand sanitizer thrown into fire pit- clothes catch fire)	Approx 18%, 3rd degree	Debridement and STSG	Yes, 7 days	
11	Ohio, USA	2020	1	Post	6/f	Flame(playing with sanitizer- caught fire when lighter used by another child	Approx 5%		Yes	
12	New Zealand		1	Post	3/m	Chemical(hand sanitizer with foot paddle dispenser)		Loss of vision left eye	Yes	Spray sanitizer
13	Chennai, India	2021	1	Post	50/m	Flame(lit cigarette after applying sanitizer)	Approx 30%		Yes	
14	New York, USA	2021	1	Post	29/m	Flame(caught fire from police taser after dousing himself with hand sanitizer)	-	Death	40 days in ICU	
15	Washington, USA	2021	1	Post		Flame (Car exploded after lit cigarette with hands cleaned with sanitizer)			No	
16	Texas, USA	2022	1	Post	12/m	Flame (science experiment by school teacher gone wrong)	Approx 2%, 3rd degree		Yes	
17	Oklahoma, USA	2022	-	Post	-	Manufacturing building caught fire	-	No casualty		
18	Texas, USA	2022	-	Post	-	Warehouse with bottles of sanitizer caught fire		No casualty		
19	Los Angeles, USA	2023	-	Post	-	Piles of pallets of sanitizer caught fire		No casualty		

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Hand sanitisers are usually alcohol-based. The usual components are alcohol, hydrogen peroxide and glycerol. Some additives for colour or perfume or some gelling agents are added in some formulations. Alcohol is the main active ingredient in sanitiser formulations. Either ethyl alcohol or isopropyl alcohol can be used. Hydrogen peroxide is not an active substance for hand antisepsis. It is used to inactivate contaminating bacterial spores. Glycerol is used as a humectant. Some non-standard formulations use methanol instead of ethanol or isopropyl alcohol. While methanol is not a toxin by itself, after absorption it may be metabolised to form formaldehyde and Formic acid which may cause metabolic acidosis, brain injury, blindness or CVS instability, even though the transdermal route [3].

WHO recommends two types of alcohol-based hand rub solutions based on whether ethanol or isopropyl alcohol is being used. These are named Formulation 1 and Formulation 2 [4]. WHO does not recommend any gelling agent in any of its formulations, however, adding viscosity enhancer excipients like carbomers of various cellulose compounds makes the formulation thicker, thus less prone to spillage and evaporation with reportedly better tolerance[5]. The gel formulations are easy to use and due to less evaporation stay longer on the skin. While this definitely adds up to its sanitizing potential, at the same time adds up to more risk of burn also. Use of a trivial fire source like a cigarette or matchstick may cause a fire if the gel has not evaporated completely from the surface as is reported in a case by O'Leary [6]. In chemical burns also, due to prolonged exposure to the gel formulation, damage appears to be more, as mentioned by Sunny et al in a case of ocular chemical burns where the viscous gel in the fornices resisted wash by standard saline irrigation, hence causing prolonged symptoms [7].

The components of the WHO formulations are as follows-

REAGENTS FOR FORMULATION 1:
- Ethanol 96%
- Hydrogen peroxide 3%
- Glycerol 98%
- Sterile distilled or boiled cold water

REAGENTS FOR FORMULATION 2:
- Isopropyl alcohol 99.8%
- Hydrogen peroxide 3%
- Glycerol 98%
- Sterile distilled or boiled cold water

WHO also made recommendations about the exact percentage of each of these components in the formulations and also set up guidelines for local production [2]. The final concentrations of the components in the finished products as per the guidelines are,

Formulation 1:
- Ethanol 80% (v/v),
- Glycerol 1.45% (v/v),
- Hydrogen peroxide 0.125% (v/v)

Formulation 2:
- Isopropyl alcohol 75% (v/v),
- Glycerol 1.45% (v/v),
- Hydrogen peroxide 0.125% (v/v)

As we see, the alcohol percentages in the recommended formulations range from 75-80 %. While most of the sanitisers mentioned in the incidents mention an alcohol percentage ranging from 61% to 70%. Leaving apart the question regarding efficacy at a percentage lower than 75%, it still raises a concern regarding the lack of standardization among the manufacturers. Also, one incident reports the use of 66% methanol, which is not a recommended alcohol solution. However, the WHO-recommended formulae failed to show efficacy as per the European guidelines for surgical hand disinfection in 5 minutes[8]. Therefore, some modifications of the formulae were suggested with a lesser percentage of glycerol as it was shown that glycerol significantly decreased the bactericidal property of the hand rub formulations [9]. The modified formulation has shown to be efficacious in its virucidal property against enveloped viruses including SARS-CoV-2 [10]. Golin et al suggested that commercially available hand sanitisers in adequate volume should be effective against an enveloped virus-like SARS-CoV but suggested further research [11]. The WHO guidelines also clearly mention the flash points of both alcohol formulations. The flash points of ethanol 80% (v/v) and isopropyl alcohol 75% (v/v) are 17.5°C and 19 °C, respectively [2].

Changing the percentage will alter this flash point, thus increasing the risk of fire. A flash point of 49°C centigrade at 10% concentration of ethanol, it drops down to only 17 °C at 96% concentration[12]. So, at a higher concentration, even minor sparks may cause a significant fire hazard.

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Table 3: Ten-point guidelines and recommendations for safe use of sanitizers

		Safely sanitize: the dos and don'ts and the knowhow
1	Effectiveness of the time-tested hand-washing	Hand Sanitizer is useful and mandatory for maintaining hand hygiene in order to prevent the transmission of infection esp. during the Coronavirus pandemic. But hand washing is also an effective and time-tested tool which should be encouraged.
2	Proper labelling of bottles and containers	Do not store sanitizer in an unmarked bottle which can be mistaken as other liquids and may spill over the body to catch fire if coming in contact with any ignition
3	Proper display of the "flammable" sign	All sanitizer bottles should clearly mention the flammable properties of alcohol-based sanitizer.
4	Extra precaution for at-risk groups	All at-risk groups and individuals like health care workers, smokers, children and individuals working from home due to lockdown should be aware of the risk of catching fire while coming in contact with fire immediately after the use of hand sanitizers.
5	Gel-based sanitizers = more time to evaporate= do take more time	When using Gel based sanitizer, one should wait for a certain period before coming in contact with fire like lighting a lighter or matchstick or using electrical appliances.
6	Precautions and protocols in the manufacturing units	All companies manufacturing sanitizer should have adequate precautions and primary aid facilities for workers involved in manufacturing.
7	Public awareness	Public awareness programmes should be conducted by NGOs and Burn care professionals for the general population about its safe use.
8	Know about the alcohol content and storage of the sanitizers	Higher the concentration of alcohol, the lesser the flash point (at 80%- 17.5 degrees C and at 75 %- 19 degrees C). Most commercially available sanitizers are recommended to store in a dry, dark place at room temperature of less than 25 degrees C
9	Home care for minor injuries	Minor burns can be treated at home under the guidance of a burn care specialist during the pandemic. Tele-consultancy is a boon.
10	Hospital care for major injuries	Major burns should be admitted in burn care centre and be treated accordingly by burn surgeons.

Comparing all literature available, it is evident that during covid-19, most of the incidence occurred either at home in the kitchen catching fire or workers came in contact with electricity or engaged in smoking by using a lighter after using sanitiser. Diogo et al identified 5 cases of burns during covid 19 quarantine and have alerted there could be an increased incidence of ethyl alcohol burns [13]. They also stressed that due to home quarantine or lockdown, people are engaged in more kitchen activities or barbeque, thus most of the burn took place in the kitchen. Swaminathan et al., in their mini-series of 3 cases reported that all 3 cases occurred in the kitchen[14]. Various epidemiological studies have found that kitchen burn is most compared to others in overall burn occurrence [15]. However there has been an increased incidence of burns among children due to the closure of schools and staying at home. They found more so due to scalding burn [16]. The authors believe that children are more susceptible to sanitiser burn if not supervised. So, those high-risk groups should be identified and the fire safety department administration, NGO and other stakeholders should make them aware of the safe use of sanitiser before going in contact with fire. Another alarming trend that emerged is that of misuse of these alcohol-based hand sanitisers. Although the number of cases is very low; there are reports stating sanitisers are being used to commit suicide and worse, homicide by dousing clothes with sanitiser and then igniting them [17]. In one extreme case reported by Murphy, there was a severe burn of 62.5% in a young Male after using sanitiser on his body for fire performance for recreation [18]. Now that we are coming out of the crisis situation of the pandemic, such misuses are likely to rise, especially with piled-up stocks of sanitisers that remained unused. In fact, if we consider the very recent news articles, we see there are massive fire accidents due to the ignition of stocked-up piles of sanitisers in different places (Table 2).

Also because of the lockdown and home isolation, it will be difficult for the patients to access specialized burn care facilities. So most minor burns can be treated at home by initially pouring water over the burn and by conventional dressing with the help of tele-consultancy which has emerged as one of the boons during the lockdown period for many patients [19,20]. However, for major burns, burns at special sites and increased thickness it is advisable to get admitted to the burn unit and treated accordingly [17]. Various authors have suggested ways to prevent this type of injury. Education of the public is definitely the most important among them. Mass media

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awareness campaigns are recommended [14,17,21]. Also, some engineering and manufacturing modifications like bottles with droppers and plungers that can dispose of only a small amount at a time, tightly capped containers, proper labelling of the contents and fire hazard warning- these things may help prevent such incidents. The authors propose the guidelines for safe use of sanitiser in order to avoid burn at home isolation and at the workplace (Table 3).

Limitation of the study: There are few literature and data published from specific burn units about the incidence of sanitiser burns which could be more useful in detailing of extent and depth of burns along with exact epidemiology. Data published in the newspaper may not reveal the true picture of burns and would not be assessed by a burn care specialist, although it gives a basic idea that sanitiser could catch fire and its safe use is warranted. However, a multicentric study is required to detail the epidemiology of sanitiser burns across the globe.

CONCLUSION

Hand sanitiser is one of the most effective methods to maintain hand hygiene, during the covid-19 pandemic and also thereafter. Its safe use is warranted otherwise it can lead to increased cases of sanitiser burn. The fire safety authorities and sanitiser manufacturing surveillance agencies should guide the manufacturers to mention the flammable properties of hand sanitiser over sanitiser bottles and their safe use. Users should wait for some time after using sanitiser before going near to ignition temperature. Burn care specialists should utilise tele consultancy to treat most of such minor burns for home-isolated patients and patients at home during the lockdown period and for those who have difficult access to healthcare due to increased covid cases (if any in future). The major burn should be admitted and be treated according to its severity, increased extent and depth and special sites.

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CONFLICT OF INTEREST

None -declared.

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