Three-year epidemiology of hospitalised paediatric burn patients in a Malaysian Tertiary Hospital 2016 – 2018

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ABSTRACT

Introduction: Burn injuries incur not just significant morbidity but also long-term psychosocial impact. This study aims to identify the clinico-demographics of children hospitalised for burns and factors associated with prolonged hospitalisation.

Materials and Methods: Written medical records of burn patients admitted to the Sultanah Aminah Hospital paediatric surgical ward, from January 2016 to December 2018, were retrospectively reviewed. Details on the patients' socio-demographic background, burn injuries, management and outcomes were recorded and analysed with logistic regression.

Results and Conclusion: Of the 255 children included in the study, the majority were males (62.7%), children aged between 1 to 3 years (43.1%), and of the Malay ethnic group (83.1%). The commonest injury mechanism was scalds burns (81.2%). Staphylococcus aureus remained the commonest organism cultured from paediatric burn wounds. Most patients (66.4%) were hospitalised for less than 1 week. A significant number of patients experienced complications from their injuries. Multivariate analysis showed burns affecting total body surface area > 10% (adjusted OR, 13.45 [95% CI 6.25 - 28.96]; p = < 0.001) and non-scald burns (adjusted OR, 2.70 [95% CI 1.12 - 6.50]; p = 0.027) were the two main factors associated with prolonged hospitalisation of more than 1 week. These findings describing the epidemiology and outcomes of paediatric burn cases in a tertiary centre in Malaysia may inform future practice. More importantly, the information may contribute to the identification of at-risk populations and advise the development of effective prevention strategies to reduce the incidence and morbidity associated with paediatric burns in this region.

KEYWORDS:
Epidemiology, paediatric, burns, Malaysia, prevention

INTRODUCTION

Burns are a significant cause of mortality and morbidity for patients and incur high economic burden on healthcare systems.[1] Burn injuries in the paediatric population are potentially more severe compared to adults as children have several physiological disadvantages, such as thinner layers of skin, less subcutaneous tissue and a larger surface area to volume ratio, which gives rise to increased risk of rapid percentage of fluid loss.[2] It is clear that paediatric burns are largely preventable injuries, as various primary prevention campaigns have been effective in reducing the incidence of burn-related hospitalisation.[3,4] However, the ability to formulate an effective campaign requires the availability of epidemiological data on the various socio-demographic and clinical factors surrounding paediatric burns.

Through our literature search, only three small studies produced epidemiological data on paediatric burn patients in the Malaysian setting. Two out of the three papers included both adults and children, with the most recent study on paediatric burns being published almost 20 years ago in 2002.[5-7] In addition, the total combined number of patients (adults and children) from the three studies only amounted to 379 patients. More recent data is available in the form of a poster presentation, which provided some descriptive statistics on 94 paediatric patients who were admitted into the Malacca Hospital from January 2016 to December 2018.[8] It is clear that epidemiological data with larger sample sizes are needed to inform burns prevention strategies.

This study aims to collect the epidemiological data on the clinic-demographic factors of hospitalised paediatric burn patients from the main tertiary burns referral centre in the Southern part of Peninsula Malaysia in order to identify the parameters associated with the patients. In addition, we aim to determine factors associated with poorer outcomes by using prolonged hospitalisation, defined as hospital stay greater than 7 days, as the measurement tool.

MATERIALS AND METHODS

This is a retrospective observational study. Ethical approval has been obtained from the Medical Research Ethics Committee (MREC) of the Malaysian Ministry of Health (Approval no: NMRR-19-1111-48223) as well as the Monash University Human Research Ethics Committee (MUHREC). All children less than 12 years of age who were admitted to Hospital Sultanah Aminah Johor Bahru for burn injuries from January 2016 to December 2018 were included in this study. This study excluded burn patients treated in the emergency department, outpatient setting and patients with missing medical records. Details on the patients' socio-demographic background, management measures and

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outcomes of each individual burn case, such as demographic factors (age, sex, ethnicity), circumstances surrounding the injury (mechanism of burns, location of burns, provision of first aid), clinical presentation (extent of burns) and outcomes (length of hospitalisation, need for surgical debridement, need for blood product transfusion, need for ICU admission, wound culture results and mortality) were recorded in the case report forms (CRF).

Sultanah Aminah Hospital is the largest referral hospital in the State of Johor and the main paediatric burn referral centre for patients in the Southern region of Peninsula Malaysia. All the patients under 12 years of were managed by paediatric surgeons in the general paediatric surgical unit. Although patients were not routinely screened for methicillin resistant staphylococcus aureus (MRSA) or extended – spectrum beta lactamase (ESBL) organisms, those with known MRSA or ESBL organisms were placed under contact precautions. Burn patients generally receive management in terms of analgesia, dressings and/or fluid resuscitation. The total burn surface area (TBSA) was estimated using the Lund and Browder chart. Patients with TBSA > 10% are automatically given fluid resuscitation using Parkland formula with Hartmann's solution with a goal to maintain end organ perfusion. Adequacy of perfusion and fluid resuscitation was monitored via urine output, mean arterial pressure and occasionally blood gas measurements. Common dressings regimes used at the study centre included the following: silver sulfadiazine, carboxymethylcellulose (CMC), Bactigras™, Jelonet™ or Intrasite™.

Wound swabs, blood cultures, blood products administration and antibiotics administration were not routinely performed unless deemed clinically indicated by the treating consultant paediatric surgeon. Wound swabs were performed in circumstances where the burn wounds demonstrated signs of infection, such as pus or persistent slough. Blood cultures were generally done in patients who developed signs of sepsis. The local practice was for antibiotics to be prescribed in suspected burn wound infections, evidenced by occurrence of fever 3 days after the date of injury. The first-line antibiotic is intravenous cloxacillin, with intravenous ceftazidime and/or amikacin as second-line therapies. In addition, blood transfusions were considered in patients with haemoglobin levels less than 8 g/dL, undergoing debridement procedures or were septic. Patients with burns affecting joint areas, hands or face, severe extensive burns with TBSA > 10% and second- or third-degree burns were referred to the plastic surgery unit for review and consideration of split skin grafting. Patients with extensive burns with TBSA > 10% were also referred for dietetics input for high protein formula and inpatient dietary modifications.

Data was analysed using SPSS® Statistics 26 (IBM Corporation, Armonk, NY). Descriptive statistics were used to present the clinico-demographics of patients. Univariate analyses were carried out to identify possible associations between factors and eventual outcome of burn patients. Binary logistic regression was performed on the factors which produced a significant result to assess the impact of those individual factors on the dependent variable (prolonged hospitalisation defined as stay greater than seven days). Statistical significance was attained when $p < 0.05$.

RESULTS

Patients' Description

All of the patients in this study were aged 12 and below. Records from the Burns Registry on the paediatrics surgical ward showed that a total of 327 patients were admitted between 2016 to 2018. Despite limitations of a paper-based record, 80% of the patient records (255 out of 327 patients) were included while others were excluded due to missing data. Descriptive statistics were derived from the 255 patient records that we have identified, after removing the second and third admissions for those with numerous admissions. From the 255 patients, a further five patients were discharged against medical advice and 14 patients who were transferred in/out to/from other hospitals. After excluding these patients, a total of 236 patients were included in the association analysis to identify factors associated with prolonged hospitalisation to enhance the accuracy of results.

Descriptive Statistics: Clinico-demographic Factors

Data from a total of 255 patients were analysed. Table I shows the statistics for the clinic-demographic factors of the patients.

Gender, Ethnicity, Age Group and Past Medical Conditions

The majority of burn victims were males (n = 160, 62.7%). The breakdown of burn victims by ethnicity are as follows: Malay (n = 212, 83.1%), Chinese (n = 21, 8.2%), Indian (n = 14, 5.5%), others (n = 8, 3.1%). Burn victims were categorised into four different age groups: Infants < 1 years old (n = 62, 24.3%); toddlers aged 1 to 2.99 years (n = 110, 43.1%); pre-schooler aged 3 to 6.99 years (n = 47, 18.4%) and school going aged 7 to 12 years (n = 36, 14.1%). Only 12 patients were noted to have pre-existing medical condition(s), which included Tetralogy of Fallot (n = 1), epilepsy (n = 1), G6PD (n = 2), bronchial asthma (n = 3), unspecified congenital heart disease (n = 1), neonatal jaundice (n = 1), drug allergies (n = 3).

Mechanism of Burns, Location of Burns and Extent of Burns

Scalds were the commonest cause of injury (n = 207, 81.5%) followed by direct flame (n = 27, 10.6%) and contact burns (n = 12, 4.7%). The most common description leading to the scalding episodes describes the behaviour of the child reaching out and pulling onto various objects, such as kettle wires, tablecloths or containers with scald agents. Direct flame burns usually occurred as a result of accidental child contact with burning rubbish or child's play with lighter and/or petrol. Most of the burns occurred indoors (n = 199, 86.9%), while the rest of the burns occurred outdoors. The extent of burns sustained were divided based on their TBSA into the following groups: TBSA 0 to 10% (n = 189, 75.3%); TBSA 10 to 20% (n = 57, 22.7%) and TBSA > 20% (n = 5, 2%). The highest TBSA sustained in a child was 36%.

Patterns of Burns Mechanism in Age Groups

This is highlighted in Figure 1. In the infant group, scald burns represented 95.2% (n = 59) of burn injuries and contact burns represented 4.8% of burn injuries (n = 3). The percentage of scald burns remained at 92.7% in the toddler age group (n = 101), with direct flame burns at 2.8% (n = 3), contact burns are 2.8% (n = 3) and other burns at 1.7% (n = 2). In the pre-school age group, scald burns decreased to

68.1% (n = 32), direct flame burns increased to 25.6% (n = 12), contact burns at 4.2% (n = 2) and other burns at 2.1% (n = 1). In the school age children, scald burns decreased to 41.7% (n = 15), direct flame burns increased to 33.3% (n = 12), contact burns represented 11.1% (n = 4) and other burns represented 13.9% (n = 5).

Provision of First Aid

Half of the patients who sustained burn injuries did not receive any first aid (n = 114, 50.4%). Only one-third of the patients had their injuries under running tap water for a variable duration of time (n = 76, 33.6%). Alternative agents used by caregivers included toothpaste, aloe vera, traditional oil, ointments, soy sauce and cream. One caregiver even placed flour onto the child's wound, while another used egg white as first aid.

Descriptive Statistics: Outcomes

Table II shows the statistics for the various outcomes in our study population.

Duration of hospitalisation

This data was synthesised from a total of 236 patients. The median length of hospitalisation was 4 days (IQR = 8 days). Using 7 days as a cut-off point, one-third of the patients experienced prolonged hospitalisation (n = 80, 33.6%).

Wound cultures

Out of the 255 patients, wound cultures were done on 48 patients. Out of the 48 wound swabs, 24 were positive for organisms. There were nine patients who had multiple organisms cultured from their wounds. A total of four patients cultured drug-resistant organisms (three cases of MRSA, one case of ESBL Escherichia coli) The most common organism cultured was *Staphylococcus aureus* (n = 17). Other organisms include: *Enterococcus sp* (n = 6), *Pseudomonas sp* (n = 3), *Streptococcus sp* (n = 2), E coli (n = 1), *Acinetobacter baumannii* (n = 1), *Enterobacter sp* (n = 1).

Blood culture

Blood cultures were done on 38 patients, of which only four patients had positive results. Two of the patients who were admitted to ICU had consistent organisms cultured from both their blood and wound samples. The first patient sustained TBSA of 36% and had MRSA cultured; whereas the second patient sustained TBSA of 18% and had methicillin-sensitive *Staphylococcus aureus* (MSSA) cultured. The other two patients had the following organisms in the blood culture: *Elizabethkingia meningoseptica* in one patient and combination of *Micrococcus sp.* and *Enterococcus sp.* in the other patient. All the four patients sustained burn injuries from the scalding mechanism.

Wound debridement and blood product transfusions

Approximately one-fifth of the patients required surgical wound debridement (n = 45, 17.6%) whereas only a small portion of the patients required blood product transfusion (n = 19, 7.5%).

ICU admissions and mortality

A total of eight (3.1%) patients required ICU admission for the following reasons: four due to extensive TBSA > 15%, two due to bacteraemia; one due to corneal abrasion; one due to shock requiring central venous line insertion and albumin infusion. The patient who sustained a TBSA of 36% and MRSA bacteraemia was the only patient who required intubation in our study and was intubated for a total period of 18 days. There were no mortalities recorded among the subjects within the study period.

Factors Associated with Prolonged Hospitalisation

The main parameter utilised as the indicator of poor outcome in this study is prolonged hospitalisation. A Chi-squared test for independence (with Yates' Continuity Correction) indicated that the paediatric burn patients with TBSA > 10% are 12.4 times more likely to experience prolonged hospitalisation (OR, 12.46 [95% CI 5.96 - 26.05]; p = <0.001). In addition, children aged more than 3 years (pre-schooler and school going age children) are 2.4 times more likely to experience prolonged hospitalisation compared to infants and toddlers (OR, 2.37 [95% CI 1.34 - 4.19]; p = 0.004). Patients with non-scald burns are also associated with 2.4 times increase in odds of experiencing prolonged hospitalisation compared to scald burns (OR, 2.46 [95% CI 1.24 - 4.89]; p = 0.015).

Given that scalding was the most common mechanism of injury, our team performed further analysis if there were any significant differences in outcomes from scalding from different types of liquid. The scalding mechanism was divided into two categories: plain water scalds and scalds from other liquids (curry, oil, etc). There was no significant association between type of scald fluids and prolonged hospitalisation (OR, 1.00 [95% CI 0.53 - 1.90]; p = 1.000). Other factors such as gender and ethnicity were also not significantly associated with increase in risk of prolonged hospitalisation.

Direct logistics regression was performed to assess the impact of the individual factors on the likelihood that paediatric burn patients would experience prolonged hospitalisation. The model contained three independent variables (age greater than 3, TBSA > 10% and non-scald burns). The full model containing all predictors was statistically significant (p <0.001), indicating that the model was able to distinguish between those who experience prolonged hospitalisation versus those who did not experience prolonged hospitalisation. The model as a whole explained between 24.9% (Cox and Snell R square) and 34.5% (Nagelkerke R squared) of variance in hospitalisation duration, and correctly classified 78.8% of cases. Only two of the three independent variables made a unique statistically significant contribution to the model (TBSA > 10%, non-scald burns). The strongest predictor of prolonged hospitalisation was TBSA > 10% where patients were 13 times more likely to experience prolonged hospitalization than those with TBSA 10% or less, controlling for all other factors in the model (Adjusted OR 13.45 [95% CI 6.25 - 28.96]; p = < 0.001). Patients with TBSA > 10% are associated with higher percentage of antibiotics use (67.7% vs 20.6%), positive wound cultures (58.3% vs 41.7%), bacteraemia (13% vs 6.7%), blood product transfusions (25.8% vs 1.6%), wound debridement (38.7% vs 10.6%) and ICU admission (12.9% vs 0%) compared to patients with TBSA 10% or less, as outlined in Supplementary Table I. Patients who sustained non-scald

Table I: Patient characteristics

Clinico-demographic factors		n (%)
Sex	Male	160 (62.7%)
	Female	95 (37.3%)
Ethnicity	Malay	212 (83.1%)
	Chinese	21 (8.2%)
	Indian	14 (5.5%)
	Others	8 (3.1%)
Age group	Infants (< 1 years old)	62 (24.3%)
	Toddlers (1–2.99 years old)	110 (43.1%)
	Pre-schooler (3–6.99 years old)	47 (18.4%)
	School going (7–12 years old)	36 (14.1%)
Mechanism of burns	Scald	207 (81.5%)
	Direct flames	27 (10.6%)
	Contact	12 (4.7%)
	Others	8 (3.2%)
	Missing data	1
Type of scald fluids	Plain water	133 (64.3%)
	Others	74 (35.2%)
Location of burns	Indoors	199 (86.9%)
	Outdoors	30 (13.1%)
	Missing data	26
Extent of burns (TBSA)	0 – 10%	189 (75.3%)
	10.1 – 20%	57 (22.7%)
	> 20%	5 (2%)
	Missing data	4
Provision of first aid	Not given	114 (50.4%)
	Running water	76 (33.6%)
	Toothpaste	15 (6.6%)
	Aloe vera	3 (1.3%)
	Others	18 (7.9%)
	Missing data	29

Table II: Outcomes of paediatric burn patients between 2016 – 2018

Outcomes		n (%)
Duration of hospitalisation	Prolonged (> 7 days)	80 (33.6%)
	Not prolonged (≤ 7 days)	156 (66.4%)
Provision of antibiotics	Yes	82 (32.2%)
	No	173 (67.8%)
Results of wound culture	No growth	24 (9.4%)
	Positive	24 (9.4%)
	Not done	207 (81.2%)
Results of blood culture	No growth	34 (13.3%)
	Positive	4 (1.6%)
	Not done	217 (85.1%)
Need for wound debridement	Yes	45 (17.6%)
	No	210 (82.4%)
Need for blood products	Yes	19 (7.5%)
	No	236 (92.5%)
Need for ICU admission	Yes	8 (3.1%)
	No	247 (96.9%)
Mortality	Alive	255 (100%)
	Deceased	0 (0%)

burns were 2.7 times more likely to experience prolonged hospitalisation compared to scald burns (adjusted OR, 2.70 [95% CI 1.12 - 6.50]; $p = 0.027$).

DISCUSSION

There remains a lack of universal definition on the age cut-off point for being considered a child. The cut-off points range between 9 to 20 years of age. Our study provides data for patients aged 12 years and below as this was the criteria for paediatrics surgical ward admission for our centre. This cut-off point is consistent with studies previously performed in the Southeast Asian region.[9-11]

Male children accounted for roughly two-thirds of the overall admission, which can be attributed to their risk-taking behaviour.[2] It is not surprising that Malay children accounted for the majority of admissions, as Malays are the ethnic majority in the catchment area. The categorisation of children into various age groups was based on the child's level of education, which age ranges consistent with classification from previous studies to allow ease of data

Table III: Factors associated with prolonged length of hospitalisation

Variables	n (%)	Prolonged hospitalisation > 7 days		Crude OR (95% CI)	p	Adjusted OR (95% CI)	p
		Yes	No				
Gender (N = 236)							
Males	146 (62.9%)	51 (34.9%)	95 (65.1%)	1.13 (0.65 – 1.97)	0.775		
Females	90 (38.1%)	29 (32.2%)	61 (67.8%)	Ref	-		
Ethnicity (N = 236)							
Malay	198 (83.9%)	68 (34.3%)	130 (65.7%)	1.13 (0.54 – 2.39)	0.887		
Non-Malay	38 (16.1%)	12 (31.6%)	26 (68.4%)	Ref	-		
Age (N = 236)							
> 3	76 (32.2%)	36 (47.4%)	40 (52.6%)	2.37 (1.34 – 4.19)	0.004	1.63 (0.79 – 3.40)	0.189
≤ 3	160 (67.8%)	44 (27.5%)	116 (72.5%)	Ref	-		
Burns mechanism (N = 235)							
Non - scalds	41 (17.4%)	21 (51.2%)	20 (48.8%)	2.462 (1.24 – 4.89)	0.015	2.70 (1.12 – 6.50)	0.027
Scalds	194 (82.6%)	58 (29.9%)	136 (70.1%)	Ref	-		
Scald injuries (N = 193)							
Plain water	123 (63.7%)	37 (30.1%)	86 (69.9%)	1.00 (0.53 – 1.90)	1.000		
Non-plain water	70 (36.3%)	21 (30.0%)	49 (70.0%)	Ref	-		
Delayed presentation (N = 156)							
> 2 hours	52 (33.3%)	16 (30.8%)	36 (69.2%)	0.77 (0.38 – 1.57)	0.592		
< 2 hours	104 (66.7%)	38 (36.5%)	66 (63.5%)	Ref	-		
TBSA (N = 232)							
> 10%	52 (22.4%)	40 (76.9%)	12 (23.1%)	12.5 (5.96 – 26 .05)	< 0.001	13.45 (6.25 – 28.96)	<0.001
10% or less	180 (77.6%)	38 (21.1%)	142 (78.9%)	Ref	-		

*p values presented are extracted from the Yates Continuity Correction as it is a 2 x 2 table

Supplementary Table I: Extent of burns (TBSA) vs outcomes

Outcomes	TBSA 10% or less, n (%)	TBSA > 10%, n (%)
Provision of antibiotics		
Yes	39 (20.6%)	42 (67.7%)
No	150 (79.4%)	20 (32.3%)
Wound culture		
Not done	165 (87.3%)	38 (61.3%)
Done	24 (12.7%)	24 (38.7%)
Positive	10 (41.7%)	14 (58.3%)
No growth	14 (58.3%)	10 (41.7%)
Blood culture		
Not done	174 (92.1%)	39 (62.9%)
Done	15 (7.9%)	23 (37.1%)
Positive	1 (6.7%)	3 (13.0%)
No growth	14 (93.3%)	20 (87.0%)
Blood transfusion		
Yes	3 (1.6%)	16 (25.8%)
No	186 (98.4%)	46 (74.2%)
Wound debridement		
Yes	20 (10.6%)	24 (38.7%)
No	169 (89.4%)	38 (61.3%)
ICU admission		
Yes	-	8 (12.9%)
No	189 (100%)	54 (87.1%)

*N = 251

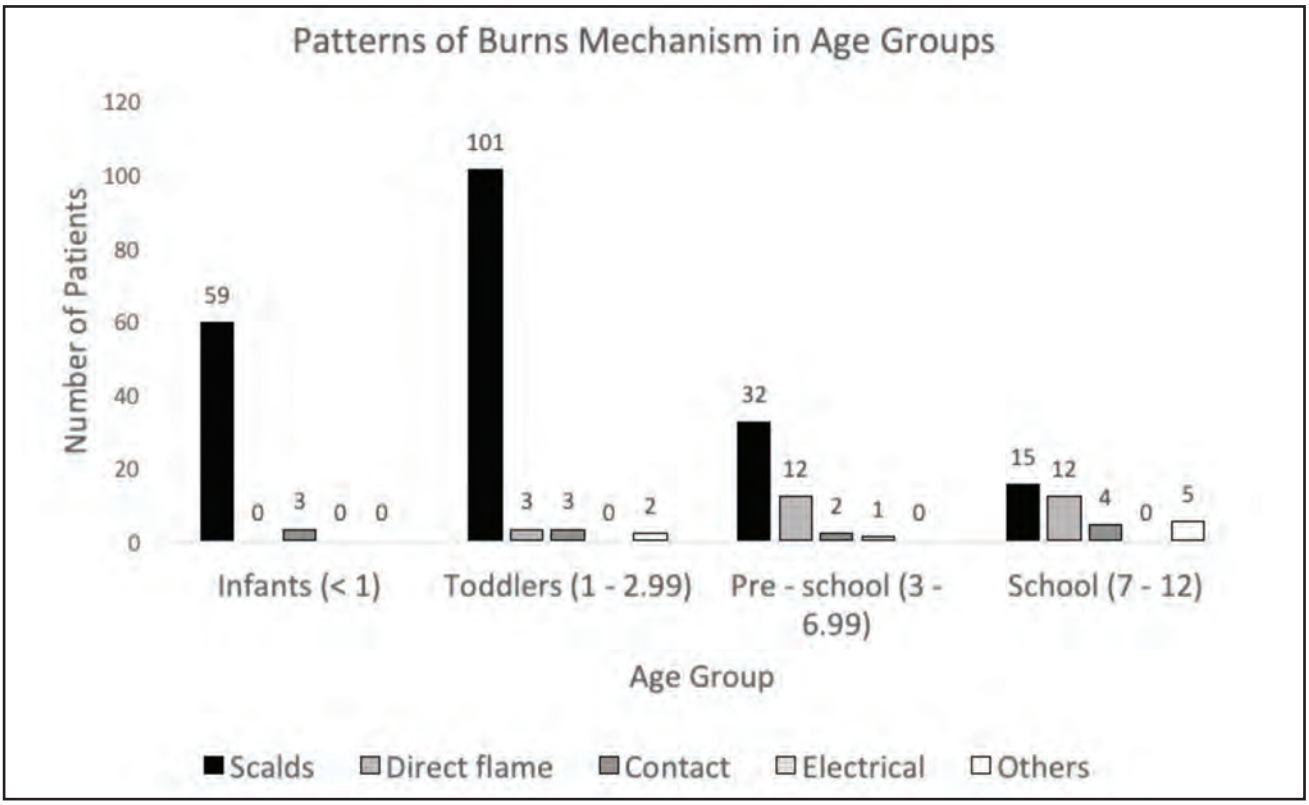

Fig. 1: Patterns of burns mechanism in age groups.

comparison.[7,11-13] Our study found that toddlers (aged 1–2.99 years) were the most vulnerable age group as they represented the highest number of admissions.

Various data uncovered in this study would be crucial in the development of an effective burn prevention campaign. Our data confirms that scalding remains the main mechanism of burns injury among young children, with most injuries occurring at home.[2,14] This is related to the normal developmental stages of the children, as most of them start to reach for objects and crawl by the age of 6 months followed by becoming fully mobile by the age of 18 months.[15] This tendency for young children to reach out and pull onto objects that cause scalding episodes are crucial intervention points for injury prevention by caregivers. It is also interesting to note that children become more prone to direct flame burns as they approach the school age group. This trend was observed in other studies worldwide and was attributed to fires from children's play.[15,16] Drawing upon paediatric burn prevention measures employed worldwide, examples of prevention strategies to reduce scald and flame burns that are relevant to the local population include short radio messages on burns prevention, raising height of cooking surfaces, safe storage of flammable substances, guarding of open fires and home visits with counselling on home hazards.[17] The introduction of "Child Safe Home" concept with online information disseminated in the local language may be considered.

It is also evident that there is a lack of awareness on the appropriate provision of first aid for burns as only one-third of the children had their wounds under running water post-injury. It is unclear if other alternatives, such as toothpaste, soy sauce and egg white, placed on the wound may potentially aggravate or contaminate the wound further leading to poorer outcomes. However, numerous studies below have proven the effectiveness of immediate running water lavage for burn injuries. Large scale data from the New South Wales Agency for Clinical Innovation State-wide Burn Injury Service showed initial treatment with running water up to 20 minutes was associated with reduction in burn wound depth, wound healing time and graft area requirements.[18] The seven-year study in Taiwan on over 12,000 patients demonstrated proper first aid resulted in a reduction in length of stay for burns with TBSA less than 30%.[19] A small study in Nigeria observed that burn patients who received water lavage as first aid had a 50% reduction in the development of complications compared to those who did not received it (35.3% vs 18.4%).[20] Overall, this highlights the utmost importance of emphasising adequate first aid with at least 20 minutes of running water in any burns prevention campaign. Additional first aid strategies include immediate removal of child from burn source and prevention of hypothermia by wrapping unaffected areas of child in clean dry blankets prior to arrival of the emergency medical services team.[21]

The majority of the paediatric patients (75.3%) who were admitted had TBSA < 10%. This was consistent with various local and international data.[7,11,12,22,23] Comparing our data with the data presented in 1995 by Ibrahim et al based on a tertiary burn referral in the capital city of Kuala Lumpur,

Malaysia, we found that there is a significant reduction in proportion of patients requiring hospitalisation greater than 7days (33.6% in our study vs 49% in Ibrahim et al's study). This improvement in outcome is thought to be attributed to recent advancements in management of paediatric burns and improvements in healthcare infrastructure throughout the years.[24]

Our study also provided some preliminary data on the local bacteriological profile of burn wounds in children. *S. aureus* remains the predominant organism cultured from wounds of our study patients, which was consistent with data from the study by Ibrahim et. al.[7] This is in contrast to studies in Turkey and Iran, where coagulase-negative Staphylococcus sp. was shown to be the main organism.[23,25] In a study conducted in India, Acinetobacter baumannii was presented as the main organism cultured from paediatric burn wounds.[26] This variability in reported organisms suggests that bacteriological profiles of pathogens vary between region to region. The trend in adult burn patients is more predictable, with *S. aureus* and Pseudomonas aeruginosa being the two most common pathogens isolated from overall burn wound samples; whereas Acinetobacter baumannii, MRSA and Pseudomonas aeruginosa were the common organisms cultured from wounds of severe burn victims.[27] 31 It is unclear if this bacteriological trend is similar in paediatric burns. Hence, the data provided by our study may suggest S. aureus as the most common organism implicated in local paediatric burn wound infections. However, this remains to be proven in future studies given that only 48 patients in our study had wound swabs sent for cultures and the possibility of *S. aureus* being a contaminant rather than an infective organism as it is a common skin commensal.

Generally, the mortality rates in paediatric burn patients are rather low worldwide. In Malaysia, Ibrahim et al recorded 1% mortality rate in 1995, whereas a 3-year study conducted between 2016 to 2018 at the Malacca Hospital did not record any deaths.[7,8] Data from Singapore suggested mortality rates of 0.28 to 0.4%, and studies in China and Saudi Arabia provided rates of 0.24% and 0.76% respectively.[10,11,13,16] In a study, which analysed 57 years of paediatric burns data from a single centre in South Australia, it was found that all the children with TBSA < 40% survived, whereas those with TBSA > 40% had a mortality rate of 34%.[32] It is worth noting that studies which included older children up to 18 years of age recorded a higher mortality rate.[26] This could be due to older children having higher risk of sustaining severe burns, especially from flame injuries, where flame injuries were observed to be significant predictors of mortality in numerous studies.[33,34] We were unable to provide the accurate mortality rate for paediatric burns at our centre as none of our patients died during the course of this study.

TBSA > 10% and non-scald burns are the two strongest predictors for prolonged hospitalisation based on data from our study. This corresponds to data presented in known literature on the influence of these two factors on other measures of poor outcomes, such as increased risk of infections and mortality.[26,33-37] This information would be useful in guiding clinicians to triage paediatric burn patients' presentations, provide rapid care and close monitoring for those with TBSA > 10% and non-scald burns. Burn depth is also important in the initial assessment process given that deeper wounds carry higher risk of complications and may require surgical intervention. However, there remains inaccuracies in burn depth approximation even in large experienced burn centres.[21] Hence, it may be more practical for centres to adopt TBSA measurements in favour of burn depth evaluation to guide initial triaging protocols and resuscitative efforts with fluid therapy.

Due to the retrospective nature of our study, there were some limitations such as an inadequate account of additional sociodemographic variables (e. g., family size and income group), clinical data such as burn depth and long-term complications such as scarring and psychological trauma. As this study was based on hospitalised children, the findings may be less applicable to children with milder burns injuries treated in an outpatient setting. This study was conducted on subject prior to COVID-19 pandemic when there were likely changes to the demographics and management approaches adopted by healthcare systems.[38,39] Nevertheless, as we emerged from the COVID-19 pandemic, the study findings are likely relevant to the current post-pandemic population.

CONCLUSIONS

The findings mentioned above provide a recent update on the epidemiology and outcomes of paediatric burn cases based on a single tertiary centre in Malaysia in the pre-COVID-19 era. Data collected on the demography of paediatric burns patients would contribute to the identification of at-risk populations, development of effective prevention strategies and inform clinical practice and research in the future.

AUTHOR CONTRIBUTIONS

C.X.L, R.Z.M.L, S.Y.Q and C.F.N performed the relevant literature search, conceived and designed this retrospective study. Y.Q.K, X.S.L and C.X.L organised rigorous data collection and critical data analysis. C.X.L, Y.Q.K and X.S.L performed the manuscript writing. R.Z.M.L, S.Y.Q, and C.F.N provided conceptualisation, technical support, and proofreading. All authors have read and agreed to all the information and conclusions in the submitted version of the manuscript.

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DISCLAIMER

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DECLARATION OF INTERESTS

The authors declare that there is no conflict of interest.

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