ESTIMATION OF TOTAL BODY SURFACE AREA BURNED - A COMPARISON BETWEEN BURN UNIT AND REFERRING FACILITIES

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DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SURGERY (PLASTIC SURGERY)

UNIVERSITI SAINS MALAYSIA

2022

ACKNOWLEDGEMENTS

It is my pleasure to express my sincerest gratitude and warm appreciation to the following persons who had contributed much in helping me shape and reshape this valuable piece of work.

My deep gratitude goes to Professor Dato' Dr Ahmad Sukari Halim, USM Hospital and Campus Director, who expertly guided me through my graduate education and keep me constantly engaged with my research.

My appreciation also extends to Professor Dr Wan Azman Wan Sulaiman, Consultant Plastic Surgeon, Programme Chairperson & Coordinator of the Reconstructive Science Programme, School of Medical Sciences, Universiti Sains Malaysia for his expert and valuable guidance.

I wish to express my sincere thanks to Miss (Dr) Fatimah Noor bt Mat Johar, Lecturer and Plastic Surgeon of USM Hospital for the unceasing encouragement and support.

Above ground, I am indebted to my family, whose value to me only grows with age. And finally, I acknowledge my husband, Mr (Dr) Yong DJ, who is my champion, for his enduring love, for believing in me long after I'd lost belief in myself.

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LIST OF SYMBOLS, ABBREVIATIONS OR NOMENCLATURE

%TBSA	Percentage of Total Burn Surface Area
ABA	American Burn Association
BSA	Body Surface Area (Calculation is by The Du Bois and Du Bois Formula)
BMI	Body Mass Index (kg/m^2)
ED	Emergency Department
TBSAr	%TBSA calculated from the referring centre
TBSAb	%TBSA calculated by the Burn Unit staff
USM	Universiti Sains Malaysia

Area of burn	Anterior trunk, posterior trunk, upper limbs, lower limbs, face, neck
Mechanism of burn	Flame, flash, scald, contact, friction, electrical, chemical
Depth of burn	Superficial partial thickness, deep partial thickness (deep-dermal) and full thickness burns
Prehospital management	Management prior to referral to Hospital USM Burn Unit
Assessment method	Lund & Browder chart, Rule of 9, Rule of Palm, Others/Not specified
Number of days of hospitalisation	Calculated as number of days regardless of any discharge or home leave in between stay
Referring facilities	All District Hospitals and Private Medical Centres in Kelantan and Terengganu and The Emergency Department of Hospital Universiti Sains Malaysia

ABSTRAK

Pengenalan: Ketepatan anggaran luka kelecuran sangat penting dalam rawatan luka kelecuran akut dan secara langsung mempengaruhi keadaan dan prognosis pesakit. Kajian ini bertujuan untuk mengukur perbezaan TBSA (Total Body Surface Area) luka kelecuran yang dikira oleh staf Unit Rawatan Kebakaran (TBSAb) dan pihak yang membuat rujukan (TBSAr).

Metodologi: Kajian retrospektif terhadap semua pesakit dewasa dan pediatrik yang dirujuk dan dirawat sebagai pesakit dalam Unit Rawatan Kebakaran HUSM (Hospital Universiti Sains Malaysia) dalam tempoh 24 jam selepas kelecuran telah dilakukan dari tahun 2015 hingga 2019. Peratus percanggahan TBSA diambil kira dengan perbezaan antara TBSAb dan TBSAr.

Keputusan: Sebanyak 208 orang pesakit (111 orang dewasa dan 97 orang pesakit pediatrik) telah direkrut dalam kajian ini. Daripada jumlah tersebut, 60.58% dinilai berlebihan, 13.46% diremehkan, 7.69% adalah tepat dan 18.27% rujukan tidak menyatakan TBSAr. Perbezaan %TBSA adalah tertinggi di kalangan pesakit dengan luka bakar yang paling serius, dengan purata 10.80 untuk orang dewasa dan 7.59 di golongan pediatrik ($P < 0.001$). Selang waktu antara rujukan dan penilaian semula serta BMI pesakit adalah tidak signifikasi secara statistik untuk perbezaan %TBSA. Bilangan kawasan terbakar berkorelasi dengan perbezaan %TBSA, dengan perbezaan tertinggi sebanyak 21.50 dalam satu kes yang melibatkan seluruh badan.

Kesimpulan: Terdapat perbezaan yang ketara antara %TBSA dari pihak yang membuat rujukan dan TBSA dari Unit Rawatan kebakaran Hospital USM. Oleh itu, pelaksanaan program pendidikan oleh pakar rawatan luka kelecuran dan persetujuan kaedah universal dalam penilaian TBSA penting dalam mengurangkan percanggahan %TBSA. Anggaran TBSA yang tepat adalah pendorong utama dalam pengembangan alat sejagat untuk anggaran TBSA yang cepat dan tepat meskipun di kalangan kakitangan perubatan yang tidak berpengalaman.

Kata kunci: Luas Permukaan Pembakaran Total (TBSA), Ketidakseimbangan, Penilaian berlebihan, Penilaian kurang

ABSTRACT

Background: Accuracy of burn size estimation is critical in acute burn management which directly affects the patient's outcome and prognosis. This study aims to quantify the discrepancies of TBSA (Total Body Surface Area) calculated by the Burn Unit staffs (TBSAb) and the personnel from the referring facilities (TBSAr).

Methods. A retrospective review of all referred adult and pediatric patients admitted to the Hospital USM (Universiti Sains Malaysia) Burn Unit within 24 hours post burn was performed from year 2015 to 2019. Percentage TBSA discrepancies were calculated the difference between TBSAb and TBSAr.

Results: A total of 208 patients (111 adults and 97 pediatrics) were recruited in this study. Of these, the measurements were 60.58% overestimated, 13.46% underestimated, 7.69% accurate. A total of 18.27% of the referrals had no TBSAr stated. The %TBSA discrepancy was the highest in severe burns with mean difference of 10.80 in adults and 7.59 in paediatrics ($P<0.001$). Time interval between referral and reassessment and patients' BMI were not statistically significant for magnitude of TBSA discrepancies. Number of burn areas involved correlated with the %TBSA discrepancies with the highest recorded discrepancy being 21.50 in whole body involvement.

Conclusion: There was significant discrepancies of TBSA estimation between the referring facilities and that of the Hospital USM Burn Unit. Implementation of educational programs by the burn care experts and agreement of a universal method of TBSA assessment are deemed necessary in reducing the discrepancies. Accurate TBSA estimation serves as an important course for the development of a universal tool for fast and accurate TBSA estimation even in the hands of inexperienced medical staffs.

Keywords: Total Burn Surface Area (TBSA); Discrepancy; Overestimation; Underestimation

CHAPTER 1: INTRODUCTION

1.1 Introduction

Hospital Universiti Sains Malaysia (USM) is a tertiary centre with a dedicated Burn Unit of four beds and the capacity of supporting ventilated patients who require intensive care management. Being a specialised burn centre, we receive burn referrals from the East Coast of Kelantan state and occasionally the neighbouring states such as Terengganu, Perak and Kedah. A five-year retrospective study performed in the Burn Unit of Hospital USM showed 485 burn cases treated both as inpatient and outpatient [1]. Over the years, it is found out that there were pronounced inaccuracies in assessment of TBSA by the referring centres, which may not have put the best use of the available resources.

In the literature, as reported by Harish and colleagues, the tendency for TBSA overestimation occurs in all severity of burn injuries. Underestimations are less frequent but rise with increasing time interval after the burn injury and with increasing TBSA. However, severe burns of more than 20% TBSA are more accurately estimated. The inaccuracies in burn size assessment directly influence the treatment, which may cause over- or under-resuscitation fluid regime and inappropriate referral to specialised Burn Units [2].

Overestimation of TBSA leads to undue fluid resuscitation and therefore result in pulmonary edema, compartment syndrome and an increased need for escharotomy [3]. “Fluid creep” caused by excess fluid resuscitation is associated with abdominal compartment syndrome [4]. It can also result in inappropriate transfers to the Burn Unit, unnecessary consumption of healthcare resources and psychological strains to the patients and their families [5]. Conversely, underestimation of TBSA can lead to inadequate fluid

resuscitation which could result in circulatory collapse and renal failure and ultimately progress to burn shock [6] apart from progression of burn depth, causing increased need for escharotomy, fasciotomy and skin grafting.

Several studies have emphasized the inaccuracies in TBSA assessment by the referring facilities, however, there seems to be inconsistence in the trend for inaccuracy. Some authors have found that smaller burns have a tendency to be overestimated and larger burns a tendency to be underestimated while others have found a general tendency for overestimation in all burn severities.

Most studies, however, do not relate the time frame or have assessed either adult or paediatric populations only [6,7]. Additionally, no studies have examined the correlation between BMI and areas of burn injuries with the accuracy of burn size estimation in both adult and paediatric burn patients.

Calculation of the body surface area is utilised in several clinical aspects, for example dosing of chemotherapy, calculation of glomerular filtration rate and cardiac index as well as burn size estimation. Therefore, the accuracy of the estimated %TBSA and relevant body segments is essential to avoid undesirable clinical implications.

Following burn injury, evaluation of %TBSA and burn depth assessment will determine appropriate fluid resuscitation and wound management. %TBSA estimation plays an important role in the early burn management and is one of the criteria for decision on hospitalisation or outpatient care. According to the World Health Organization (WHO) 2004, criteria for burn injuries requiring hospitalizations include adult with %TBSA greater than 15%, child with %TBSA greater than 10%, any burn in the very young, the elderly or the infirm, full-thickness burn, burn involving special regions, circumferential burn, inhalational injury and those with associated trauma or underlying medical illness [8].

The %TBSA discrepancies between the referring centres and the specialised Burn Units have been reported [2,9,10]. Minor burns tend to be overestimated while larger burns are underestimated [11]. Errors from %TBSA can be potentially lethal and lead to unnecessary ambulance transfers and inconvenience for the patients [12].

The %TBSA is the key for calculation of volume needed for early fluid resuscitation following acute burn injury. Burns over 15% TBSA in adults and 10% TBSA in paediatrics require fluid resuscitation as systemic inflammatory response syndrome (SIRS) is initiated and there is massive fluid shift resulting in burn oedema and burn shock if adequate volume is not given [13]. In fact, the inflammatory response in burns can be worse than that of trauma and sepsis. Burn shock is a combination of distributive, cardiogenic and hypovolemic shock. Therefore, it is imperative to replace the fluid in the intravascular compartment in order to preserve tissue perfusion of vital organs [14,15].

Parkland formula: 4mL x %TBSA x patient's weight (kg) = Total fluid in the first 24 hours, with 50% of total volume given in the first 8 hours and the rest in the next 16 hours [16] although over the years, controversy has been outlined regarding the accuracy of various guidelines [17,18,19]. There are many other formulas in the literature in the aim of providing more precise fluid resuscitation such as the Brooke formula, the Evans formula, the Shriner's Cincinnati formula for paediatrics, the Muir-Barclay formula, the Monafo formula, to name a few [20-23]. In Hospital USM, the Parkland formula is used as a guideline to determine the fluid requirement in the first 24 hours.

The difference between the adult and the paediatric age group in burn size assessment can be seen when the paediatric age group has a lower threshold in starting fluid resuscitation due to different %BSA at their different developmental stages. Chan QE and colleagues have described a tendency of overestimation of %TBSA by mean of

10.5% among the paediatric population [6]. Another study reported of only 60% of paediatric patients referred with TBSA of >10% were similarly assessed as being >10% by the Burn Unit, rendering almost half of the children receiving treatments and transport that may not have been indicated [24]. Reasons are inclusive of simple erythema and the usage of different methods of calculations (Wallace Rule of Nine, Rule of Palm and the Lund and Browder chart). The zone of hyperaemia should not have been included into the TBSA calculation since these are the areas of vessel dilatation induced by inflammatory mediators [6].

The most commonly used methods for %TBSA calculation are the Rule of Nine, Rule of Palm and the Lund and Browder chart, in which all of them utilise the BSA with no variations made according to the body weight. In obese patients, it is found that the Du Bois and Du Bois formula underestimated the BSA in obese patients by 20% [25]. Furthermore, individuals with higher muscle composition may mistakenly be classified as overweight or obese as the BMI does not distinguish between the weight of muscles and fat [26]. Hand surface area reduced remarkedly as BMI increased and is found to be more evident in women, particularly those with a BMI greater than 31 kg/m^2 in which the hand surface area represented only 0.64% [27].

The %TBSA of patients with more areas of burn injuries also pose more difficulties to the healthcare providers in calculation and estimation, causing more %TBSA discrepancies. In both the Rule of Nine and the Lund and Browder chart, the area of the trunk lacks sufficient landmarks for precision whereas the hands, feet and head are too small to enable precision in recording [28].

The purpose of this study is to compare the estimation of TBSA by the referring hospital or the emergency departments (TBSAr) and that of the Hospital USM Burn Unit (TBSAb) in both adult and paediatric burn patients requiring treatment or transfer to a

specialised Burns Unit. Additionally, we seek to determine the extent of any differences, quantify the degree of concordance between the two burn size area assessments and elucidate the effect of body mass index (BMI), time following burn injuries and number of burn areas on TBSA assessment and the outcomes such as duration of hospital stay and the need for surgical operation.

1.2 Objectives

1.2.1 General Objective

To compare the burn size estimation by the referring centres or emergency department (ED) with the %TBSA calculated in the Burn Unit of Hospital USM, Kubang Kerian.

1.2.2 Specific Objectives

1. To compare the discrepancy of %TBSA between the referring centres and the Hospital USM Burn Unit in adult and paediatric patients.
2. To determine the association between the discrepancy of %TBSA in minor, moderate and major burns.
3. To compare the discrepancy of %TBSA with the time following burn injuries.
4. To determine the association between the discrepancy of %TBSA with BMI.
5. To determine the association between the discrepancy of %TBSA with number of areas of burn.

CHAPTER 2: MANUSCRIPT

Title Page

Estimation of Total Body Surface Area Burned - A Comparison Between Burn Unit Hospital Universiti Sains Malaysia and Referring Facilities

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Conflict of Interest: None

Disclosure: None of the authors receive any financial support for this study.

Abstract

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quantify the degree of concordance between the two burn size area assessments and elucidate the effect of body mass index (BMI), time following burn injuries and number of burn areas on TBSA assessment and the outcomes such as duration of hospital stay and the need for surgical operation.

Methodology

Research Design

We conducted a retrospective review of 208 inpatients referred to the Burn Unit of Hospital USM from January 2015 to December 2019. The case files of all adult and paediatric burn inpatients were analysed. The %TBSA estimated by the referring institution (TBSAr) was compared with the %TBSA measured by the Burn Unit staffs (TBSAb). All adult and paediatric burn referrals within 24 hours of injury were included. The following cases were excluded from this study: case files that cannot be traced; patients who have been managed at other tertiary centres and subsequently transferred care for logistics purpose; patients electively admitted for surgical operation only; patients who presented with infected burn wounds; patients presented more than 24 hours after burn injury.

Sample size calculated is 194 with estimation of 10% drop-out from total of 216 sample. Calculation is made via Microsoft Excel using two-tailed method. The standard deviation (σ) is of 14.2; precision of 2.0; significance level of 0.005 and confidence level 95%

All referrals within 24 hours of the burn injury and patients who sought medical attention after incident within 24 hours were included in this study. Additional data collected includes patient's demographic data (age, gender, address, height, weight, co-morbid, mechanism and area of burn injury, presence of inhalational injury, duration of hospitalisation, time of burn injury, time of referral, time of reassessment at the Burn Unit, method of %TBSA assessment during referral, choice of fluid, depth of burn recorded during referral and reassessment and whether surgical intervention is needed.

%TBSA Discrepancy

The burn size estimation by the referring facilities (TBSAr) and the Burn Unit (TBSAb) is calculated by:

$$\%\ \text{TBSA Discrepancy} = \text{TBSAr} - \text{TBSAb}$$

TBSAr is done singly by the medical personnel who referred the burn case whereas TBSAb is the assessment upon arrival of patient to the burn unit by the medical officer in charge.

The %TBSA discrepancy is categorised into 'overestimation', 'underestimation', 'perfect accuracy' and 'TBSAr not stated'. The category 'overestimation' and 'underestimation' are further grouped into ≤5%, 6-10%, 11-15%, 16-20% and >20% for secondary variable analysis. This is based on the distribution of absolute burn estimate error where the TBSAb is used as a reference point of accuracy in all analyses. [9]

Burn Severity

Burn severity is categorised into three groups based on the TBSAb. With reference to the Burn Severity Grading System by the American Burn Association (ABA) Burn Injury, paediatric patients have lower threshold of %TBSA for major burn. [29] In adults, the groups are minor burn (<10%), moderate burn (10-20%) and major burn (>20%). In paediatrics (≤12 years old), they are divided into similar groups with different TBSAb, namely minor burn (<5%), moderate burn (5-10%) and major burn (>10%). Percentage TBSA discrepancy in each group of burn severity is calculated for mean and standard deviation (SD). Pearson correlation test was used to assess the significance.

Time following Burn Injuries

Time of burn injury, time of referral and time of reassessment by the Burn Unit staff were recorded from the case files. Time elapsed between injury to referral and time interval between referral and reassessment were further calculated in hours and minutes (hh:mm) using Microsoft Excel. Patients who presented more than 24 hours after the initial injuries were excluded from this study.

Time interval between referral and reassessment was further categorised into: <5 hours, 5-10 hours and >10 hours. Significance between the time interval groups with the %TBSA discrepancy was calculated using one way ANOVA. The mean time spent between burn injury to referral was calculated.

Body Mass Index (BMI)

For adults, BMI (kg/m^2) was calculated from the height and weight and categorized into four groups based on BMI categories from the WHO: <18.5 or underweight, 18.5-22.9 or normal weight, 23-27.4 or overweight and ≥27.5 or obese [30]. Mean and SD of %TBSA discrepancy in each category was calculated and correlated with one way ANOVA.

For paediatrics aged less than two years old, obesity was defined as ≥97^{th} percentile, overweight as ≥85^{th} percentile, underweight as ≤15^{th} percentile and severely underweight ≤3^{rd} percentile for weight-for-age (Appendix A) [31].

BMI (≥2 years of age) using a standard equation: weight in kilograms divided by height in meters squared (kg/m^2), with age- and gender-appropriate cut-offs applied according to Centers for Disease Control (CDC) algorithms [32].

Number of Burn Areas

Areas of burn were divided into six categories: upper limbs, lower limbs, trunk (front), trunk (back), head and neck, genitalia. For the upper and lower limbs, unilateral and bilateral involvement were both considered as one area. Mean and SD of %TBSA discrepancy in each category was calculated and correlated with Spearman's rho correlation test.

Statistical Analysis

Data entry was done using Microsoft Excel Version 16.45 (21011103) and statistical analysis with IBM® SPSS® Statistics version 27. Descriptive statistics was used to summarise the socio-demographic characteristics of subjects. The numerical data obtained was expressed as mean with standard deviation (SD) for numerical variables and n=frequency with percentage (%) for categorical variables.

Categorical data – %TBSA discrepancy (overestimation, underestimation, perfect accuracy), burn severity (minor, moderate, major), time interval between referral and reassessment (<5 hours, 5-10 hours, >10 hours), BMI (underweight, normal weight, overweight, obese), number of burn areas (one, two, three, four, five, six), method of TBSAr assessment (Lund and Browder, Rule of 9, Palm method, sketch on 2D print stamp, hand drawn method, photo sharing, not stated) and length of hospitalisation (<24hours, 1 to 10 days, 11 to 20 days, 21 to 30 days, >30 days) were presented as frequency (percentage). Statistical significance was defined as $P < 0.05$.

Results

Demographic Data

Throughout the five years, there were a total of 247 burn injuries referred and managed as inpatient in the Hospital USM Burn Unit. Of the included 208 burn inpatients, 97 (46.63%) patients were adults, and 111 (53.37%) patients were from the paediatric group (Table 1). Two mortalities were reported where patients suffered from inhalational injuries.

A total of 57 (27.40%) cases were referred from within Kota Bharu (KB) and the rest of 148 (71.15%) cases were transferred from other districts in the Kelantan state. There were three cases transferred from other states, each from the Kedah, Terengganu and Perak state (Figure 1).

A feature of bimodal peaks was observed in the age distribution of burn patients with 98 (47.11%) out of 208 burn injury patients in the younger age group of less than 11. Another peak was seen at the age group of 61 to 70 (Figure 2).

In adults, minor burn injuries are those with TBSAb less than 10%; moderate burn injuries with TBSAb between 10 to 20% and severe burn injury with TBSAb more than 20%. For adults, 67 (69.07%) patients had minor burn injuries and 30 (30.93%) patients had moderate and severe burn injuries (Figure 3).

In paediatrics, minor burn injuries are those with TBSAb less than 5%, moderate burn injuries with TBSAb between 5 to 10% and severe burn injuries with TBSAb more than 10%. For paediatrics, 54 (48.65%) patients had minor burn injuries, 34 (30.63%) patients had moderate burn injuries and 23 (20.72%) patients had severe burn injuries. Mean TBSAb for adults was 11.25% and 6.88% for paediatrics (Figure 4).

Commonest mechanism of burn injury for paediatrics were scalded injuries (64.86%), followed by flame injuries (12.61%), flash burn injuries (10.81%), contact burn

(8.11%) and electrical burn (3.60%). For adults, most prevalent mechanism of burn injuries were flash burn (32.99%), followed by flame burn (29.90%), scalded injury (25.77%), electric and contact burn (4.12%) and chemical burn (3.09%). None of the patients had friction, cold or radiation burns (Table 1).

%TBSA Discrepancy between the referring centers and the Burn Unit in adult and pediatric patients

A total of 126 (60.58%) burn cases were overestimated by the referring centers while 28 (13.46%) cases were underestimated. Up to 16 (7.69%) cases had the same agreed TBSA by the referring centers and the Burn Unit. As many as 38 (18.27%) referrals had no TBSAr stated (Figure 5).

%TBSA Discrepancy between Minor, Moderate and Major Burns

As tabulated in Table 2, there were significant differences between minor, moderate and major burns in both adult and paediatric patients with %TBSA discrepancy ($P< 0.001$). The mean %TBSA discrepancy of 3.30 ± 3.21, 3.93 ± 5.98 and 10.80 ± 9.05 for minor, moderate and major burns, respectively in adults and 3.02 ± 2.93, 3.39 ± 3.57 and 7.59 ± 6.81 in paediatrics. With P value < 0.001, %TBSA discrepancy rises with increasing burn severity (Table 2).

%TBSA Discrepancy between different groups of BMI and Time Interval between Referral and Reassessment

There were no correlations between both BMI and the time interval between referral and reassessment with %TBSA discrepancy with P values of 0.508 and 0.887,

respectively (Table 3). Of the 208 burn patients, 174 (83.65%) sought medical attention within the first five hours of the incident (Figure 7).

%TBSA Discrepancy and the Number of Burn Areas

Areas of burn were allocated into six groups – upper limbs, lower limbs, trunk (front), trunk (back), head and neck and genitalia. With each area involved, one point was given. Whole body involvement will have the maximum score of six. Out of the 208 patients, 94 (45.19%) patients had one burn injury area, 58 (27.88%) had two areas affected, 41 (19.71%) had three areas affected, 12 (5.77%) had four burn areas, two (0.96%) had five areas affected and 1 (0.48%) patient had the whole body involvement. As shown in Table 4, there was significant correlation between %TBSA discrepancy and the number of burn areas (p value < 0.001). with increasing number of areas burned, the %TBSA discrepancy also increases (Figure 10).

Method of TBSA Assessment

In both adult and paediatric patients, hand drawings on the referral letters were the most used method for TBSA assessment which constitutes 29.90% and 33.33% respectively. Only 20.62% of adult referrals and 15.32% of paediatric referrals utilised the Lund and Browder chart. Up to 24.74% of adult referrals and 18.92% of paediatric referrals did not state the method of TBSA assessment (Table 5).

Duration of Hospitalisation

There were 24 (11.54%) burn patients admitted for less than 24 hours in the Burn unit with the mean TBSAb of 1.45. A total of 147 (70.67%) patients were admitted between one to 10 days with mean TBSAb of 6.93 and 3.37% of them required burn

surgeries. Only 2.4% of the admitted patients required inpatient care for more than 30 days (Table 6).

Discussion

As a specialised burn centre in the east coast of Malaysia, Burn Unit Hospital USM receives referrals from the district hospitals, emergency department and the neighbouring states for acute burn management and burn reconstructions. Over the years, we noticed poor agreement in the estimation of TBSA among the referring facilities and the Burn Unit. Therefore, this study highlights the magnitude and trend of the discrepancies and look into the possible causes of the discrepancies.

As many as 53.36% of our patients were paediatrics where burn injuries occurred domestically. They accounted for the highest incidence of scalded injuries (Figure 2 & 4, Table 1). Parents often gave a history of child pulling the electric cables of the kettle. Others described accidental flip of instant noodles cup or hot beverages and child putting hand into hot foods. We also encountered rare cases where child fell into a hot steel caldron used in a feast by the local folks and a father attempting to remove a child's hair lice with hot boiled water and comb. Scalded injuries in adults were commonly seen in females during food preparation and the agent was commonly the hot cooking oil or hot soup splashes from the pots.

For adults, the mean age of burn patients is 35.27, which is the productive age group. Flash and flame injuries were the commonest mechanisms (Table 1). In Kelantan state, open burning is a fairly common practice among the local folks. Burn patients with flash injuries often described a sudden explosion from the burning rubbish pile, which could be due to aerosol can explosion. Others described injuries due to explosions from the firecrackers during festive seasons. For flame injuries, these patients gave an account of pouring gasoline onto a burning rubbish pile, causing hair and clothing to catch on fire. For teenagers, some attempted to strip paint from a bicycle frame by setting fire on it.

Contact burn injuries were not common and patient usually came after accidental contact with hot motorcycle exhaust pipe. There were no friction burn injuries admitted to the Burn Unit as these patients were managed by other disciplines for polytrauma secondary to road traffic accidents. There were no chemical injuries in paediatrics. Two cases of chemical injuries in adults were work-related and the other was an assault case.

Cold injuries were uncommon in a tropical country, however, we did encounter two patients with Freon-induced cryogenic injury involving the hands. These cases were excluded from this study for presenting late to the Burn Unit [33].

Electrical injuries were rare. Paediatric cases were all domestic and caused by household electrical cord or outlet. For adults, three out of four cases were work-related accidents. The other case was caused by a fishing rod placed between the patient's legs which accidentally came in contact with an electric pole.

The aim of this study is to calculate the discrepancy between the TBSAr and TBSAb among adult and paediatric burn patients. Factors such as burn severity, time following burn injuries to assessment, BMI and number of burn areas were assessed. A standard referral from a referring centre will include the total burn surface area (TBSAr) and depth of burn. Following transfer to the Hospital USM, it is standard practice for the attending clinician from the Burn Unit to re-calculate the burn size (TBSAb) and ascertain if it has been accurate, over- or underestimated. This is plotted on the Lund and Browder chart and fluid resuscitation, if required, is adjusted accordingly. Parkland formula is used in the calculation and choice of fluids.

Overestimation was significantly higher than underestimation in both adult and paediatric burn patients by a ratio of 5:1, which is similar to the literature [2,9,34]. In paediatrics, overestimation made up 63.06% and underestimation consisted of 11.71%. In adults, overestimation was 57.73% whereas underestimation was 15.46%. This shows

higher tendency of overestimation in the paediatric group. This finding is consistent with a study reported from the United Kingdom, where as high as 43% of patients from the younger age group (up to five years old) had their TBSA overestimated, resulting in unnecessary transfers [9]. Non-stated TBSAr showed prevalence of 18.27% and it was found out that all of these patients had TBSAb of less than 3% with only three of the patients having TBSAb of 8% and 9%. TBSAr overestimation caused unnecessary admissions that did not meet the ABA transfer criteria [29] and potentially deleterious interventions. This explained the 11.54% of Burn Unit admissions which lasted less than 24 hours, of which, 9.87% consist of the paediatric patients. It is important to ensure the best use of healthcare resources while maintaining the best standard of care and optimization of outcome.

The reasons for %TBSA discrepancies are diverse. Our study reported %TBSA discrepancy rises with increasing burn severity in both adult and paediatric groups. This is different from a study conducted in Australia where the researchers reported severe burns (≥20% TBSA) tend to have more accurate TBSAr [2]. Referrals with larger TBSA discrepancy were found to have included the first degree burns or zone of hyperaemia. This pose great challenges to medical officers who were not familiar with burn care as the gold standard of burn depth assessment is still by clinical assessment.

It is known that burn wounds undergo dynamic changes especially in the first three days [35]. Although this study did not look into the assessment of burn depth, all included patients in this study were reassessed within 24 hours from the burn injuries to avoid another possible determinant of TBSA discrepancies. However, we did look into the time interval between assessment by the referring facilities and by the Burn Unit staffs. Time interval between referral and reassessment was found to have no correlation