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Use of the burn intervention score to calculate the charges of the care of burns

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ABSTRACT

Background: To our knowledge this is the first published estimate of the charges of the care of burns in Sweden. The Linköping Burn Interventional Score has been used to calculate the charges for each burned patient since 1993. The treatment of burns is versatile, and depends on the depth and extension of the burn. This requires a flexible system to detect the actual differences in the care provided. We aimed to describe the model of burn care that we used to calculate the charges incurred during the acute phase until discharge, so it could be reproduced and applied in other burn centres, which would facilitate a future objective comparison of the expenses in burn care.

Methods: All patients admitted with burns during the period 2010–15 were included. We analysed clinical and economic data from the daily burn scores during the acute phase of the burn until discharge from the burn centre.

Results: Total median charge/patient was US$ 28 199 (10th–90th centiles 4668-197 781) for 696 patients admitted. Burns caused by hot objects and electricity resulted in the highest charges/TBSA%, while charges/day were similar for the different causes of injury. Flame burns resulted in the highest mean charges/admission, probably because they had the longest duration of stay. Mean charges/patient increased in a linear fashion among the different age groups.

Conclusion: Our intervention-based estimate of charges has proved to be a valid tool that is sensitive to the procedures that drive the costs of the care of burns such as large TBSA%, intensive care, and operations. The burn score system could be reproduced easily in other burn centres worldwide and facilitate the comparison regardless of the differences in the currency and the economic circumstances.

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1. Introduction

The care of burns is one of the most costly areas of hospital care [1]. It includes intensive care for severe injuries, many expensive materials for repeated dressings, extended affected areas, repeated operations, and a long duration of hospital stay [2–6].

Resources that are required can be estimated using recorded workload or intervention scores [7,8]. The Linköping burn intervention score has been validated, and has been used to calculate the charges for each burned patient since 1993. The first validation was done when the score was implemented and compared with the Therapeutic Intervention Scoring System TISS in parallel to reach a calculation system which would avoid unnecessary overpayment for the small burns [9]. Two decades later, we explored its association with the factors important for the outcome in burn care. The current study is focusing on the economic perspective of burn care which seldom has been described [10].

The burn score combines the mixed approach for collecting information about charges in our centre and is balanced between two broad principles. The "bottom-up" principle has been made less time-consuming (less expensive), as categories of care based on particular interventions are used as indicators for the resources that are used to provide the specialised care, and a value has been assigned to these items. These values are summed and linked to a unit of activity to derive a total unit cost. The nine categories of care are what the charges are based on. The "top-down" principle is a simple calculation in which the sum of the annual budget of the department is divided by the number of patient-days to estimate a mean charges/patient per day, and used alone it takes no account of the disproportionately high costs of intensive care [30]. We use "top-down" to calibrate the basic cost to the local region index for hospital charges, taking into account issues such as inflation.

It is difficult to compare charges for the care of burns between different centres in the world because of the variability in methods of charging, and other important differences such as the variability among those patients who survive. It is not fair to compare charges between centres in which there is a large difference in mortality [11,12], because of the different degrees of care given. The variability of the methods of charging in burn centres also confounds the results [1,9,13,14].

The treatment of burns is versatile, and depends on the depth and extension of the burn. This requires a flexible system to detect the actual differences in the provided care. We aimed to describe our model for the calculation of charges for the care of burns during the acute phase until discharge, so it could be reproduced and applied in other burn centres, which would facilitate a future objective comparison of the expenses in burn care.

2. Methods

All patients admitted to Linköping University Hospital Burn Centre during the period 2010–2015 were included in the study. We analysed clinical and economic data from the prospectively-maintained burn registry, in which the nursing staff enter all patients' data daily (the Burn Centre Database). The study was approved by the Regional Ethics Review Board in Linköping (2013/341-31).

The burn score was calculated based on the following records: surveillance, respiration, circulation, wound care, mobilisation, laboratory tests, infusions, and operations [9] (Supplemental Table S1). A diagram (Fig. 1) explains the daily process of recording the scores in regards to the number of interventions done to the patient. Calculations of the charges for each patient have been based on the sum of the daily points of the burn score. The total range of daily scores is divided into three levels of care: "low" when the burn score is less than 5, "moderate" when it is between 5 and 12, and "intensive" when it is 13 or more (the corresponding charges for each level are shown in Table 1).

The Swedish health system is financed from tax, and each of the 21 Swedish counties is responsible for paying for health care for their inhabitants. All patients are treated free in public health care hospitals, except for small administrative fees (US$ 12/day). No additional charges are paid. There are different terms that describe hospital finances, such as costs, payment and charges that are often used interchangeably. We chose to use the term charges in this study because the patient's charges are paid by the county directly to the hospital, a process in which payments, in most of the cases, are equivalent to the charges. The payments received are sufficient to cover the total costs of running the burn centre.

Patients were treated according to a protocol that included early excision and grafting [9], revision of the wound every second day, standard ventilation [15,16], fluid management [17], and early enteral nutrition. All patients who received intensive care were managed by both the intensive care physicians and the plastic surgeons daily.

The usual daily care of the patient is by nurses and assistant nurses. The family and other relatives are welcome to be present, but are not expected to participate in daily care. Occupational therapists, physiotherapists, and social counsellors participate in treatment, and the patients are managed entirely in the Burn Centre until they are discharged [18].

The variables used were charges/TBSA%, charges/day, charges/admission, TBSA%, age, sex, cause of burn, deaths, and duration of hospital stay, hospital stay/TBSA%, intensive care, and mechanical ventilation. All amounts presented are for inpatient treatment only.

2.1. *Data analysis and statistics*

Data were analysed with the help of Statistica (version 12, Dell Inc., Tulsa, USA), and presented as mean (95% CI) or median (10th–90th centiles) unless otherwise stated. The significance of differences between personal and clinical variables was assessed with the aid of the Mann Whitney *U* test and the chi square test. Probabilities of less than 0.05 were accepted as significant.

3. Results

Six hundred and ninety-six patients were included. Total median charges/patient were US$ 28 199, which were three

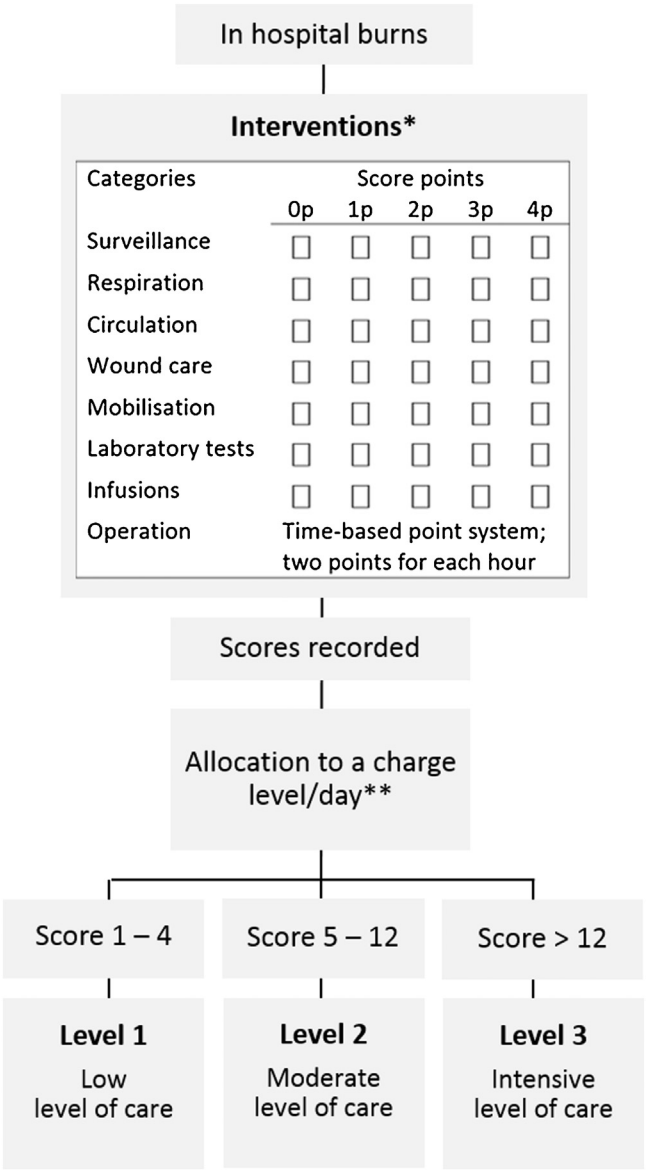


Fig. 1 – Diagram of the daily process of allocation of patients to one of the three levels based on the intervention score system.
***Each patient is given a score from 0 to 4 based on the number of the interventions received.**
***Sum of the scores and allocation to a charge level/day.**

times higher for those who died. However, the charges/TBSA% were similar. When compared with those among survivors, charges/day were double for those who died. Duration of hospital stay was longer among those who died, although the difference was not significant because of the variations among the group (Table 2).

Table 1 – Our charges according to the level of care in different currencies.

Levels	Burn score	SEK	US$	EUR	Aus$
Low	Less than 5	19 133	2334	2062	3050
Moderate	5–12	44 236	5396	4768	7053
High	13 or more	60 032	7323	6471	9571

Burns caused by hot objects and electricity resulted in the highest charges/TBSA%, while charges/day were similar for the different causes of injury (Fig. 2). Flame burns resulted in the highest mean charges/admission, probably because they had the longest duration of stay (mean 24 days, 95% CI 21–28) (Fig. 3). There was a linear increase in charges/TBSA% in the older age groups, the oldest being three times as high as that of children younger than 5 years, while daily charges did not increase with age by the same magnitude (Fig. 2). Mean charges/patient increased in a similar linear fashion among the different age groups. Compared with the youngest age group, the mean charges increased six fold in the oldest age group, but those results have not been adjusted for TBSA% (Fig. 4). Although the number of calculated days was 41% in Level 1, it generated only 21% of the charge (Fig. 5).

Table 2 – Descriptive details by survival status.

	All (n=696)	Survivors (n=671, 96%)	Deaths (n=25, 4%)	p Value	
Total charges, US$	28199 (4668-197781)	27611 (4668-180047)	108148 (12720-644048)	0.001	M
Charges/TBSA%	5438 (1288-20471)	5470 (1414-20471)	5174 (147-17464)	0.06	M
Charges/day	3461 (2334-6202)	3427 (2334-5609)	7173 (5018-8108)	<0.001	M
TBSA%	6.0 (1.0-27.0)	6.0 (1.0-24.0)	38.5 (24.5-77.0)	<0.001	M
Superficial dermal burn, BSA%	2.1 (0.0-12.0)	2.3 (0.0-11.8)	0 (0-15.5)	0.047	M
Deep dermal burn, BSA%	0.5 (0.0-9.5)	0.5 (0.0-8.3)	6.0 (0.0-25.0)	<0.001	M
Full thickness burn, BSA%	0 (0-8.5)	0 (0-6.0)	27.0 (2.0-65.5)	<0.001	M
Duration of hospital stay, days	8.0 (2.0-37.0)	8.0 (2.0-35.0)	13.0 (2.0-80.0)	0.14	M
Hospital stay/TBSA%	1.5 (0.4-5.1)	1.6 (0.5-5.2)	0.7 (0.0-2.6)	<0.001	M
Age, years	32.3 (1.1-72.5)	30.7 (1.1-71.1)	71.8 (51.4-81.2)	<0.001	M
Male sex	486 (70)	472 (70)	14 (56)	0.13	Chi square
Patients who had intensive care	182 (26)	157 (23)	25 (100)	<0.001	Chi square
Patients who had mechanical ventilation	147 (21)	123 (18)	24 (96)	<0.001	Chi square

Data are median (10-90 centiles) or No (%). Mann Whitney U test (M) and chi square test p values for differences according to survival. TBSA% =percentage total body surface area (burned), BSA=body surface area.

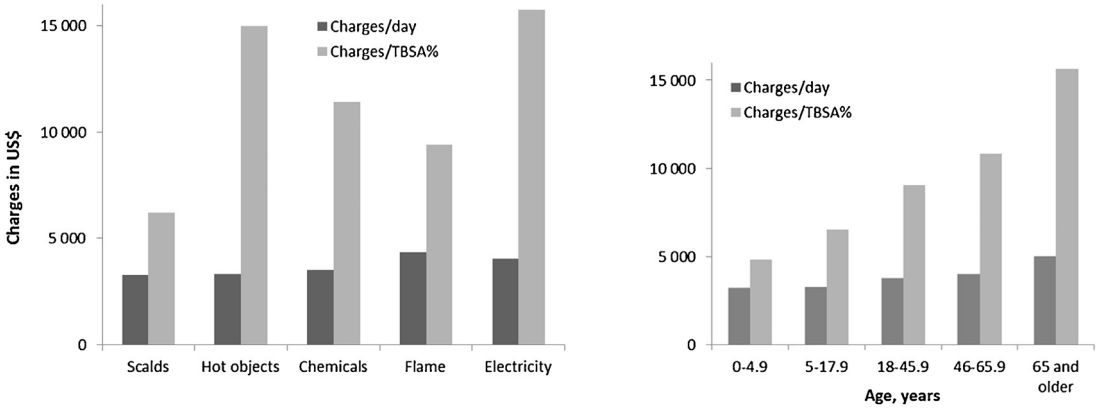


Fig. 2 – Mean daily charges (dark grey bars) and mean charges/TBSA% (light grey bars) by cause of injury and age groups (n=696). TBSA%=percentage total body surface area (burned).

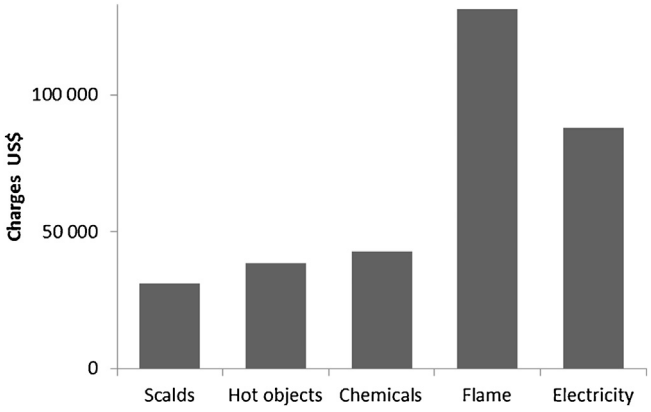


Fig. 3 – Charges per patient by cause of injury (n=696).

4. Discussion

This is to our knowledge the first study to focus on the charges of care of burns in Sweden. The purpose to describe this process was mainly to elaborate about our intervention score and its usefulness as a tool to estimate the charges for the admitted patients. We think that the burn score system could be reproduced easily in other burn centres worldwide and facilitate the comparison regardless of the differences in the currency and the economic conditions.

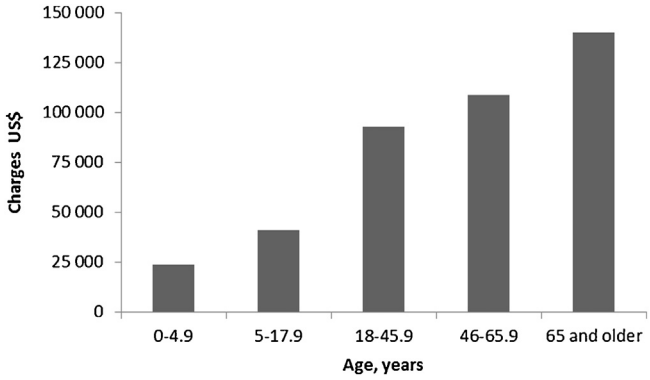
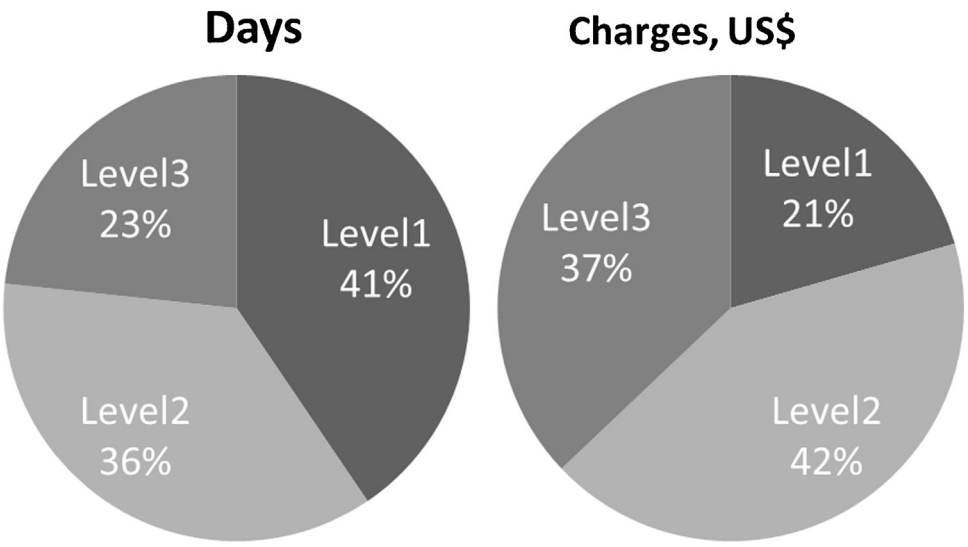


Fig. 4 – Charges per patient among different age groups (n=696).



	Days	Charges per day	Total charges US$
Level1	4606	2334	10 750 404
Level2	4111	5396	22 182 956
Level3	2651	7323	19 413 273

Fig. 5 – Days and charges during 2010-15, proportion by the three levels of calculation of the charge.

The system could have the advantage of being flexible and accurate in detecting the actual factors that drive the cost during the inpatient admission. It has the potential to be accurate, as it measures the patient's clinical condition and the interventions made for which daily charges should be estimated. Operations and days in intensive care are automatically detected and scored daily. It takes prolonged duration of stay into account, which is an essential indicator of the estimation of charges [19].

It was obviously noted that charges increase non-linearly with increasing %TBSA in the group of patients with TBSA% 50–59.9% (n=9), with a mean increase of US$ 372 000 compared with that of the group with TBSA% 40–49.9% (n=11). The same pattern was reported in a previous publication [20]. We found that every TBSA% increases the charges of the hospital admission by almost US$ 16 000 in the oldest group of patients. Elderly patients received more care, which had consequently resulted in higher charges as shown in our study, and that was in line with other reports [20–23] because this group usually has coexisting medical conditions, impaired immune response, and slower wound healing [23–26]. Children usually cost less, probably because they heal more rapidly than adults or elderly patients even if they have a similar TBSA% extension and depth of burn. In other charging systems [20,21] (which are based on diagnosis) all age groups will be charged equally, contrary to our system, which will charge children less as younger patients utilise fewer resources than older ones (Fig. 4).

Charges for each TBSA% were highest among patients with electrical burns, followed by burns that resulted from direct

contact with hot objects, which was similar to the finding in a previous study of electric burns [27]. This could be explained by the nature of those burns, which are usually full thickness. Flame burns had the highest charges/admission, probably as a result of the diversity of extensions of the burns (including the patients with major burns) during the study period.

Most of the patients with severe burns received intensive care during the first weeks after injury which is classified as level 3 charges because they need a mechanical ventilator and surveillance, including circulatory support and monitoring. Those procedures are usually expensive. It has, however, been shown that the daily intensive care unit charges of patients with burns is no more expensive than that of general intensive care patients, except for physiotherapy and dressings [6].

Although hospital charges look high when compared with many other centres in the world, such as Finland, Spain, Australia, England, and Turkey [13,20,27–29] they are in the same range as the other burn centre in Sweden because we calculate the charges of burn care using the same method. A recent report from Finland showed a lower median charge/patient (US$ 5922) than ours; however, the data in that study were collected between 1999 and 2009 [20]. When comparing our charges with those presented in the annual NBR report 2015 [21] we found that the level of charges is lower in Sweden, which could be explained by the difference in the payment systems for health care. These are usually paid by the health insurance organisations (payors) in the USA instead of the county governments in Sweden. Furthermore, the charges that are claimed by the hospitals are usually higher than they expect to recover in payments from the insurance companies. Another confounder could be the difference between the intervention-based system and the American Diagnosis Related Group system, which includes differences in charges in relation to certain diagnoses.

4.1. *Limitations*

We did not include outpatient visits, duration of care after transfer back to referral hospital, or subsequent reconstructive operations, which in many cases are done outside the burn centre, as we did not have access to data from other hospitals.

The study was done based on the records from a single centre and the burn score has not been verified in other centres as a charge calculation system in burns.

5. Conclusion

Our intervention-based system of estimating costs has been shown to be a valid tool that is sensitive to what we know drives costs in burn care such as large TBSA%, intensive care, and operations. It provides a flexible calculation of the charge based on what is happening to the patient, and not a preset tariff for the main diagnosis.

Conflict of interest

None.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.burns.2018.12.007.

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