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MISCELLANEOUS

Do the severity and the body region of injury correlate with long-term outcome in the severe traumatic patient?

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Abstract
Background and objectives: To investigate if the Injury Severity Score (ISS) and the Abbreviated Injury Score (AIS) are correlated with the long-term quality of life in severe trauma patients.
Methods: Patients injured from 2005 to 2007 with an ISS $\geq$ 15 were surveyed 16–24 months after injury. The Health Assessment Questionnaire (HAQ-DI) was used for measuring the functional status and the Short Form-12 (SF-12) was used for measuring the health status divided into its two components, the PCS (Physical Component Summary) and the MCS (Mental Component Summary). The results of the questionnaires were compared with the ISS and AIS components. Results of the SF-12 were compared with the values expected from the general population.
Results: Seventy-four patients filled the questionnaires (response rate 28%). The mean scores were: PCS 42.6 $\pm$ 13.3; MCS 49.4 $\pm$ 1.4; HAQ-DI 0.5 $\pm$ 0.7. Correlation was observed with the HAQ-DI and the PCS (Spearman's Rho: -0.83; $p < 0.05$) and no correlation between the HAQ-DI and the MCS neither between the MCS and PCS (Spearman's Rho = -0.21; and 0.01 respectively). The cutaneous-external and extremities-pelvic AIS punctuation were correlated with The PCS (Spearman's Rho: -0.39 and -0.34, $p < 0.05$) and with the HAQ-DI (Spearman's Rho: 0.31 and 0.23; $p < 0.05$). The physical condition compared with the regular population was worse except for the groups aged between 65–74 and 55–64.
Conclusions: Patients with extremities and pelvic fractures are more likely to suffer long-term disability. The severity of the external injuries influenced the long-term disability.

Introduction

In 1976 the American College of Surgeons Committee on Trauma categorized hospitals in Trauma-Centers; in consequence since then a decrease of mortality has been recognized.[1] However, other questions arousedsuch as the

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long-term quality of life and outcome improvement of trauma patients.[2]

In 1999 an international consensus conference remarked the heterogeneity of the available instruments for the measurement of the quality of life.[3,4] Several tools have been used: the Short Form-36 questionnaire (SF-36) and the Short Form-12 questionnaire (SF-12), the Glasgow Outcome Scale, the Functional Independence Measure, the Quality of Well-being Scale, the Hannover Score for Polytrauma Outcome and the EuroQOL-5D.[2,5–7] Each one of them has its advantages and limitations, but none of them measure all the dimensions that involve health status in trauma patients. A questionnaire should satisfy the following requirements: understandable, briefness on its accomplishment and analysis, validation in different languages, being of public domain, low cost use and validated for auto administration via e-mail or regular mail and by personal or phone interview. In addition, it should have a worldwide diffusion to be able to establish comparisons between different groups of patients in different countries. Based on these characteristics there are two questionnaires which have been used frequently: the Health Assessment Questionnaire-Disability Index (HAQ-DI) and the SF-12.

The HAQ-DI questionnaire was initially used for assessing rheumatic diseases,[8,9] and afterwards subsequently extended to any kind of condition.[10] The HAQ-DI can be realized in less than 5 min; it has been translated to more than 60 different languages and validated for its use by telephone. The SF-12 questionnaire is also validated to be administered by telephone and it needs only 2 min to be finished. It was initially designed to represent the summary components of the SF-36 with a 90% of precision, which completely overcame[11] and it has been used in the evaluation of patients who suffered multiple trauma, pelvic traumatism or workplace injuries.[12–16]

Recent guidelines have been published by the European Consumer Safety Association[17] grading the disability of trauma patients, in base on a systematic review and expert's opinion. Four different assessing points have been described: the acute phase within the first month; the rehabilitation phase, till 2 months; the adaptation phase, at the fourth month, and the recovery phase, up to 6 months.

The health and quality of life after discharge have been associated to age, sex, comorbidity, the severity of the traumatism and the length of stay at the hospital.[6,7,18–20] The severity of the traumatism is stratified according to the Injury Severity Score index (ISS) which correlates to mortality.[21] The ISS is an anatomical scoring system based on the Abbreviated Injury Scale (AIS) that graduates the severity of the injuries in different anatomical regions.[22] When the ISS is greater than 15 a severe trauma patient can be predicted.[23]

The aim of our study was to determine if the long-term health status of severe trauma, measured by the HAQ-DI and the SF-12 correlate with the extended injuries measured by the ISS.

Methods

After Hospital Ethics Committee approval, a database was created. All trauma patients who were attended in our trauma center due to a blunt or penetrating injury within the years 2005 –2007 were included. Patients who had an ISS $\geq$ 15, with an age $\geq$18 years and who were discharged from the hospital were followed up. The data collected were the demographic characteristics of patients, the type of injury, the ISS, and the AIS.

The HAQ-DI questions were grouped into 8 categories (dressing, rising, eating, walking, hygiene, reach, grip and usual activities), each category was scored from 0 to 3 (0: without any difficulty; 1: with some difficulty; 2: with much difficulty; 3: unable to do); afterwards the average of the 8 categories was made to obtain the score of the questionnaire. In case of the patient needing help or using special devices on any of the categories a correction factor was applied. At least 6 of the 8 categories must be answered or the questionnaire cannot be computed. Scores were classified as 0 meaning no disability, 0–1 mild disability, 1–2 moderate disability and 2–3 severe disability.[8,9]

The SF-12 included 8 categories (physical function, physical role, emotional role, social function, mental health, general health, body pain and vitality). The numerical score obtained in each category was calculated by the sum of the items, and converted to a scale from 0 (worst score) to 100 (best score).[11] The results were divided into two main components, the Physical Component Summary and the Mental Component Summary both validated in the American and the Spanish population, obtaining similar summary component weights for both populations.[24] There are two ways of estimating the summary components: the standard which refers to data from USA, and the specific where the data used refers to each country in particular; we selected de standard form as it is recommended for international publications. Summary components were created reflecting the standard deviation from the average with a value of 50. It was considered a normal health status if the values of the summary components were between 40 and 60; limited health status if the values were below 40; and good health status if the values were above 60.

The results obtained with the SF-12 were compared with those expected from the general population, stratified according to age. The power of the effect size of each population was calculated.

The questionnaires were performed 16–24 months post-injury, by trained personnel via telephone; if the patient did not answer the phone at the first call, three extra calls were made in morning, afternoon and evening times. Losses in follow up were considered if it was not possible to get in touch with the patient or the patient did not want to answer the surveys.

The statistical analysis was performed using the SPSS WIN 15.0 package. We used the Chi-square test (Yates correction and Fisher exact test) to compare the proportions of responders and non-responders. The Kruskal–Wallis was used to compare the categorized scores of the different questionnaires. The Spearman test was used to compare the relationship between quality of life with the ISS and the AIS components. The effect size was used to compare the scores of the responders with that of the reference population. Data are shown as mean and standard deviation or median and range when indicated. A value of $p \leq 0.05$ was considered significance.

Table 1 Comparison of demographic characteristics and AIS values between responders and non-responders to the surveys.

	Responders $n = 74$	Non-responders $n = 193$	$p^{\dagger}$
Age	43 ± 17	36 ± 14	0.02
Men	59 (79%)	155 (80%)	0.50
ISS	24.4 ± 6.3	24.5 ± 7.5	0.85
Extern-AIS ≤ 3	37 (50%)	114 (56%)	0.57
Head-AIS ≤ 3	37 (50%)	85 (44%)	0.46
Thorax-AIS ≤ 3	43 (58%)	107 (55%)	0.33
Abdomen-AIS ≤ 3	20 (27%)	40 (21%)	0.26
Spin-AIS ≤ 3	18 (24%)	45 (23%)	0.18
Pelvis-Extremities-AIS ≤ 3	42 (57%)	129 (67%)	1
Body region of injury			
Thoracic	59 (80%)	131 (67%)	0.07
Abdominal	41 (55%)	105 (54%)	0.90
Vertebral	18 (24%)	48 (25%)	0.90
Pelvis	15 (20%)	50 (26%)	0.43
Extremities	42 (57%)	120 (62%)	0.48
Cranial	42 (57%)	98 (51%)	0.49
Glasgow Coma Scale ≤ 8	12 (16%)	28 (14%)	0.70

ISS, Injury Severity Score; AIS, Abreviated Injury Scale.
† Statistic χ^2; data expressed as mean $\pm$ standard deviation, absolute values and (percentage).

Results

A total of 267 patients with an ISS ≥ 15 were discharged from the hospital. In 160 cases there were no answers because of erroneous telephone number or more than three calls without response; 24 patients refused to answer the questionnaires; in 5 cases there were an idiomatic barrier; in 2 cases the patient had passed away and in 2 cases the medical condition made impossible answering the questionnaires. A total of 74 patients filled the questionnaires.

Comparing the patients who answered the questionnaires with those who did not, the non-responder population were younger (36 ± 14 vs. 43 ± 17; $p = 0.02$). There were no differences in the demographic data, the injured anatomical regions and in the AIS registered (Table 1).

The median scores and ranges were 46 (11.8–60.9) for the Physical Component Summary; 51 (12.9–74.2) for the Mental Component Summary, and 0.12 (0–3) for the HAQ-DI.

The ISS values were comparable for the different categories of the HAQ-DI and for the physical and mental summary components of the SF-12 (Table 2).

We obtained a negative correlation between the HAQ-DI and the physical component of the SF-12 (Spearman's Rho = −0.83; $p = 0.000$) and no correlation between the HAQ-DI and the mental component of the SF-12 (Spearman's Rho = −0.21; $p = 0.07$), neither between the mental and physical components of the SF-12 (Spearman's Rho = 0.01; $p = 0.9$).

Analyzing the AIS components of the ISS (Table 3) we found a significant negative-correlation between the PCS and the cutaneous-external score of the AIS and with the extremities-pelvic score. Likewise, we found positive significant correlation of these two scores with the HAQ-DI; and a positive correlation between the PCS and the abdominal-pelvic contents score of the AIS. There was also a correlation between the Abdomen AIS and the pelvic extremities (Spearman's Rho = −0.35; $p = 0.002$).

When comparing the physical and mental health status of our trauma patients with the normal values of population, we observed that the physical condition was globally worse in all age intervals, except in patients aged between 55–64 and 65–74, where the effect size was smaller. Regarding to the mental health status, the values obtained showed a mild difference in the interval between 35 and 44 years, where the mental health status was lower than the norm (Table 4).

Table 2 Relation between levels of the Health Assessment Questionnaire, the Physical Component Summary of the SF-12 and the Mental Component Summary of the SF-12 with the ISS (injury severity store).

	n	ISS	P^{a}
HAQ-DI			
No disability	36	26.5 (16–45)	
Mild disability	21	21 (16–38)	0.22
Moderate disability	12	23 (17–34)	
Severe disability	5	22 (17–34)	
PCS			
Good Health Status	3	16 (16–26)	0.15
Normal Health Status	42	26 (16–45)	
Limited Health Status	29	22 (17–34)	
MCS			
Good Health Status	12	21.5 (17–29)	
Normal Health Status	50	25 (16–45)	0.68
Limited Health Status	12	24 (16–34)	

HAQ-DI, Health Assessment Questionnaire; PCS, Physical Component Summary of the SF-12; MCS, Mental Component Summary of the SF-12.
Data expressed as median and range.
^{a} Kruskal–Wallis.

Table 3 Correlation between the Health Assessment Questionnaire, the Physical Component Summary of the SF-12 and the Mental Component Summary of the SF-12 with the Abbreviated Injury Score components.

	PCS[a]	MCS[a]	HAQ[a]
ISS	0.06	−0.09	−0.13
AIS-External	−0.39*	0.01	0.31*
AIS-Head	0.09	−0.05	−0.05
AIS-Thorax	0.06	−0.12	−0.14
AIS-Abdomen	0.28*	−0.54	−0.20
AIS-Spine	−0.17	−0.05	0.12
AIS-Pelvis-Extr	−0.34*	0.09	0.23*
PCS	–	0.01	−0.83*
MCS	0.01	–	−0.21

ISS, Injury Severity Score; AIS-Pelvis-Ext, Extremities and Bony pelvis; AIS-Abdomen, Abdomen and pelvic contents; PCS, Physical Component Summary of the SF-12; MCS, Mental Component Summary of the SF-12; HAQ-DI, Health Assessment Questionnaire.

[a] Rho of Spearman Correlation.

* $p \leq 0.05$.

Discussion

After the application of the HAQ-DI and the SF-12 to our patients, we obtained values in the lower health status range, with worse values in the physical component than in the mental component. We evaluated the health status 16–24 months post-injury; therefore the low values obtained were measured after a long period of rehabilitation. The measure of the long-term quality of life in trauma patients should be considered when a complete rehabilitation is achieved. According to some authors[17,25] after 12 months from injury a high percentage of patients showed a full recovery of their lesions. However, it is considered better to evaluate the health status after 24 months from the traumatism, in order to assure a stable situation of the disabilities.[2,19]

We could not observe any relation between the health status and the ISS values. The ISS is based on anatomical injuries; for this reason an association to health status can be expected. Nevertheless, the results of our study were in accordance with the results published by other authors.[12,13,18,26] However, some association between the ISS and the physical component of the long-term health status[14] and with the global quality of life evaluated 2–7 years after the traumatism,[7] has been observed, as well as a relation of the ISS with the physical component of the quality of life measured immediately after the injury.[13] The global interpretation of opposite papers is difficult and results are not comparable because of the different questionnaires used and the different time of measurement.

We found a significant correlation between the long-term quality of life measured twice through the Physical Component Summary and the HAQ-DI with the cutaneous-external component and the extremities-pelvic ring component of the ISS. There was no relation of these two components with

Table 4 Evaluation of the effect size of the study group with the normal population measured by the SF-12.

	n	PCS	*d*	MCS	*d*
18–24 years					
Study group	11	48 ± 11	−1.24	51 ± 7	0.06
Normal	2081	55 ± 5		50 ± 9	
25–34 years					
Study group	17	46 ± 12	−1.38	52 ± 8	0.21
Normal	2810	54 ± 5		51 ± 8	
35–44 years					
Study group	14	38 ± 16	−1.87	44 ± 18	-0.72
Normal	1730	53 ± 7		51 ± 8	
45–54 years					
Study group	12	40 ± 12	−1.17	50 ± 11	-0.03
Normal	622	50 ± 9		50 ± 8	
55–64 years					
Study group	9	44 ± 13	−0.31	47 ± 10	-0.19
Normal	647	47 ± 10		49 ± 10	
65–74 years					
Study group	7	44 ± 12	0.06	50 ± 17	0.12
Normal	1692	45 ± 10		48 ± 9	
≥75 years					
Study group	3	33 ± 34	−0.7	53 ± 18	0.29
Normal	1312	41 ± 11		48 ± 10	

PCS, Physical Component Summary of the SF-12; MCS, Mental Component Summary of the SF-12; *d*, effect size of Cohen ($d = 0.20–0.3$ small effect; $d = 0.50$ medium effect; $d \geq 0.80$ large effect).

Data are mean ± standard deviation.

the Mental Component Summary. The association between pelvic and extremities injuries with the long-term quality of life has been described by other authors,[12,18,27] nevertheless, the association with the cutaneous region has not been recognized. The correlation of the cutaneous scores with the long-term quality of life can be interpreted as a reflection of these injuries by the magnitude of the fractures in the extremities. Similarly, we were able to associate the AIS punctuations of the abdomen component and the pelvic ring injury which indicates the association of serious pelvic fractures with the presence of traumatized vessels and other intra-abdominal injuries. We also found a correlation between the abdominal component of the ISS and the Physical Component Summary, but not with the HAQ-DI.

The correlation between the HAQ-DI and the Physical Component Summary of the SF-12; reinforces the physical disability in our patients. The Mental Component Summary values of the SF-12 were not correlated with the physical disability measured by the HAQ-DI. Therefore both questionnaires are measuring different components of the disability and it reinforces the importance of using complementary questionnaires for measuring the health status. The HAQ-DI includes evaluation of precise movements and motor activities of the upper and lower extremities.[8–10,28] Nevertheless one of the weak points of this questionnaire is that it does not measure the disability related to psychiatric problems, affectation of sensory organs, and satisfaction of the patient or social integration. These deficiencies can be complemented with the application of the SF-12 questionnaire taking in consideration both summary components, the physically component and the mental.

When compared the health condition of our population with the population standard norms, we observed that the Physical Component Summary values were lower than the norm, and this difference was higher in the population under 54 years who presented a worse physical status. Polinder et al.,[19] verified that patients, on age under 65, presented a worse long-term quality of life than the older group, and that it was influenced by the presence of other illnesses. Livingston et al.[5] found a weak correlation of the health status with age, but they also pointed that the population above 65 years evaluated their quality of life as better and this might be related to a less expectation about health than the younger population.

The low response rate is one of the limitations of our study, being this percentage variable according to the literature and ranging between 21% and 88%.[19,29] This variability depends on the methodology used,[12,14] but normally long-term outcome studies, like ours, have a low response rate. Polinder et al.[19] at 24 months follow-up registered a response rate of 21%. In our study, we found no differences in the trauma characteristics of the responders and non-responders, expecting therefore similar outcome in both populations.

We conclude, that determining the long-term quality of life might help to identify those patients in whom there would be necessary more effort and emphasis in the rehabilitation and adjustment processes; and also may help to detect preventive approaches directed to diminish the post-traumatic disability. In our population, those who suffered extremities and pelvic fractures are more likely to suffer long-term disability and the severity of the external injuries are also predictive for long-term disability of traumatic patients.

Conflicts of interest

The authors declare no conflicts of interest.

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