ORIGINAL ARTICLE

Cost-Utility Analysis Applied to the Treatment of Burn Patients in a Specialized Center

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Objective: To discover the total costs and quality of life of burn patients in a specialist center classified by diagnosis-related groups (DRGs).

Design: Prospective study of 5-year follow-up from January 1, 1997, through December 31, 2001.

Setting: Burn Center of Valencia.

Patients: A total of 898 patients treated at the Burn Center of Valencia.

Main Outcome Measures: Hospital, extrahospital, caregiving, labor, and social costs of the burn patients grouped by DRG (code 457: extensive burns without operating room procedure; code 458: nonextensive burns with skin graft; code 459: nonextensive burns with wound debridement or other operating room procedure; code 460: nonextensive burns without operating room procedure; or code 472: extensive burns with operating room procedure) were studied. The costs were compared with those that the DRG system assigns. The quality of life of the patients at the end of the follow-up period was also studied. To measure quality of life, the EuroQol 5-Dimensions survey was used. Utility calculations and cost-utility analysis were undertaken according to life expectancy.

Results: The number of quality-adjusted life-years produced by the center was 13 577, with a mean quality-of-life level on release from the study of 0.87. The mean cost per patient, including the social and labor costs, was \$95 551, with health care costs amounting to only 10%. The mean cost per quality-adjusted life-year was \$686.

Conclusions: The labor costs were the most important and amounted to 56%; together with the social costs, these constituted 85% of the total costs. The DRG code 456 was an option dominated by the remaining DRG codes 458 through 460 and 472. Given the high costs of treating burn patients, a clear health care policy is urgently needed.

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HEALTH CARE FOR BURN PAtients is one of the most expensive aspects of current health care systems and, possibly, one of the least studied in terms of costs and results. Every year in the United States 1.25 million burn patients are treated, of whom at least 50 000 require hospitalization. Severe burns with mortality rates of 50% or higher continue to provide a challenge to science. In addition, burn centers are subject to the growing pressure of improving their services, with regional coordination of facilities and institutions and improvement of facilities and management.[1] The aim of burn treatment centers should change from trying to save lives to enabling patients to return to productive activity.[2]

Patients admitted to the hospital for burns are subject to the classification known as diagnosis-related groups (DRGs). Although few subdivisions (DRG code 456: burns, transferred to another acute care facility; code 457: extensive burns without operating room procedure; code 458: nonextensive burns with skin graft; code 459: nonextensive burns with wound debridement or other operating room procedure; code 460: nonextensive burns without operating room procedure; and code 472: extensive burns with operating room procedure) are used, such a classification is important because it gives weight to each event that is related to the cost theoretically incurred by the hospital.[3]

See Invited Critique at end of article

To our knowledge, no studies on the total costs and results of treatment of burn patients, measured from the concept of utility, have been published. The con-

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cept of utility is applied in clinics as quality-adjusted life-years (QALYs), a term first used by Klarman et al[4] in 1968. It is based on a group of values called utilities, 1 for each possible health status, reflecting its relative need. The advantage of a QALY-based study is that it uses a common unit, so comparisons can be made among different treatments or alternatives, as was the case in this study. The QALYs take into account both the quality of life and survival. However, different utility determinations have been described in the literature.[5-7] Because the QALY is a general measure of quality of life, its use in this study is an attempt to capture specific health outcomes within 1 overall measure, providing a summary index of the impact of each technique on overall quality of life. The inclusion of a generic measure, the EuroQol 5-Dimensions (EQ-5D), from which the QALY can be estimated, is an attempt to provide information on the value of the different types of burn treatments. The aim of this work is to study the total costs of the different DRGs of burn patients admitted to a burn center and of the quality of life that the burn patients attain.

METHODS

Information was obtained from the clinical records of the patients who were admitted to the Burn Center of Valencia from January 1, 1997, through December 31, 2001. This center treats most of the burn patients from the Comunidad Valenciana (CV) and is one of the biggest in Spain; therefore, all significant burns in the CV are referred to the Burn Center of Valencia. The center has 54 staff members, mainly nurses (23) and nursing auxiliary staff members (18). The CV is a typical Mediterranean area located in the east of Spain on the Mediterranean coast, with a population of more than 4 million.

QUALITY OF LIFE

To develop the analysis, a health questionnaire (EQ-5D) was used. The EQ-5D is a generic measure of health status that defines health in terms of 5 broad dimensions, each containing 3 levels. Combinations of these dimensions and levels give rise to 243 health states, besides the states of unconsciousness and death. In addition, it includes a visual analog scale (VAS). The VAS is presented as a vertical 10-cm thermometer with grid marks that go from 0 (dead) to 100 (perfect health). Each patient used the VAS to rate his or her health state. The mean group VAS scores can also be transformed into time tradeoff (TTO) scores by a power function.

The standard values of the EQ-5D were determined from a random sample population of patients when they were released from the hospital, both with and without residual lesions. The health status table of values was obtained with the TTO system.[8] Afterward, a trained nurse classified the patients according to EQ-5D health state before operation, and therefore 1 quality-of-life value corresponding to each patient was assigned.

Two years after discharge from the hospital (final cutoff point), with the patient undergoing rehabilitation or being finally discharged, the health questionnaire was completed again. Of all the patients admitted, 49 had to be eliminated and were therefore excluded from the final utility study. The survey was completed through direct clinical observation of the patients, contrasted with the nursing notes, during admission and external checkups.

The DRGs studied were codes 456 through 460 and 472. Sixteen patients who were assigned DRG codes 264 and 265 were eliminated because these codes indicate skin grafts for other reasons for treatment (eg, ulcers or cellulitis). Similarly, one outlier, excessively long hospital stay, was eliminated from DRG 459 because it produced a large deviation. For the weighted study of the DRGs, the DRG classification of 1997[9] was used. Three patients with tracheostomies were eliminated from the DRG study.

A clinical decision model strictly followed in the burn center was used. This model has been validated by a group of specialist physicians in the treatment of burn patients and did not change during the period of study. Each of the clinical decisions is paired to inclusion and exclusion clinical criteria of direct application for burn patients and does not take into account any patient quality-of-life criteria. The different options in the study were considered exclusive. Eighty-nine respondents completed the EQ-5D a second time (mean time, 12.5 months). The test-retest correlation was 0.84.

COSTS

The cost model used was that of the cost of the illness based on the theory of human capital.[10] Hence, in this study both direct and indirect costs were considered. Direct costs, in this study, consider the consumption of health system resources, including the costs of hospital care (both hospitalization and outpatient care at outpatient departments), primary care, drugs (including medication administered during the operation) and curing materials, and emergencies. Hospital costs were calculated according to the cost accountability system, which includes all the staffing costs of the burn center, the costs of subsequent operations and processes performed on the same patient, the costs of health material and diagnostic tests, the costs of treatment and transport, and the costs of general maintenance, management, hostelry, and general services. For outpatients, the costs that the patient incurred at home or from health care centers, through either visits or treatment, and the medication that he or she received from the outpatient department were included.

Direct non–health care costs were also included. Informal care is defined as the performance of tasks outside a professional capacity that help maintain or enhance patient independence. In this way, informal services are defined as the group of tasks and/or care provided without pay by family, friends, or neighbors. This type of information was obtained from the questionnaire from those questions concerning the time spent in the patient's care. The study of caregivers was undertaken for up to 3 years after discharge from the hospital.

Indirect costs consist of loss of productivity due to premature mortality and labor incapacity attributable to the illness. Labor costs include those due to the loss of productivity through temporary incapacity and/or permanent incapacity and social costs through loss of productivity due to premature death.

Loss of productivity affects later years. A discounted value of the productive capacity lost throughout the patient's life in the year when the permanent incapacity or death happened is assigned. For example, one day of absence from work involves a loss of production equal to the salary received for that same day.[9-11] In the case of individuals without working activity or unemployed individuals, the productive capacity lost was calculated by assigning them the minimum interprofessional salary. Indirect costs were obtained through surveys. Data on wages were provided by the patients themselves on the day when their quality of life was evaluated and, in the case of the deceased, by a close family member.

As far as mortality is concerned, the years of productive life lost, which are the years between the patient's death and retirement age of 65 years, were calculated. When the burn pa-

Table 1. Distribution of Patients Admitted for Burns According to Hospital, DRG, and Mean Stay, Comunidad Valenciana, Spain, 1997-2001

	Burn Center at Hospital of Valencia		General Hospital of Alicante		Other Hospitals			
DRG*	No. of Admissions	LOS, d	No. of Admissions	LOS, d	No. of Admissions	LOS, d	Total No. of Admissions	Mean LOS, d
456	94	4.5	12	12.0	4	8.3	**110**	5.4
460	439	11.5	229	10.1	56	7.8	**724**	10.8
459	8	18.7	91	21.2	3	24.0	**102**	21.1
458	371	24.2	38	31.7	0	0	**409**	24.9
457	56	17.2	8	32.1	1	6.0	**65**	12.9
472	74	34.8	21	30.2	3	14.8	**98**	33.2
Total	**1042**	21.3	**399**	15.7	**67**	8.8	**1508**	15.8

Abbreviations: DRG, diagnosis-related group; LOS, length of stay.
*DRG code 456: burns, transferred to another acute care facility; code 457: extensive burns without operating room procedure; code 458: nonextensive burns with skin graft; code 459: nonextensive burns with wound debridement or other operating room procedure; code 460: nonextensive burns without operating room procedure; code 472: extensive burns with operating room procedure.

tient did not die, it was assumed that he or she did not have a substantial alteration in his or her life expectancy and that it would remain stable for the rest of his or her life.

A 3% rate of discount was applied to all costs when they involved a period greater than a year, except when they were reflected as nominal. Additionally, an increase in productivity of 2% was applied to the years of productive life lost. The costs were converted into dollars (€1 = $1.2).

Length of hospital stay was analyzed using the Mann-Whitney *U* test. Costs and utilities were deflated to make them constant in relation with 1997. Finally, the mean cost per patient, per QALY, and the incremental cost utility rate (ICUR) were calculated as follows in accordance with the procedure established in other works.[8,12,13]

Function for transforming VAS and TTO values:

$$\text{TTO} = 1 - (1 - \text{VAS})^b,$$

with b ranging from 1.55 to 1.81; in our study, $b = 1.53$.
Cost per QALY ratio and the ICUR:

$$\text{ICUR} = \frac{\bar{C}_A - \bar{C}_B}{\bar{E}_A - \bar{E}_B} = \frac{\Delta\bar{C}}{\Delta\bar{E}},$$

where $\bar{C}_A$ and $\bar{C}_B$ are the mean costs and $\bar{E}_A$ and $\bar{E}_B$ are the mean effects.

RESULTS

The CV had a total hospital admittance due to burns of 1508 in the 5-year study period, which represents a hospital morbidity rate of 7.54 per 100 000 inhabitants per year. The incidence of burns demonstrated great stability during the 5-year study in the CV. Per DRG, the most frequent (**Table 1**) code was 460 (nonextensive burns without operating room procedure), which represented 48% of the total number of patients admitted because of burns.

Among the basic data obtained on burn patients included in the study (**Table 2**), the following should be stressed: the mean QALYs gained per patient and year were 0.35, whereas with the VAS they were 0.26. Notably, mean group VAS scores can also be transformed into TTO scores by a power function; therefore, those values can be used to evaluate the validity of the results obtained for the TTO. The mean age of the patients was 44.3 years, the mean surface grafted was 291 cm^2, and the mean length of stay of patients who did not undergo surgical procedures was almost 12 days. When grafting was undertaken, the length of stay was 6 days longer, whereas when the patients underwent debridement plus grafting, the length of stay was approximately 15 days longer. Total costs were almost $17 million for each of the 5 years studied (179 patients per year with $95 551 total cost per patient), including the labor costs—the most important—with 56% of the total.

The patients arrived at the hospital within the first 3 hours of the incident. Most of the burns had been caused by fire and were second- or third-degree burns. Of all the patients attended to at the burn center, those classified as DRG code 456 were excluded because these patients were directed to a general hospital. Therefore, 898 patients were studied, 727 (80.9%) after local treatment (DRG codes 458-460) and the remaining 171 patients after general treatment plus local treatment (DRG codes 457 and 472).

From the medication costs study (**Table 3**) in nominal values, it can be observed how products classified as group B (blood and hematopoiesis) and group D (dermatologic products) constituted 60% of medication costs, followed by group J (anti-infection products for systematic use), with almost an additional 15%. The differences in terms of hospital costs per patient (**Table 4**) were significant. The highest cost was $32 033 for DRG code 472, whereas DRG code 460 was the cheapest, amounting to $3621. Therefore, attending to patients with different codes can result in differences in mean costs per patient of up to 9 times as much. This cost relationship provided by the weighting system of the DRG strays a little from the real costs incurred in the hospital, especially in the case of DRG code 472, which deviated by almost $4300. The differences in extrahospital costs were less among the different DRGs, with DRG code 472 amounting to barely twice that of others.

A total of 5.4% had their cause of death classified as DRG code 458, whereas the mortality rate from DRG code 472 was 17.8%, followed by DRG code 457, which was used to classify the deaths of 2 patients (**Table 5**). The cost of absence from work per patient (temporary incapacity) was $9116, with DRG code 472 once again approximately 4 times higher in cost than the mean. The days of absence varied among the patients, amounting to 441 days on average in the patient who underwent the most aggressive surgical option. Likewise, the costs per permanent incapacity were still greater in this DRG because practically all permanent incapacity is associated with this code.

Of the total costs of the different DRGs (**Table 6**), approximately 9% were hospital costs, 1% extrahospital costs, approximately 5% caregiving costs, 56% labor costs, and 28% social costs. Regarding the patients' quality of life (**Table 7**), the mean QALY value on completion of the study was 0.87, whereas the number of QALYs gained per patient, referring to life expectancy, was 15.13 per patient. The number of QALYs gained per patient was higher for surgical options, with the highest being DRG code 472, with 22.79 QALYs gained. The mean cost per QALY was $686, the most expensive QALY cost was associated with DRG code 472 at approximately $1500, and the cheapest was associated with DRG code 460 at $353.

Regarding the marginal analysis of costs, taking hospital costs into account, the additional units of QALYs produced by DRG codes 472, 458, and 459 cost practically the same, between $2300 and $3900 when DRG code 459 was used as the basis. However, when total costs were taken into account, a marginal unit of DRG code 472 cost approximately 4 times more than the other DRG codes (458-460); this analysis used DRG code 460 as a standard, which was always an option dominated by all DRGs.

COMMENT

EPIDEMIOLOGIC FEATURES

The profile of the typical burn patient in our study is as follows: male, younger than 10 years, single, covered by the National Health Service (Spanish Social Security), burns resulting from an unintentional event, and referral to our hospital in the first 3 hours after the incident. In addition, the burn was most often caused by fire or scalding.

From an epidemiological perspective, many studies are available on the most important characteristics of the burn patient and also on the factors related to mortality or length of stay. Such factors include the area and deepness of the burn, age and sex of the patient, and time from the incident to the application of treatment.[14-18] In our study, 4.12% of the patients died, with the most frequent cause being sepsis and one of the most frequent agents being *Candida*, which occurs especially in elderly people and those with comorbidities. This finding generally coincides with the findings of other studies.[19,20]

The epidemiologic distribution of our patients was similar to that of other environments. The mean patient age was 40 years, and the patients had a somewhat low total body surface area (TBSA) of 18.2%. Reports from other countries indicate that children younger than 6 years are at the highest risk of burns.[21] However, their distribution will depend much on the country of residence and possibly on its level of social and economic development. In a study undertaken in Tehran, Iran, the mean patient age was 20 years and the TBSA was 30.6%, although the length of stay was 16.7 days,[22] which is lower than that of our study. In another study performed in Brazil, 50% of burn patients were children,[23] whereas in another study undertaken in Beirut, Lebanon,[24] 32% were younger than 9 years.

Our environment demonstrated a hospital rate of 7.54 per 100 000 people, which is somewhat lower than the rates presented by other US studies.[25] Therefore, our study produced a lesser risk of burns and a higher mean age,

Table 2. Baseline Values for the Burn Patients in the Study

Variable	Value (N = 898)
QALY per year gained with VAS, mean ± SD	0.26 ± 0.09
QALY per year gained with TTO, mean ± SD	0.35 ± 0.13
LOS of nonsurgical patients, mean ± SD, d	12.09 ± 4.0
Extra LOS due to grafting, mean ± SD, d	6.16 ± 5.90
Extra LOS due to debridement plus grafting, mean ± SD, d	14.84 ± 11.50
Skin-grafted area, mean ± SD, cm^2	291.0 ± 21.0
Total burn surface area, mean ± SD, %	18.2 ± 16.0
Length of stay, mean ± SD, d	18.27 ± 13.0
No. of days absent from work, mean ± SD	158.0 ± 99.0
Hospital cost per percentage of burn, $	505.77
Costs (% of total costs), $	
Total	85 805 (100.0)
Total direct costs	13 107 (15.3)
Health total	9318 (10.9)
Hospital costs	8175 (9.5)
Inpatient medication	675 (0.8)
Outpatient	1143 (1.3)
Primary care	380 (0.4)
Outpatient medication	763 (0.9)
Non–health care costs (caregivers)	3789 (4.4)
Total indirect costs (% of total costs), $	72 698 (84.7)
Labor	48 509 (56.5)
Social	24 189 (28.2)
Sex, No. (%)	
Male	574 (63.9)
Female	324 (36.1)
Age, No. (%)	
<10 y	215 (23.9)
10-65 y	613 (68.3)
>65 y	70 (7.8)
Hours since injury, No. (%)*	
<3	669 (74.5)
3-24	103 (11.5)
25-48	81 (9.0)
>48	49 (5.5)
Unknown	18 (2.0)
Agent, No. (%)*	
Scalding	355 (39.5)
Fire	413 (46.0)
Electricity	41 (4.6)
Contact	44 (4.9)
Chemicals	39 (4.3)
Unknown	28 (3.1)
Depth*	
1°	37 (4.1)
2° superficial	210 (23.4)
2° deep	376 (41.9)
3°	297 (33.1)

Abbreviations: LOS, length of stay; QALY, quality-adjusted life-year; TTO, time tradeoff; VAS, visual analog scale.
*Values include 22 patients who were transferred to another hospital.

Table 3. Consumption of Medication According to Therapeutic Group and Year*

Therapeutic Group	2001	2000	1999	1998	1997
Digestive apparatus and metabolism	3690	3451	3896	3348	3123
Blood and hematopoietic organs	51 277	47 965	40 859	39 719	37 428
Cardiovascular apparatus	1063	995	591	676	531
Dermatologic	38 079	33 136	36 205	36 299	34 901
Genitourinary and sexual hormones	39	87	42	43	28
Hormones for systemic use, except sexual hormones	545	333	264	315	299
Anti-infectious for systemic use	17 210	16 459	20 271	16 227	14 323
Antineoplastics and immunomodulating medications	106	133	46	97	80
Musculoskeletal apparatus	3004	2665	2862	2631	2499
Nervous system	9705	9996	11185	9627	9233
Antiparasites, insecticides, and repellents	0	1	4	2	2
Respiratory apparatus	851	554	563	613	456
Sense organs	240	171	194	243	187
Various	1412	970	1156	936	809
Total	**127 221**	**116 916**	**118 138**	**110 776**	**103 899**

*Values are presented in dollars.

Table 4. Health Cost Analysis of the Different DRGs of Burns in Valencia, Spain, 1997-2001

DRG*	Patients, No. (%)	LOS, d	Cost per Day, $	Hospital Cost per Patient, $	1999 National Base of Hospital Cost per Patient, $	Differences, $	Outpatient Cost per Patient, $
460	411 (45.8)	11.94	303.30	3621	1951	1670	1081
459	8 (0.9)	18.79	329.10	6184	3283	2901	1134
458	351 (39.1)	22.34	486.60	10 871	8841	2030	1248
457	55 (6.1)	17.34	507.40	8798	5091	3707	1464
472	73 (8.1)	34.94	916.80	32 033	36 313	−4280	2345
Total or Mean	**898** (**100.0**)	19.08	477.0	9104	7642	1462	1284

Abbreviations: DRG, diagnosis-related group; LOS, length of stay.
*See Table 1 for explanation of DRG codes.

Table 5. Labor, Social, and Caregiver Cost Analysis per DRG in Valencia, Spain, 1997-2001

DRG*	No. of Days Off Work per Patient	Cost per Patient of Temporary Incapacity, $	Cost per Patient of Permanent Incapacity, $	Total Labor Costs, $	Mortality Rate	No. of Patients Who Died	YPLL	Social Costs, $	Indirect Costs, $
460	77	2133	0	2133	0.73	3	64	1843	3976
459	165	96	0	96	0	0	0	0	96
458	195	3971	2779	6750	5.41	19	412	12 189	18 939
457	147	627	2462	3089	3.64	2	36	1052	4141
472	441	2289	34 152	36 441	17.81	13	304	9104	45 545
Total or Mean	158	**9116**	**39 393**	**48 509**	4.12	**37**	**816**	**24 188**	**72 697**

Abbreviations: DRG, diagnosis-related group; YPLL, years of productive life lost.
*See Table 1 for explanation of DRG codes.

which is possibly one of the characteristics of our Mediterranean environment.

COSTS

Regarding the costs and methods of our study, many of the cost distributions show evidence of substantial skew, so statistically it would not be accurate to study mean costs. Despite this, we preferred to use the mean rather than the median because we were evaluating total costs. The cost per stay in our burn center was $477. However, this apparently high cost was less than half of the daily cost of patients treated in an intensive care unit, as pointed out by Chassin.[26]

In a study by Eldad et al[27] published in 1993, hospitalization costs of a severely burned patient, in 1991, were higher than ours. In the work by Eldad and colleagues, the costs of treating a severely burned patient were distributed as follows: salaries, 37.5%; medical and surgical materials, 22%; medicines, 7%; nutrition, 3.5%; laboratory, 14%; blood and derived products, 15%; and laundry, 1%. Likewise, we should not forget that these values refer to Israel, a country where salaries are low. In our research, the staff cost represented 59% of the hospital costs.

Table 6. Cost Analysis of the DRG Burn Patients in Valencia, Spain, 1997-2001

DRG*	Hospital Costs, $ (% of Total Costs)	Outpatient Costs, $ (% of Total Costs)	Caregiver Costs, $ (% of Total Costs)	Labor Costs, $ (% of Total Costs)	Social Costs, $ (% of Total Costs)	Total Costs, $	Cost per Patient, $
460	1488 (25.10)	444 (7.49)	21 (0.35)	2133 (35.98)	1843 (31.44)	**5929**	14 426
459	49 (26.34)	9 (4.84)	32 (17.20)	96 (51.61)	0 (17.20)	**186**	23 250
458	3816 (16.25)	438 (1.87)	288 (1.22)	6750 (28.75)	12 189 (53.14)	**23 481**	66 897
457	484 (8.94)	81 (1.50)	708 (13.07)	3089 (57.06)	1052 (32.51)	**5414**	98 436
472	2338 (4.60)	171 (0.34)	2740 (5.39)	36 441 (71.74)	9104 (23.32)	**50 794**	695 808
Total or Mean	**8175** (9.53)	**1143** (1.33)	**3789** (4.41)	**48 509** (56.53)	**24 188** (32.61)	**85 804**	95 551

Abbreviations: DRG, diagnosis-related group.
*See Table 1 for explanation of DRG codes.

Table 7. Incremental Cost Utility Rate of DRG Burn Patients, Valencia, Spain, 1997-2001

DRG*	Total Hospital Costs, $	Hospital Cost per Patient, $	Cost per Patient, $†	Total QALYs	QALY per Patient	Cost per QALY, $	QALYs on Discharge	ICUR Hospital Cost Base, $	ICUR Total Cost Base, $
460	1488	3621	14 426	5483	1214	271	0.89	. . .	. . .
459	49	6184	23 250	102	1279	567	0.86	3943	13 575
458	3816	10 871	66 897	5367	1529	793	0.86	2302	16 657
457	484	8798	98 436	961	1748	587	0.86	969	15 732
472	2338	32 033	695 808	1664	2279	1508	0.82	2668	63 980
Total or Mean	**8175**	9104	95 551	**13 577**	1513	686	0.87	. . .	. . .

Abbreviations: DRG, diagnosis-related group; ICUR, incremental cost utility ratio; QALY, quality-adjusted life-year.
*See Table 1 for explanation of DRG codes.
†Including hospital, social, and labor costs.

FACTORS THAT INFLUENCE HEALTH CARE COSTS

Obviously, with this diversity of values in costs, various factors may have an influence. Wheeler et al[28] found a direct relationship between the severity of burns and health care costs. In another study,[29] the cost per patient with severe burns amounted to US $46 069 in 1991. In our study, those patients incurred a cost of $32 033, but this amount is from almost 10 years later and obviously does not take into account the labor and social costs to make the costs comparable.

Therapeutic actions may also influence costs. The treatment of a burn patient consists of covering the skin of the patient, although the conditions and the way of doing so depend on the type and extent of the injury. When the TBSA is less than 30%, autograft skin can be used in a single operation. However, in full-thickness burns with TBSAs of more than 30%, it is necessary to cover the burns with some kind of skin and undertake various operations; in burns with TBSAs of 20% to 30%, the wound should be treated with cerium nitrate and sulfadiazine until the patient can be operated on. For a long time, expanded meshed autografts and, more recently, cultured epidermal autografts have been used on massive burns. With these autografts, the variability in costs may depend on various factors. As indicated by numerous authors,[21,29] early surgical treatment tends to shorten the hospital stay and reduce sepsis incidence. A suitable diet is also useful in reducing the hospitalization costs of burn patients, as pointed out by Weinsier et al.[30] There may also be differences attributable to different techniques. Hence, a modified technique of postage stamp autografting compared with the modified Meek technique produces a reduction in costs and other advantages, mainly in patients with extensive burns,[31] although there is still much discussion regarding the optimal dermal substitute.

Other factors that could influence costs are the introduction of cultures in the first 24 hours after burn injuries as a means of reducing the hospital stay and expenses of the burn patient[32] and the use of topical treatment, such as topical silver sulfadiazine combined with cerium nitrate, which according to some studies[33] produces a reduction of 8 days in reepithelialization and shortens the hospital stay by 7 days. Which therapeutic techniques should be used is also a cause for confusion. One study[34] questions the utility of early excision in the first 4 days after the injury and concludes that it produces a higher mortality rate compared with spontaneous eschar separation and late skin grafting, although it was undertaken with elderly patients approaching 80 years old. That study also concludes that cultured epidermal autografts cause an increase in length of stay and therefore hospital costs. Another interesting US study concluded that "routine cultures during the first 24 hours after admission to the hospital [are] not cost-effective"[35(p300)] and even estimated that their elimination could reduce the expenditures of that center by $14,000 a year. However, studies unanimously agree that burn patients should be administered antibiotics and that positive culture results show signs of clinical sepsis.[36,37] The highest costs in medication consumption classified by therapeutic groups were blood and hematopoiesis and dermatological products. Other factors that may influence costs are the size of the burn center or the fact that the center may not be specialized in the treatment of burn patients.[28]

Finally, another factor that strongly influences cost differences and in turn is the result of another series of factors is length of stay. In 1987, Gillespie et al[38] indicated that in the most advanced burn centers the mean length of stay per burn patient must not be more than 1 day per percentage of the TBSA. According to that study, this goal should be achieved by means of early aggressive surgical treatment, a suitable diet, physiotherapy and occupational therapies, nursing care, and psychological support. In our study, the mean length of stay was practically equal to 1% of the TBSA, although it was not equal in all the therapeutic options, especially when the treatment was undertaken with debridement plus grafting.

FACTORS THAT INFLUENCE LABOR AND SOCIAL COSTS

As far as indirect costs are concerned, the mean number of days of absence from work for the population studied was 158, which is somewhat higher when compared with another US study,[39] which had an absence rate of 100 days. However, the TBSA in the other study was 13.3%, whereas in our study it was 18%. In any case, more clinical trials should be undertaken to establish the most appropriate treatment of burn patients, since the cost studies of those patients present wide variability and it is complicated to obtain generic conclusions. Therefore, it would be necessary to arrive at a greater clinical consensus on the most appropriate standards to be used in treatments. From the product cost point of view, the costs of treating a patient admitted to the hospital for burns classified as DRG code 472 were almost 50 times higher than when the burns were classified as DRG code 460, although 85% of the costs of the former were sociolabor costs.

Uncertainty exists concerning the method selected to evaluate the resources and health outcome consequences. There is also some debate concerning whether and how to include the cost of production losses from work and/or time losses from particular activities (without wages) that may be valued by society or the individual.[39]

QUALITY OF LIFE

In this study, we used the TTO reference in correlation with VAS to determine the quality-of-life values, given that most researchers believe this is the best method. However, others, such as Feeny and Torrance,[40] prefer the technique known as standard gamble. Moreover, and in accordance with the data obtained, the cost per QALY was always much less than the cost per patient.

COST-UTILITY ANALYSIS

From the ICUR point of view, DRG code 456 was an option dominated by the remaining DRGs, and even more so when total cost was used. Recently, attempts have been made to estimate the maximum willingness to pay for QALYs. This process generated an amount of approximately $20 000 (US) per QALY, and it has even been used as a barrier for health care programs. Some researchers believe that a health care program that exceeds this amount should not be undertaken.[41] Therefore, all burns, according to the data obtained, would have justified their inclusion within the health care system.

Regarding the study's limitations, it should be borne in mind that intangible costs have not been included (such as those related to pain, forced change of life due to scarring, or restrictions on independence). Also, the level of response in the caregivers' survey did not reach the total, which may put a certain bias on its evaluation and may indicate that the costs in this portion could have been even greater. The information that home caregivers need appears to include the age of the patient and extent and location of the burn, but this would require a specific study to verify. Some authors advise use of the burn scar rating scale introduced by Yeong et al.[42] However, the EQ-5D survey used herein, although it did not include measuring the scars' characteristics, enabled a greater overall evaluation of the quality of life of the burn patient.

In conclusion, burn patients continue to be complicated to treat, and such treatment continues to be clinically reviewed. This study attempts to contribute an integrated vision of what a burn center means to society from the costs and product point of view. In addition, our study contributes to the burn patient literature a perspective of the measured results of their treatment and quality of life.

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Invited Critique

Sánchez et al provide us with outcomes data that go beyond hospital cost, length of stay, and morbidity and mortality statistics. They found that labor expenses were the major cost of treating burn patients, pointing out that burn care remains labor intensive. Currently, nearly two thirds of burn centers in the United States are experiencing a nursing shortage, and many have similar problems for burn surgeons. During the past decade, less than 50% of fellows completing burn fellowships have remained active in burn care, and 30% of those who are currently active plan to retire within 5 years. These shortages may become all the more significant by 2020 if the predicted shortages of 400 000 nurses and 200 000 physicians in the United States are correct.

Although using DRGs seems a reasonable approach to classify patients and cost of care, there are flaws inherent in this approach. The first is whether it is appropriate to use this approach for children, since children younger than 10 years made up 24% of this series. Also, the DRGs used in this study are no longer valid and have been replaced by 8 newer DRG codes (504-511). This change occurred because DRGs 457 through 472 did not adequately cover the costs involved in treating patients with extensive burn injuries that required grafting, those with inhalation injuries, or those with associated trauma. Furthermore, burn patients who undergo tracheostomy would be assigned DRG code 483 and therefore would not have been a part of this study.

The cost of reconstructive procedures, rehabilitation therapy, and wound care after discharge was not analyzed in the overall cost analysis. Return to work is probably not a reliable end point because, for many patients, other factors determine the actual time of returning to work. A functional capacity evaluation would give a more objective assessment of work capacity and recovery. Patients who returned to work at a job with a reduced level of compensation were not specifically analyzed. A cost not reported in this study is the loss of productivity for family members required to care for a patient after discharge. We can either continue to examine postevent cost and outcomes and design strategies to improve our performance or use the most cost-effective strategy before us—burn prevention.

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