ORIGINAL ARTICLE

A Comparison of Burn Size Estimation Methods' Accuracy Applied by Medical Students

Background: General practitioners are the first who visit burn patients and they first calculate burn size and required fluid for the patient. Error in calculation can be disastrous. The purpose of this study is to compare four methods of estimating burn size to teach students.

Methods: This is a descriptive-analytic study on 37 medical students. Four methods of estimating burn percentage was taught to all students. Students individually estimated four different burn wounds by Rule of nines, patient's palm, clinician's palm, and Lund-Browder chart. Students' results were recorded for the whole body and for organs separately. Data was analyzed by ANOVA test with repeated measures and by SPSS 16.

Results: There was a significant difference in 4 methods of estimating burn wound size. Maximum standard deviation in estimation was in patient's palm method and minimum was in Lund-Browder chart method. Range of improper body surface burn size was 4 to 17 percent. There was a correlation between Lund-Browder chart and rules of nine methods. Wounds larger than 20% were underestimated. There was no significant relationship between the estimation of burn size with gender, average, and body mass index of the students.

Conclusion: Considering that failing to use Lund-Browder chart in estimating burn size can decrease the effectiveness of treatment, it is essential to inform general physicians in continuing medical education courses about the importance of choosing the right method to estimate burn size.

Keywords: burn, burn size, rule of nines.

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دراسه مستوى التخمين الصحيح لمستوى الحروق الجسديه عند طلاب الطب الذين كانوا يتابعون اخر عام دراسى لهم

التمهيد والهدف: إن الطبيب العام هواول من يواجهه الشخصى المحترق فى الكادر الطبى و هو من يعين مستوى الحروق فى الجسم و يضع مستوى المغذى المطلوب . إن الخطاء فى هذه المحاسبه يؤدى الى مشاكل رئيسيه للمريض . إن هذه الدراسه تسعى الى البحث فى مستوى الخبره عند طلاب السنه فى تعيين نسبه الحروق الجسميه.

الأسلوب: تم تعليم اربعه اساليب لتعيين نسبه الحروق، للطلاب و طلب منهم تعيين النسبه عند ٤ مرضى افتراضيه . و تم مقارنه النتيجه مع نتائج الاساتذه فى القسم.

النتائج: اعطى أسلوب جدول لاند- برادرافضل نتيجه ٣.٢±٣٠٠ و كان الاختلاف ذوقيمه نسبتا الى الاساليب الاخرى (f:14.886, df:1.49,sig :0.00) . كان التخمين عند ٥١٪ اكثر من الواقع. كان هناك فرق واضح بين الحروق مادون ٢٠٪ . كان التخمين فى مادون الـ٢٠٪ اكثر و فى مافوق الـ ٢٠٪ اقل .فى التخمين على اساس قانون التسعه، كان عند الأناث اكثرمن الواقع و عند الذكور اقل من الواقع.

الأستنتاج: أن وجود معيار دقيق و معين من قبل يرفع مستوى الدقه فى التخمين .إن الاساليب التى لا يكون فيها جداول و معايير حسابيه دقيقه تكون ذو دقه قليله. تعليم تعيين مستوى الحروق عبر جداول مدونه قد يكون امرا مناسبا. من الافضل أن يخضع الاطباء الشاغلون فى قسم العنايه الى دورات تعليميه فى مجال الحروق.

الكلمات الرئيسيه: الحروق ، مستوى الحروق، طلاب السنه الاخيره.

جھلسے ہوئے مریضوں کے بدنوں میں زخموں کا پرسنٹیج کا صحیح اندازہ کرنے میں میڈیکل کے آخری برس کے طلباء کی توانائیوں کا جائزہ

بیک گراونڈ: عام طور سے جلے ہوئے افراد کو سب سے پہلے عام ڈاکٹر (جنرل فزیشین) کے پاس ہی لایا جاتا ہے اور وہی یہ اندازہ لگاتے ہیں کہ بدن کتنے فیصد جھلس چکا ہے اور بیمار کے بدن کو پانی کی کتنی ضرورت ہے ۔ اس مرحلے میں غلط اندازہ لگانے سے مریض کی زندگی خطرے میں پڑسکتی ہے۔ اس تحقیق میں جھلسے ہوئے مریضوں میں بدن کے جلے ہوئے حصے کا پرسنٹیج نکالنے میں میڈیکل کے آخری برس کے طلباء کی توانائیوں کا جائزہ لیا گیا ہے۔

روش: اس تحقیق میں طلباء کو جسم پر جھلسن کا پرسنٹیج نکالنے کے چار طریقہ سکھائے گئے۔ طلباء سے کہا گیا کہ وہ چار فرضی بیماروں کے بدن کی جھلسن کا اندازہ لگائیں۔ طلباء کے اندازوں کا اسٹاف کے اندازوں سے موازنہ کیا گیا۔ اسٹاف کے اندازے گولڈن معیار کے مطابق ہیں۔

نتیجے: لند براوڈر چارٹ سے سب سے زیادہ باریک بینی سے اور سب سےکم غلطیوں سے جلے ہوئے حصوں کا پرسنٹیج نکالا گیا۔

سفارشات: پہلے سے معین شدہ معیار کے ہونے سے جلے ہوئے حصوں کا صحیح پرسنٹیج نکالنے میں کافی مدد ملتی ہے جو جن مریضوں کے جلے ہوئے حصوں کا پرسنٹیج بغیر کسی چارٹ کے نکالا جاتا ہے اس میں غلطی کا امکان زیادہ ہوتا ہے لھذا چارٹوں کے ذریعے اس کام کو انجام دئے جانے کی سفارش کی جاتی ہے۔ عام ڈاکٹروں کو نظام الاوقات کے تحت برن سنٹرز یا وارڈز میں ٹریننگ حاصل کرتے رہنا چاہیے۔۔

کلیدی الفاظ: جھلسن، پرسنٹیج، طبی طلبہ ۔

ارزیابی میزان توانایی دانشجویان سال اخرپزشکی در تخمین صحیح درصد سوختگی سطح بدن

زمینه و هدف: پزشکان عمومی خط اول برخورد با بیمار سوختگی هستند و دراولین قدم درصد سوختگی و مایع مورد نیاز بیماران را محاسبه میکنند. اشتباه محاسبه میتواند برای بیمار مصیبت بار باشد.در مطالعه فعلی توانائی دانشجویان سال اخر پزشکی در تعیین درصد سوختگی مورد بررسی قرار گرفت

روش: چهار روش تعیین درصد سوختگی را به دانشجویان سال اخر پزشکی اموزش دادیم. از دانشجویان خواسته شد درصد سوختگی ۴ بیمار فرضی را محاسبه نمایند. این رقم با رقم محاسبه شده توسط استاف بخش سوختگی (استاندارد طلائی) مقایسه شد.

یافته ها: روش جدول لاند-برادر نسبت به سایر روش ها با کمترین میانگین و انحراف معیار اختلاف از استاندارد، برآورد دقیقتری (۳/۰۰) ± ۳/۹۰ را بطور معنی داری نشان داد. (F: 14.886 df: 1.49, Sig: 0.00) در ۵۱ درصد تخمین ها بیش برآورد صورت گرفته بود. در تخمین بوسیله روش های کف دست، در زخم های کمتر از ۲۰ درصد خطاها بصورت معنی داری بطور بیش برآورد و در زخم بالاتر از ۲۰ درصد بطور کم برآورد بوده است. در تخمین ها به روش قانون نه برای دانشجویان مونث بطور معنی داری بصورت بیش برآورد و برای دانشجویان مذکر بصورت کم برآورد در تخمین وسعت زخم بوده است.

نتیجه گیری: داشتن یک ملاک از قبل تعیین شده میتواند دقت تخمین درصد سوختگی را بالاتر ببرد روشهائی که در صد سوختگی بیمار بدون جدول و نمودار محاسبه میشود دقت کمتری دارد. اموزش تخمین درصد سوختگی با جداول و کارت های مربوطه راه حل مناسبی است. پزشکان عمومی شاغل در اورژانس بایددر فواصل منظم در بخش سوختگی اموزش مجدد ببینند.

واژه های کلیدی: سوختگی .درصد سوختگی .دانشجویان سال اخر پزشکی

INTRODUCTION

Burning is one of the most terrifying and disabling traumas. Estimating burn size is very essential (1) (2). Despite the importance of treatment and caring of burn patients, there are various estimations in emergency departments (3) and significant differences occur in estimating burn percentage. Inconsistency in estimating burn percentage endangers fluid therapy of the burned patient. Therefore, burn size estimation methods used by clinicians have been the focus of burn studies. Studies indicate that in burn wounds less than 20 percent, clinicians tend to overestimate in emergency departments and burn wounds larger than 20 percent are underestimated (4) (5). Wounds larger than 20 percent had the highest estimation accuracy (5). Determining burn percentage was done by one the 3 common methods of Lund-Browder, rule of nines and patient's palm. In Lund-Browder's method burn size estimation is done by special charts. In rule of nines method the body is divided into 11 parts with 9 percent each and in patient's palm method, each palm represents one percent of burn.

Paper charts have been used in practice to estimate burn size for years. Usually the primary investigation is done by inexperienced clinicians in general hospitals, which leads to significant errors. Paper charts like Lund-Browder are not usually easy to use in practice and can be lost in critical situations of caring burned patient. However, reports have been made regarding various estimations which indicate an increase in burn size estimation using this method. In computer-based method, when transferring the estimation from a 3D to a 2D surface, a tendency to underestimate has been observed (6). Also, a study showed that in using Lund-Browder chart in fat patients there is a difference in estimating head and hands from chest and legs and they are overestimated (2). It must be considered that burn size estimation methods have been invented by the Caucasian race, therefore it is based upon their sociology which makes the application of these methods in other areas biased (1). In a research by Liao et al. (2008) titled "using 2D method to estimate the area of Chinese adult hand", palm area was 0.44 percent of body for men and 0.42 percent for women and for palm and fingers it was 0.76 for men and 0.73 for women. Thus, the hand to body ratio in Chinese adults is different with white people and this should be considered in clinical investigations (1).

Using rule of nines, as another estimation method was inconsistent regarding the results (3) (7) (8) and overestimation has been reported. Wounds of chest and lower extremity had the most variability in estimating burn size (9). In a retrospective research, Fribourg et al (2007) concluded that in transferring hospitals, small wounds were overestimated and big wounds were underestimated (10). Malek et al. (2007) invented a 45 cm quadrate card with Lund-Browder chart printed at the back and the formula of determining required fluid printed at front. They suggested this card as a valuable means of primary care for inexperienced clinicians (3).

In general, researches show that each method has some level of inconsistency which can be due to geographical, racial and technical differences. A study indicating the accuracy of estimation by Iranian clinicians was not available. Thus, it is very essential for hospital clinicians to test these methods and determine the usability and efficacy of them. Also, by comparing burn estimation methods, we can introduce the best method to the students. Therefore, the study is designed to compare four methods of determining burn area size and evaluating the accuracy of medical students in using these methods to correctly estimate burn size.

METHODS

Current study is a descriptive-analytical study which is done by attendance of medical students who have passed their course in burn department in 1391 in Imam Reza Hospital, Mashhad. Interns who were familiar with burn estimation methods or interns who consulted with others for burn size estimation were omitted from the study. Four simulated patient models with predefined burn size, which only the professor knew, were presented to students, and students estimated burn size with methods of rule of nines, palm, clinician's palm, and Lund-Browder chart. All methods were taught equally to students by the professor (plastic surgeon and working professor of Imam Reza hospital burn department). First, purpose and method of study was explained to students so that all students have a similar procedure.

In first phase, calculating body burn size by patient's palm, which is equal to one percent, was taught to students, and then they were asked to calculate the area of wound A on their own body using palm method. Wound A consists of the right upper extremity (from upper part of arm to the end of wrist) and right leg (from the middle of thigh to the ankle) parts of chest and face. In second phase, the standardized clinician's palm method was taught to students. In this phase students calculated the area of their own hand and made a card according to its size. They calculated wound B with that card. Wound B consists of the left lower extremity (from groin to the middle of leg bilaterally) and left lateral trunk between anterior and posterior axillary lines. In the third phase estimating burn size using rule of nines method was taught to students. Students were asked to calculate and record wound C which consisted of the left upper extremity (from shoulder to wrist) and the whole right upper extremity, chest, the whole face. In the last phase Lund-Browder method was taught to students. They were asked to calculate the area of wound on their own body. Face (without neck) and two upper limbs (from wrist to above) and anterior part of the right thigh and left leg and the whole anterior part of abdomen were in wound D. Students recorded the results of burn size estimation in questionnaire. To calculate the difference of estimations from different methods and to compare groups, considering different wound sizes in each group, mean deviation modulus was calculated for each student's estimation. The real wound sizes by four methods were respectively 18.5, 40, 37.5 and 37.25, which students were not aware of. For example, if a student had an

estimation of 31.5 for a wound with the exact size of 37.25, 5.75 was recorded for him (31.5-37.25=5.75). Therefore, as four methods were used for one group, they were compared by the variance analysis of repeated measurements with SPSS 16.

RESULTS

Demographic features of 37 students are mentioned in table 1. To calculate the difference between estimation methods and to compare groups with each other, the modulus of estimation was calculated for each estimation and four methods were compared by variation analysis for repeated measurements. Students made 148 decisions to estimate burn size. Maximum standard deviation was in patients' palm method and minimum was in Lund-Browder chart method (Table 2).

Table 1. Features of subjects

Mean (standard deviation)	
Age	23.83 (±0.93) years
Frequency (percent)	
Gender	Male 16 (43.2%) Female 19 (51.4%) Unknown 2 (5.4%)
Last grade-point average	16.62 (±1.19)

Table 2. Burn estimation methods Mean (standard deviation)

Method 1: patient's palm	17.47 (±8.88)
Method 2: clinician's palm	6.58 (±3.95)
Method 3: rule of nines	5.88 (±3.42)
Method 4: Lund-Browder chart	3.90 (±3.00)
Frequency (percent)	
Total	8.26 (±2.26)
Total overestimation	66 (51%)
Total underestimation	63 (49%)

As data had normal distribution, Mauchly's Test, used to analyze variation of repeated data, showed that the null hypothesis indicating the equivalence of variances was rejected (Mauchly's W: 0.143 df; 5, Sig: 0.00). Therefore, the Greenhouse-Geisser Epsilon factor was used (F: 14.886 df: 1.49, Sig: 0.00) which due to its significance we can conclude that the null hypothesis indicating the equivalence of means is rejected and there is a significant difference between study groups (Figure 1). All four methods of burn wound estimation were significantly different from each other (Table 3). It was also observed that there is no significant relationship between gender, grade-point average and body mass index of students with burn size estimation in none of the methods.

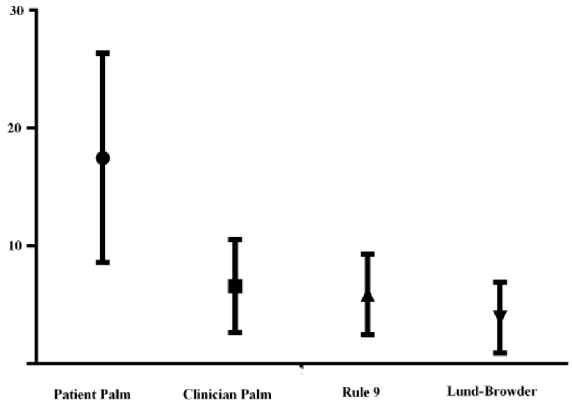

Figure 1. Average of mean deviations in four burn size estimation methods (%)

It was also showed that the maximum correlation between the rule of nines and Lund Browder method was 0.55 (Pearson r=0.55 Sig<0.002).

Fischer's exact test regarding wound size and type of students' errors in estimation with rule of nines method showed that in wounds smaller than 20 percent errors were significantly overestimation and in wounds bigger than 20 percent they were underestimation (<0.00). Also, precise Fischer test regarding the relationship between gender and types of errors of students in burn estimation using Rule of nines showed overestimation in female students and underestimation in male students. 60 percent of subjects preferred Lund-Browder method and 14 percent preferred Rule of nines method to estimate burn size and 26 percent did not answer.

DISCUSSION

Estimating burn size is a complicated estimation which can be affected by different factors. The resultant of three factors including method of estimation, wound size and the clinician may lead to error in burn size estimation. Liao et al. (2008) showed that palm area of the Chinese is less than 1 percent (1) and Fribourg et al. (2007) concluded that in transferring hospitals small wounds were overestimated and large wounds were underestimated (10). Lund-Browder method with predefined instructions can minimize that estimation error. Malek et al. (2007) invented a reanimation card for burn patients containing information of Lund-Browder chart and required fluid (3). Also, Berry et al. (2006) developed computerized burn calculator as a substitute for paper charts in applying rules of burn size estimation.

Calculating burn size in the first visit is important for different reasons. First, it is the basis of determining required fluid for the patient. Second, it is one of the most trusted methods to decide for the hospitalization of the patients and last, determining prognosis of patients is, to a great extent, dependent on this estimation. Lund-Browder chart is used to determine burn size in burn department of Imam Reza hospital. General practitioners are the first who

Table 3. Comparison of burn estimation methods (%)

(I) factor1	(J) factor1	(I-J) Mean Difference	Std. Error	Sig.	95% Confidence Interval for Difference	
					Lower Bound	Upper Bound
Patient palm	Cpalm	10.889	.469	.000	9.968	11.811
	Rule9	11.585	.455	.000	10.690	12.480
	Lund	13.565	.455	.000	12.671	14.460
Clinician palm	Ppalm	-10.889	.469	.000	-11.811	-9.968
	Rule9	.696	.237	.004	.229	1.162
	Lund	2.676	.189	.000	2.305	3.046
Rule9	Ppalm	-11.585	.455	.000	-12.480	-10.690
	Cpalm	-.696	.237	.004	-1.162	-.229
	Lund	1.980	.143	.000	1.700	2.260
Lund	Ppalm	-13.565	.455	.000	-14.460	-12.671
	Cpalm	-2.676	.189	.000	-3.046	-2.305
	Rule9	-1.980	.143	.000	-2.260	-1.700

visit burn patients and they pass a theoretical and practical 10-day course for dealing with burn patients in burn department. Inexperience and terrifying view of burn wound inevitably increase human error in burn size estimation. Our investigation showed that estimation error is 4 to 17 percent. The role of human error in burn size estimation must be considered; it seems that there is no trusted solution yet. Considering that there is only one burn center in province capitals which admit almost all transferred patients, usefulness of informing general practitioners about estimation errors and the role of primary cares and reanimation is undeniable.

In this study we investigated the ability of medical students to estimate burn size at the end of their course in burn department. Our study showed that there is a significant difference in estimating burn size with different methods and only Lund-Browder chart had the most estimation accuracy and Rule of nines method was in second place. This can mean that having a predefined criterion to be compared with each patient can increase the accuracy of inexperienced clinicians in burn size estimation. On the other hand, inexperienced clinicians using methods which calculate burn size without comparing with predefined tables and charts had less accuracy. Thus, it may be necessary that methods like palm or our invented method, revised palm method, should be considered as the history of burn estimation methods and should not be taught to medical students to eliminate improper estimations. Our investigation showed that palm method does not have enough credibility even in patients with low burn size which is a reason for the inconsistency of this method. According to this study, in cases with less than 20 percent, burn size is overestimated. Thus, transferring these patients to specialized centers causes unnecessary overcrowd in these centers. Burn department of Imam Reza hospital always lacks hospital beds and this overcrowd increases this problem and it also makes patients with low burn size exposed to dangerous hospital infections which is inevitable and it can potentially worsen the treatment procedure.

Also, our investigation showed that in patients with high burn size students underestimated the size in a quiet place. These students are graduated next year and they are the first who visit burn patients and they admit patients and transfer them after doing primary cares. Underestimation of burn size is important regarding the transferring instructions and especially reanimation with fluid. Reanimation with less than required fluid has dangerous consequences for the patient. It seems that persistence in more effective education of burn size estimation methods is necessary to overcome this problem.

It is suggested that charts and cards of burn size estimation must be available in all emergency departments. Another useful approach can be the regular continuing medical education of general practitioners who work in emergency departments. Practicing burn size estimation based on clinical education can be useful.

Current study had two weak points. First, current investigation was done on simulated patient models. It is obvious that critical situations in dealing with burn patients can affect the clinician and may affect the final result. Second, students in this study were asked shortly after burn size estimation methods were taught to them. In case that current study is done frequently after graduation, results would be closer to the real value.

Conflict of interest

Authors of this article declare no conflict of interest.

REFERENCES

1. Liao C-Y, Chen S-L, Chou T-D, Lee T-P, Dai N-T, Chen T-M. Use of two-dimensional projection for estimating hand surface area of Chinese adults. Burns. [doi: 10.1016/j.burns.2007.07.017].2008;34(4):556-9.
2. Neaman KC, Andres LA, McClure AM, Burton ME, Kemmeter PR, Ford RD. Estimation of Body Surface Area in the Obese Patient: A Proposed New Algorithm for Burn Resuscitation. Plastic and Reconstructive Surgery. 2009;124(4S):32-3.
3. Malic CC, Karoo RO, Austin O, Phipps A. Resuscitation burn card--a useful tool for burn injury assessment. Burns. 2007 Mar;33(2):195-9.
4. Berry MG, Evison D, Roberts AH. The influence of body mass index on burn surface area estimated from the area of the hand. Burns. 2001 Sep;27(6):591-4.
5. Collis N, Smith G, Fenton OM. Accuracy of burn size estimation and subsequent fluid resuscitation prior to arrival at the Yorkshire Regional Burns Unit. A three year retrospective study. Burns. [doi: 10.1016/S0305-4179(99)00007-8]. 1999;25(4):345-51.
6. Berry MG, Goodwin TI, Misra RR, Dunn KW. Digitisation of the total burn surface area. Burns. 2006 Sep;32(6):684-8.
7. Choi H, Park MS, Lee H-M. Hand surface area as a percentage of body surface area in Asian children: A pilot study. Burns. [doi: 10.1016/j.burns.2011.03.010].In Press, Corrected Proof.
8. Nagel TR, Schunk JE. Using the hand to estimate the surface area of a burn in children. Pediatr Emerg Care. 1997 Aug;13(4):254-5.
9. Wachtel TL, Berry CC, Wachtel EE, Frank HA. The inter-rater reliability of estimating the size of burns from various burn area chart drawings. Burns. [doi: 10.1016/S0305-4179(99)00047-9]. 2000;26(2):156-70.
10. Freiburg C, Igneri P, Sartorelli K, Rogers F. Effects of differences in percent total body surface area estimation on fluid resuscitation of transferred burn patients. J Burn Care Res. 2007 Jan-Feb;28(1):42-8.
11. Neaman KC, Andres LA, McClure AM, Burton ME, Kemmeter PR, Ford RD. A new method for estimation of involved BSAs for obese and normal-weight patients with burn injury. J Burn Care Res. 2011 May-Jun;32(3):421-8.
12. Yu C-Y, Hsu Y-W, Chen C-Y. Determination of hand surface area as a percentage of body surface area by 3D anthropometry. Burns. [doi: 10.1016/j.burns.2008.03.010]. 2008;34(8):1183-9.