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**Substance use and misuse in burn patients: testing the classical hypotheses of the interaction between posttraumatic symptomatology and substance use**

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## **Substance use and misuse in burn patients: testing the classical hypotheses of the interaction between posttraumatic symptomatology and substance use**

**Background:** We aimed to test whether the three classical hypotheses of the interaction between posttraumatic symptomatology and substance use (high risk of trauma exposure, susceptibility for posttraumatic symptomatology, and self-medication of symptoms), may be useful in the understanding of substance use among burn patients.

**Methods:** We analysed substance use data (nicotine, alcohol, cannabis, amphetamines, cocaine, opiates, and tranquilizers) and psychopathology measures among burn patients admitted to a Burns Unit and enrolled in a longitudinal observational study. Lifetime substance use information (n=246) was incorporated to analyses aiming to test the high risk hypothesis. Only patients assessed for psychopathology in a six months follow-up (n=183) were included in prospective analyses testing the susceptibility and self-medication hypotheses.

**Results:** Regarding the high risk hypothesis, results show a higher proportion of heroin and tranquilizer users compared to the general population. Furthermore, in line with the susceptibility hypothesis, higher levels of symptomatology were found in lifetime alcohol, tobacco and drug users during recovery. The self-medication hypothesis could be tested partially due to the hospital stay “cleaning” effect, but severity of symptoms was linked to caffeine, nicotine, alcohol and cannabis use after discharge.

**Conclusions:** We found that the three classical hypotheses could be used to understand the link between traumatic experiences and substance use explaining different patterns of burn patient’s risk for trauma exposure and emergence of symptomatology.

**Key words:** *Burn patients, substance use, substance misuse, trauma, coping strategies, self-medication.*

## **Introduction**

### **Substance use and misuse among burn patients**

Until now, substance use and misuse among burn patients has been an understudied feature in this population. Although it could be considered a secondary factor into the complexity of the burn recovery process (usually including painful surgery and physical rehabilitation), previous research evidences the high rates of substance use among patients admitted to burn units <sup>1-4</sup>, the specific recovery difficulties of patients with substance misuse problems <sup>5-7</sup>, and the higher rates of PTSD among burn patients with previous substance use disorders <sup>8</sup>.

High, although variable rates of substance misuse, have been detected in clinical studies measuring it as primary or secondary outcome. Alcoholism was proposed as the most reliable predisposing factor in a classical study carried by MacArthur and Moore <sup>9</sup>. McKibben et al. <sup>1</sup> reviewed rates of alcohol and substance use disorders in different samples of patients admitted to burn units. Alcohol misuse rates among participants of burn studies seem to be high (32-41%) although comparisons with the general population are not always feasible, as the methodologies used are different from population-wide studies. Furthermore, drug misuse have different rates in studies made in different countries (6-24%). These results may respond to different drug cultures and the methodologies used.

Differences with the general population regarding substance use can be seen in studies such as the one carried by Fauerbach et al. <sup>10</sup>. This study group found higher lifetime and follow-up rates for alcohol and drug abuse and dependence among burn injured adults compared to a community-dwelling sample. Accordingly, higher rates of substance use disorders are shown by Meyer et al. <sup>11</sup>, who compared young adults who suffered burn injuries during childhood, with the US population of comparable age.

All this information taken together, suggests an influence of substance misuse as a possible cause of the injury and, subsequently, an aggravating condition in patients' recovery. It may also be assumed that burn injuries may lead to substance use, however, the lack of longitudinal data has prevented analyses in this regard.

### **Shared pathways of trauma and substance use**

Despite the lack of information about substance use among burn patients, interaction of trauma and substance use has been extensively studied in general and specific samples of traumatized patients. In a classical revision, Brown and Wolfe <sup>2</sup> proposed three mechanisms by which traumatic stress and substance use disorders may interact: 1) substance users' higher risk of exposure to traumatic events, 2) substance users' increased susceptibility to psychiatric disorders due to deteriorating physical and psychological conditions, and 3) the use of drugs as self-medication of posttraumatic symptoms. The high risk hypothesis, postulates that substance users are more prone to risky behaviours (e.g. theft or dangerous driving), which increase the probability of exposure to potentially traumatizing events. The susceptibility hypothesis postulates that the vulnerability to comorbid substance use disorders and PTSD is due to persistent changes in physiology and neurochemical systems because of substance misuse, or a complex interplay between all of the above. Finally, the self-medication hypothesis postulates that PTSD develops first and substances are used as a means of achieving symptom relief. In other prominent revisions, these three hypotheses appear as the principal pathways by which trauma and substance use and misuse interact <sup>12,13</sup>, having been tested in some empirical works. For instance, Chilcoat and Breslau <sup>14,15</sup> tested the three hypotheses in an epidemiological study of young adults. They found support for the use of substances to self-medicate symptoms among persons suffering from PTSD, no support for the high risk hypothesis, and they could not rule out the possibility of

shared vulnerability to PTSD and drug use. However, it has been long advocated that substance misuse makes people more vulnerable to accidents such as burns<sup>16,17</sup>.

Recent works show support for the three models. The high risk hypothesis receives evidence from epidemiological<sup>16</sup> and family genetic studies<sup>17</sup>, and the susceptibility hypothesis mainly from neurobiological and genetic studies<sup>18,19</sup>. The self-medication hypothesis has received support mainly from clinical<sup>20</sup> and epidemiological studies<sup>21-23</sup>.

To our knowledge, to date no study has longitudinally assessed the interaction between injury conditions, posttraumatic symptomatology and recovery characteristics with substance use within a sample patients admitted to a burn unit. In this study we use information extracted from an extensive clinical sample of burn patients to test the three hypotheses proposed by Brown and Wolfe<sup>2</sup>: the high risk hypothesis, the susceptibility hypothesis and the self-medication hypothesis. Our expectation is that all three will shed some light on how trauma interacts with substance use in this group of survivors.

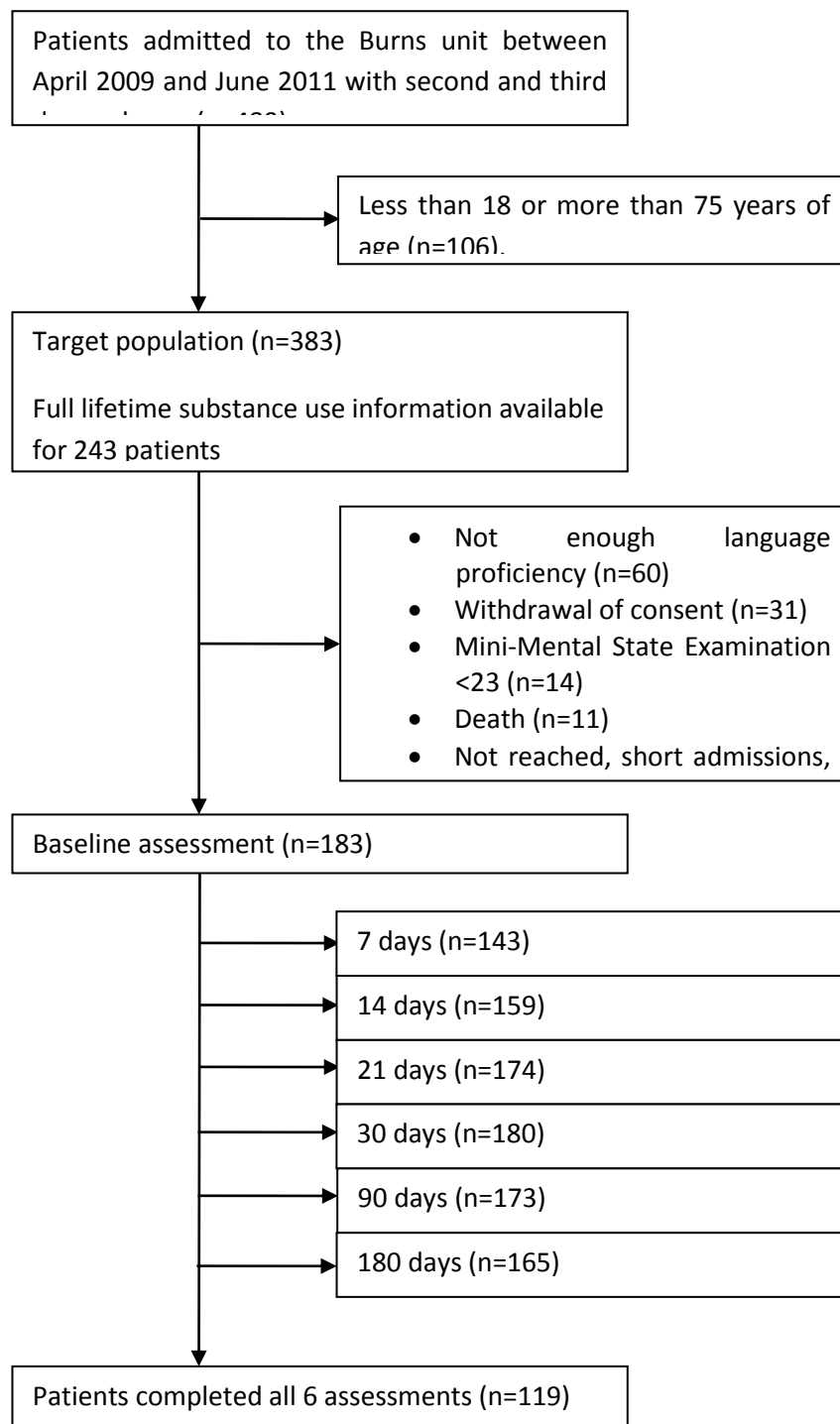
## **Methods**

### ***Sample.***

All adult patients (n=246) screened in the Burn Unit of the University Hospital Vall d'Hebron during a period of two years were incorporated to baseline analyses aiming to test the high risk hypothesis. From this sample, with the objective of testing the susceptibility and self-medication hypotheses, 183 patients were included in prospective analyses after applying the following exclusion criteria: a) not enough Spanish/Catalan language proficiency; b) Mini-Mental State Examination <23; c) decease and, d) recruitment limitations (*i.e.* not reached, short admissions or admission for long term sequelae). No patient explicitly withdrawn consent once included in the study. This

study was performed according to the guidelines of the Helsinki Declaration <sup>24</sup>. The ethical committee of the hospital approved the protocol and all patients signed an informed consent. Participation was confidential and on a voluntary basis. A flowchart of the study can be seen in figure 1.

**Figure 1.** Flow diagram of the study



### ***Procedure.***

In this follow-up study, participants between 18 and 75 years of age were assessed by two trained psychologists consecutively at six different stages: once a week during the first month after burn injury (for acute stress symptomatology), once more at three months (when posttraumatic stress disorder, PTSD, is considered to become already chronic), and again at six months (for delayed onset of posttraumatic symptoms) after the injury. The assessments were conducted face to face in the case of hospital interviews and by telephone when participants were already discharged.

### ***Measures.***

Sociodemographic information, previous health (including mental health) problems and burn data were collected at first assessment, or when the recovery of the patient allowed it, using an ad-hoc structured interview and also at the six months follow-up. Substance use information, depressive, anxiety and traumatic stress symptoms, as well as positive and negative emotions were assessed, whenever possible, at every one of the six consecutive assessments. Both lifetime and longitudinal (at 7, 14, 30, 90 and 180 days) substance use was recorded for nicotine, alcohol, cannabis, amphetamines, cocaine, opiates, and tranquilizers, using a brief ad-hoc inventory. Regarding the latter, reasons of consumption were also inquired about (use under medical supervision vs. unsupervised tranquilizer use).

Additionally, the COPE <sup>25</sup> was used to assess lifetime substance use coping strategies at baseline. This questionnaire measures a variety of coping behaviours. It has demonstrated good psychometric properties assessing 12 coping behaviours including: self-distraction, active coping, denial, substance use, use of emotional support, behavioural disengagement, venting, positive reframing, planning, humour, acceptance, and religion. The substance use scale, assesses the alcohol or drug disengagement as a

way of coping, e.g. I drink alcohol or take drugs, in order to think about it less. This instrument has been used in stress related studies including burn survivors<sup>26</sup>.

At all six assessments depression was measured using the Beck Depression Inventory, BDI <sup>27,28</sup>. This 21-question self-report inventory is probably the most widely used psychometric test for measuring the severity of depression, which increases comparability with other studies made on burn injuries or other medical conditions. Also anxiety was measured at all assessments using the State Trait Anxiety Inventory, STAI <sup>29</sup>, a commonly used inventory of trait and state anxiety consisting of 40 questions on a self-report basis. This questionnaire allows the differentiation of anxiety as a personality trait, with anxiety related to the fluctuation of patients' recovery. Anxiety trait only was measured at baseline.

In relation to posttraumatic stress symptoms, the revision of the Impact of Events Scale, IES-R <sup>30</sup> was administrated to measure avoidance, intrusion and hyperarousal responses to trauma at all six assessments. This instrument was chosen because of its psychometric properties and its validated three factor structure in burn patients <sup>31</sup>. The Davidson Trauma Scale, DTS <sup>32</sup>, an instrument with a reliable cut-off, was used to measure posttraumatic symptoms severity and frequency at 30, 90 and 180 days. Previous studies in burn patients have used this scale as a successful measure of posttraumatic symptomatology <sup>33</sup>. Additionally, the MINI international neuropsychiatric interview <sup>34</sup>, Spanish version <sup>35</sup>, was used at six months to perform a clinical assessment of PTSD following DSM IV criteria. Similar than other diagnostic instruments, such as the Structured Clinical Interview for DSM and the Composite International Diagnostic Interview, it has showed appropriate psychometric properties <sup>36</sup>, and it has already been successfully used in burn research to assess PTSD <sup>37</sup>.



The Positive and Negative Affect Schedule, PANAS<sup>38</sup>, was used for the measure of positive and negative emotions also in the last three assessments. This self-administered scale contains 20 multiple-choice items on a five-point scale ranging from 1 = Very Slightly or Not at All, to 5 = Extremely. It assesses the extent to which the respondent have felt that way over the past week, including items of negative affect (such as upset, guilty or scared) as well as items of positive affect (such as enthusiastic, interested or proud). This instrument has shown good psychometric properties<sup>39</sup>. In this study, the sum of negative items was subtracted to the sum of positive items, so the result expresses a positive emotional direction, ranging -40 – 40.

In summary, all these instruments have been demonstrated to be valid and reliable in burn patients research<sup>40</sup>.

### ***Data analysis***

Available sociodemographic (including age, gender, cohabitation, education, work status, and socioeconomic status) and burn characteristics (including total body burn surface [TBSA], aetiology, mechanism, place of occurrence and the presence of other persons in the burn scene) were compared between patients with and without lifetime substance use by means of t tests for continuous variables (Mann–Whitney Us if sample size was not enough to perform a parametric test), and odds ratios for categorical variables.

The *high risk hypothesis* was tested comparing lifetime substance use rates of patients with representative Spanish population data collected using the same questions (i.e. have you ever consumed...) in the period when the study was done<sup>41,42</sup> using Chi-squared tests with Bonferroni adjustments for multiple comparisons, expecting that some of the proportions will be statistically higher in our sample than in the equivalent general population. As our sample is representative of the population of severe burns in

a region, the possible overrepresentation of the use of a given substance could indicate that behaviours associated with the use of these substances may lead to an increased risk of burn injuries.

The *susceptibility hypothesis* was tested in two ways. Firstly we checked whether substance use as a coping strategy (a subscale of the COPE questionnaire) correlated with posttraumatic symptomatology, anxiety, depression and positive emotions measured in the mentioned six follow up interviews. As the distribution of the COPE subscale was skewed to the left, correlations were made using non-parametric Spearman's rank correlation coefficients.

Secondly we wanted to prove that the emergence of symptoms could be caused by lifetime alcohol and illegal substance misuse. Due to the structure of our data, multiple imputations were used to manage missing data and perform t-tests and repeated measures general linear models (RM-GLMs) using substance misuse (lifetime problematic use of alcohol, i.e.  $\geq 4$  consumption units of alcohol/day, each unit=10 g of alcohol <sup>43</sup>; and/or lifetime consumption of illegal substances) as independent variable, and symptomatology and positive emotions as dependent variables. Tobacco consumption was analysed separately. As there was a very high rate of absolute lifetime consumption and current irregular consumption of tobacco in our sample, regular smoking (ten or more cigarettes per day) at the time of the injury was used as independent variable to perform t-tests and RM-GLMs with symptomatology and positive emotions as dependent variables. The rates of PTSD at six months were compared by lifetime misuse of alcohol and/or lifetime consumption of illegal substances and regular smoking using odds ratios.

Finally, the *self-medication hypothesis* was tested correlating levels of substance use and posttraumatic symptomatology in each follow up interview (if information was available and we were able to gather a sufficient number of consumers), using non-parametric Spearman correlations due to the generalized left skewness of score distributions and low  $n$ . Due to sample  $n$  and admission characteristics restrictions (any substance use was restricted excluding tobacco), we were only able to test nicotine during the whole study, alcohol at 30, 90, and 180 days and cannabis at 180 days. We expected positive correlations between symptomatology and substance use after the injury.

All analyses were at the 95% confidence interval level, and were performed using the SPSS 18.0 statistical package.

## **Results**

From a total of 383 patients between 18 and 75 years of age admitted to the burn unit, full lifetime information for drug use was available for 243 (63.4% of the total sample) and prospective psychopathological data was available for 183 patients. Patients reporting any lifetime substance misuse (problematic use of alcohol and/or any illegal substance use, as described in the data analysis section) were more likely to drop out from the study at any of the measurement points (OR: 2.67, 95% IC=5.03—1.42). Participants' mean age was 41.14 ( $SD = 14.13$ ), 29% were females, 68.3% were in a relation, 55.7% had at least secondary studies and the same percentage were considered to be professionally active. However, 23% of the sample reported a low economic income situation. Their mean TBSA burned was 14.1% ( $SD = 13.97$ ) and the average of length of stay was 20.96 days ( $SD = 20.36$ ). From the sample, 31.1% suffered third-degree burns. Most burns were caused by flame (61.7%) followed by scalds (18.5%). A

total of 14 patients (5.8% of the sample) had a lifetime history of heroin and cocaine dependence (no patient was found to have lifetime history of heroin dependence without cocaine dependence).

### ***Patients characteristics by substance use type***

Lifetime smokers (n=173, 64.8%) were more likely to be men (OR=1.88, 95% C.I.=1.09-3.22, p=.022), unemployed (OR=.55, 95% C.I.=.32-.96, p=.034) and involved in a flame or electric accident (in contrast to accidents due to chemicals, scalds or contact with surfaces, (OR=2.26, 95% C.I.=1.33-3.81, p=.002) than patients reporting no lifetime nicotine use. Lifetime alcohol drinkers (n=180, 70.9%) were more likely to be men (OR=4.03, 95% C.I.=2.26-7.18, p<.0001) and more likely to have had an accident in a public place (vs. home, OR=1.80, 95% C.I.=1.03-3.14, p=.037) than people reporting no lifetime misuse of alcohol.

Amphetamine users (n=9, 3.7%) were younger than non-users (z=-2.403, p=.016) and also had more likely been burned in a public place (OR=9.11, 95%, C.I.=1.12-74.02, p=.016). Lifetime cannabis users (n=48, 20%) were younger (t=-5.025, p<.0001), more likely men (OR=2.68, 95%, C.I.=1.19-6.06, p=.015), had a lower socioeconomic status (OR=2.32, 95%, C.I.=1.16-4.62, p=.016), and had been burned with flame or electricity (OR=2.24, 95%, C.I.=1.11-5.31, p=.002).

Cocaine users (n= 29, 11.9%) were younger (t=-2.615, p=.009), more likely to be living alone (OR=.42, 95%, C.I.=.179-.982, p=.041), unemployed (OR=.28, 95%, C.I.=.12-.67, p=.003), had a lower socioeconomic status (OR=5.35, 95%, C.I.=2.32-12.33, p<.0001), and have been more likely burned with flame or electricity (OR=3.37, 95%, C.I.=1.13-1.08, p=.022) than non-lifetime cocaine users.

Opiate users (n=14, 5.8%) were more often unemployed (OR=.06, 95% C.I.=.01-.48, p<.0001), living alone (OR=.28, 95% C.I.= .09-.88, p=.022), had a lower socioeconomic status (OR=6.44, 95% C.I.=.82-50.45, p<.05), and were more likely to have been involved in a flame or electric accident (OR=6.44, 95% C.I.=.82-50.45, p=.043), than non-lifetime opiate users. All these patients had once received a diagnosis of opioid dependence before the injury.

Tranquilizers users (n=51, 21.4%) were more often living alone (OR=.47, 95% C.I.=.28-.963, p=.037), unemployed (OR=.24, 95%, C.I.=.12-.50, p<.0001), had a lower socioeconomic status (OR=2.54, 95%, C.I.=1.26-5.11, p=.008) and were less likely to be involved in an accident with more injured people (OR=.32, 95%, C.I.=.11-.94, p=.029). The reasons for consumption were exclusively mental health problems for the 80% of the sample, and combination with other drugs (mainly opiates) for the remaining 20%.

### ***High risk hypothesis.***

The results of the analysis of the high risk hypothesis can be seen in table 1. As said in the analysis section, rates in the sample were compared to Spanish national representative data. The basic demographic characteristics of our sample were similar in terms of mean age (41 years of age in our sample, 40 in the local general population), although not of genre distribution (with a higher proportion of men in our sample). Therefore we have included a stratification by gender. Statistical significant differences between our sample and the general population were found for alcohol in the case of men, tobacco among men, cannabis in both genders, opiates in both genders and tranquilizers. After Bonferroni adjustment, statistical signification remained only for opiates and tranquilizers in both genres.

**Table 1.** Lifetime prevalence (%) of substance use in our sample (n=246) compared to Spain population\*

		Population estimate	Burn patients	Significance
Alcohol**	Total	63.3	70.9	$\chi^2 = 6.259, p = .012$
	Men	73.3	80.1	$\chi^2 = 4.175, p = .041$
	Women	50	50	$\chi^2 = .000, p = 1$
Tobacco	Total	68.5	64.8	$\chi^2 = 1.699, p = .192$
	Men	75.5	69.1	$\chi^2 = 4.100, p = .043$
	Women	63.3	54.4	$\chi^2 = 2.675, p = .102$
Cannabis	Total	27.3	20.0	$\chi^2 = 6.444, p = .011$
	Men	36.8	24.2	$\chi^2 = 11.187, p = .001$
	Women	20.1	10.7	$\chi^2 = 4.156, p = .041$
Cocaine	Total	8.0	11.9	$\chi^2 = 5.110, p = .024$
	Men	10.5	12.6	$\chi^2 = 0.765, p = .382$
	Women	3.4	10.5	$\chi^2 = 11.751, p = .001$
Opiates	Total	.8	5.8	$\chi^2 = 75.370, p < .0001$
	Men	1.1	6.0	$\chi^2 = 525.127, p > .0001$
	Women	.2	5.3	$\chi^2 = 97.610, p > .0001$
Amphetamines	Total	3.8	3.7	$\chi^2 = .006, p = .937$
	Men	5	4.2	$\chi^2 = .230, p = .632$
	Women	1.8	2.6	$\chi^2 = .297, p = .586$
Tranquilizers	Total	13	21.4	$\chi^2 = 14.999, p < .0001$
	Men	10.04	18.9	$\chi^2 = 14.442, p < .0001$
	Women	15.02	27.0	$\chi^2 = 277.813, p < .0001$

Bonferroni adjustment for multiple comparisons:  $.05/7 = .007$ . \*EDADES[Encuesta Domiciliaria sobre Alcohol y Drogas en España] studies<sup>41</sup> \*\*At least a lifetime frequent drinking period.

## **Susceptibility hypothesis**

### *Substance use as a coping strategy.*

The correlations of the substance use subscale of the COPE questionnaire with posttraumatic symptomatology at the six follow up points can be seen in table 2. No statistically significant correlations were found for avoidance. Moderate to low statistically significant correlations were found for intrusion at all points and hyperarousal at 14, 21 days and three months. Posttraumatic symptoms severity and frequency, was found to statistically correlate with high levels of substance use coping style at 30 days and 3 months. Anxiety correlated significantly at 14, 21, 30 days and three months, while depression correlated at all-time points excluding the six months follow-up. Positive and negative emotions (in a single punctuation recoded to positive) negatively correlated at 3 and 6 months.

**Table 2.** Pearson correlations of the drug use subscale of the COPE questionnaire with posttraumatic symptomatology

	7 days	14 days	21 days	30 days	3 months	6 months
IES-R Avoidance	.040	.031	.036	.011	.134	.003
IES-R Intrusion	.192*	.245**	.174*	.164*	.158*	.160*
IES-R Hyperarousal	.163	.207**	.214**	.051	.170*	.084
DTS score	-	-	-	.183*	.202**	.128
STAI state score	.038	.231**	.270***	.169*	.155*	.133
BDI score	.313**	.203*	.232**	.179*	.172*	.149
PANAS	-	-	-	-.127	-.189*	-.169*

\* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

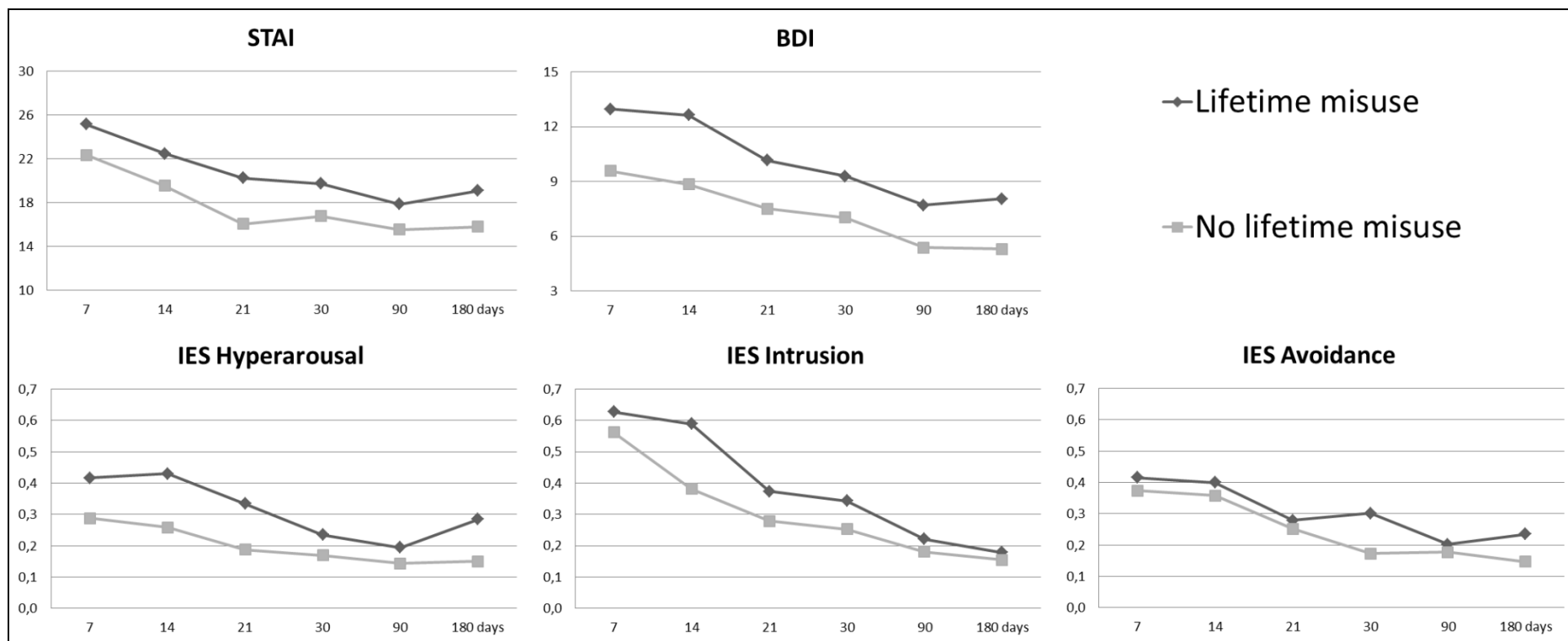
IES-R: Impact of Events Scale Revised, DTS: Davidson Trauma Scale, STAI: State Trait Anxiety Inventory, BDI: Beck Depression Inventory, PANAS: Positive and Negative Affect Schedule (negative items were recoded so the result is in a positive emotional direction)



***Emergence of symptoms by lifetime alcohol and illegal substance misuse.***

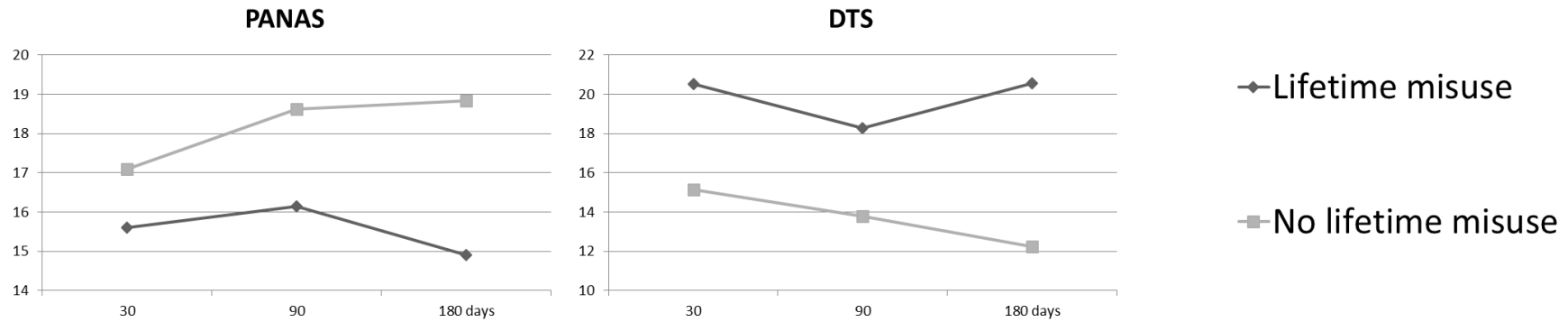
The emergence of symptomatology by lifetime alcohol and/or illegal substance misuse compared with no lifetime misuse can be seen in figures 2 and 3. Anxiety and depression had similar evolutions in both groups, although scores were higher across the evolution for patients with substance use problems. Hyperarousal was higher at the beginning among misusers, tended to converge, and had a final upturn in the misusers group. Intrusion was higher in the acute phase for misusers but it tended to converge. Avoidance had virtually identical evolutions in both groups. Positive emotions grew in the non-misusers group while decreased in the misusers group. Posttraumatic symptomatology measured with the DTS was higher at all assessments.

**Figure 2.** Evolution of symptomatology by lifetime substance misuse \* (n=183).



Substance misuse: lifetime problematic use of alcohol ( $\geq 4$  consumption units of alcohol/day, each unit=10 g of alcohol <sup>43</sup>) and/or lifetime consumption of illegal substances, BDI: Beck Depression Inventory, STAI: State Trait Anxiety Inventory, IES: Impact of Event Scale. The maximums and minimums for all figures have been adapted to the average ranges in our sample. Theoretical ranges for the scales in this figure are STAI: 0 – 60, BDI: 0 – 63, IES: each item ranges 0 – 4, total scores are divided by the number of items, and thus the theoretical range is the mean (0 – 4).

**Figure 3.** Evolution of posttraumatic stress and positive emotions by lifetime substance misuse (n=183).



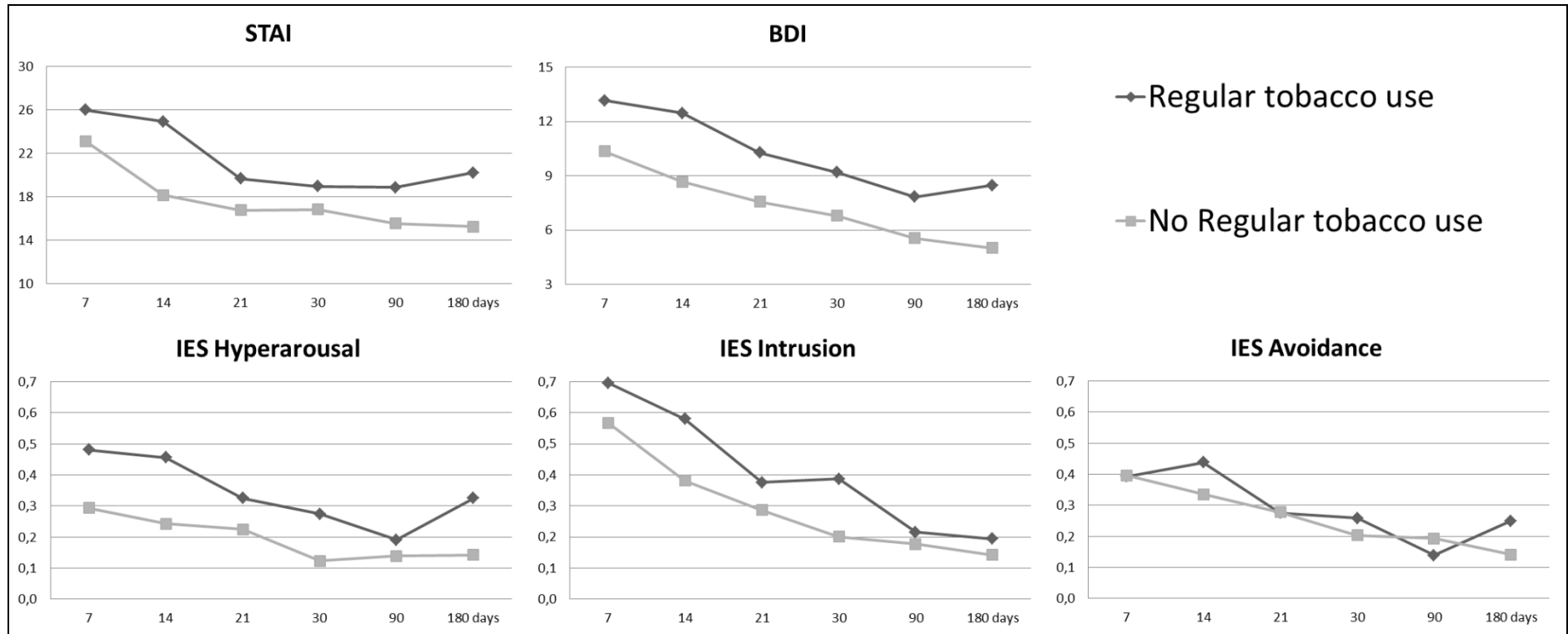
PANAS: Positive and Negative Affect Schedule, DTS: Davidson Trauma Scale. \* Theoretical ranges for the scales in this figure are PANNAS: -40 – 40 (negative emotions items subtracted to positive emotions), DTS: 0 –136.

Bivariate differences between groups were statistically different (t-tests) for STAI trait ( $t=3.602$ ,  $p<.0001$ ); STAI state at 21 ( $t=2.465$ ,  $p=.015$ ), 90 ( $t=2.135$ ,  $p=.034$ ) and 180 days ( $t=2.777$ ,  $p=.006$ ); BDI at 90 ( $t=2.227$ ,  $p=.027$ ) and 180 ( $t=2.840$ ,  $p=.005$ ) days. Regarding posttraumatic symptomatology, avoidance ( $t=2.002$ ,  $p=.047$ ) and DTS ( $t=2.460$ ,  $p=.015$ ) were statistically different at 180 days. Positive emotions measured by the PANAS were significantly different at 90 ( $t=-2.082$ ,  $p=.041$ ) and 180 ( $t=-2.177$ ,  $p=.031$ ) days. The results of the RM-GLMs showed no statistical differences (multivariate, linear or quadratic) in the evolution of symptomatology. No statistically significant difference was found for PTSD at six months measured with the MINI interview.

***Emergence of symptoms by regular tobacco consumption.***

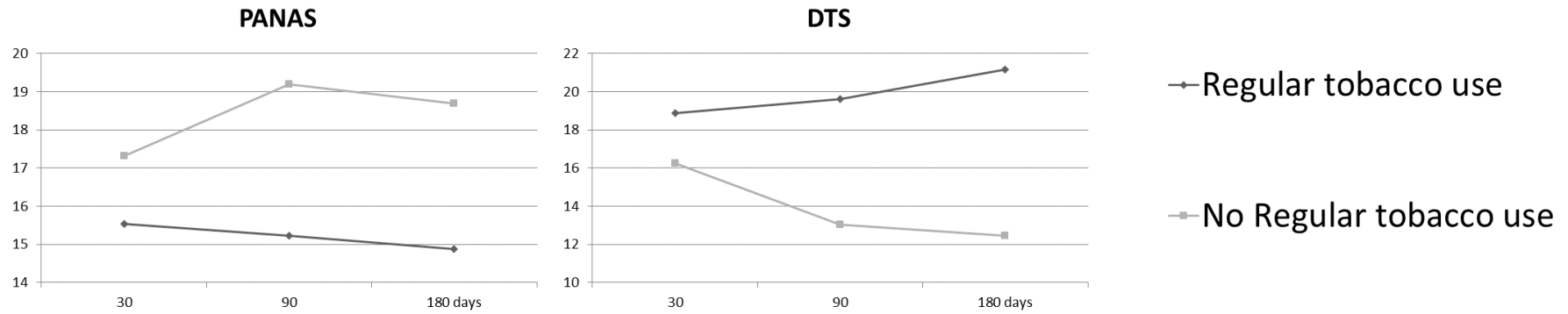
Regarding tobacco, baseline regular use was tested using a cut-off of ten cigarettes a day ( $n=72$ , 39.3% of the sample, 70.6% of the people with any tobacco use). The evolution of symptomatology by regular tobacco use can be seen in figures 4 and 5. Anxiety, depression, intrusion and avoidance had similar evolutions in both groups. As in the case of alcohol or drug misuse, hyperarousal was higher at the beginning among smokers, tended to converge, and had a final upturn in the regular smoker group. Posttraumatic symptomatology measured with the DTS was higher at all assessments and tended to increase in the regular smoker group while it decreased in the no regular smoking group. Positive emotions grew and then stayed stable in the non-smokers group, while stayed stable and lower in the smoker group.

Figure 4. Evolution of symptomatology by regular tobacco use\* (n=183).



\*Regular tobacco use: ten or more cigarettes per day

Figure 5. Evolution of posttraumatic stress and positive emotions by regular tobacco use (n=183).



Student's t-tests showed statistically significant differences between smokers and non-smokers for STAI trait ( $t=2.940$ ,  $p=.004$ ); STAI state at 7 ( $t=2.940$ ,  $p=.004$ ), 14 ( $t=3.693$ ,  $p<.0001$ ), 90 ( $t=2.198$ ,  $p=.030$ ) and 180 days ( $t=2.827$ ,  $p=.005$ ); BDI at 7 ( $t=2.082$ ,  $p=.039$ ), 14 ( $t=2.398$ ,  $p=.018$ ), 21 ( $t=2.134$ ,  $p=.035$ ), and 180 ( $t=2.353$ ,  $p=.020$ ) days. Regarding posttraumatic symptomatology, activation at 7 ( $t=2.202$ ,  $p=.029$ ), 14 ( $t=2.338$ ,  $p=.020$ ), 30 ( $t=2.132$ ,  $p=.036$ ) and 180 ( $t=2.280$ ,  $p=.025$ ) days, intrusion at 30 ( $t=2.606$ ,  $p=.011$ ) days and DTS at 90 ( $t=1.983$ ,  $p<.05$ ) and 180 ( $t=2.549$ ,  $p=.012$ ) days, were statistically different. Positive emotions were significantly different at 90 ( $t=-2.018$ ,  $p=.046$ ) and 180 ( $t=-1.965$ ,  $p<.05$ ) days. The results of the RM-GLMs showed statistical differences in the linear evolution of posttraumatic symptomatology measured by the DTS ( $F=4.234$ ,  $p=.041$ ). Regular smokers were more likely to develop PTSD at six months (55.9% vs. 33.3% for non-regular smokers,  $OR=2.53$ , 95%,  $C.I.=1.18-5.46$ ,  $p=.016$ ).

#### ***Self-medication hypothesis.***

The number of cigarettes smoked did not significantly correlate with any psychometric measure in the first 5 assessments, except for a moderate correlation with posttraumatic symptomatology measured with the DTS at 30 days ( $\rho=.251$ ,  $p<.05$ ). Nevertheless, among the total 71 patients reporting any tobacco use at six months, its daily amount significantly correlated with anxiety ( $\rho=.366$ ,  $p=.002$ ), depression ( $\rho=.247$ ,  $p=.038$ ), posttraumatic symptomatology ( $\rho=.247$ ,  $p=.038$ ) and inversely with positive emotions ( $\rho=-.325$ ,  $p=.006$ ).

A total of 28, 73 and 83 patients reported any alcohol consumption at one, three and six months (it could only be measured at these points due to its prohibition during admission). Consumption units significantly correlated with anxiety at 90 days ( $\rho=.250$ ,  $p=.033$ ). Furthermore, it correlated with activation ( $\rho=.232$ ,  $p=.035$ ), anxiety ( $\rho=.258$ ,

$p=.018$ ), depression ( $\rho=.296$ ,  $p=.007$ ), posttraumatic symptomology measured with the DTS ( $\rho=.238$ ,  $p=.030$ ) and inversely with positive emotions ( $\rho=-.324$ ,  $p=.004$ ) at six months. Due to the low number of consumers, cannabis dose could only be tested at 180 days among 20 patients, finding a statistically significant correlation with avoidance ( $\rho=.453$ ,  $p=.045$ ).

## **Discussion**

The results of the different parts of the analysis lead us to think that people who misuse substances both before the accident, and during the recovery phase have a distinct symptomatic pattern.

In the first place, patients with lifetime use of different substances had specific profiles of sociodemographic and burn characteristics corresponding generally to unemployed males involved in high risk accidents. In other studies, pre-existing and burn-related disturbances have been found associated to employment status before the burn injury<sup>44</sup>. Authors often argue that being unemployed at the time of the burn injury, was associated with previous alcohol dependence, illegal substance use and/or misuse of psychiatric medication the year before<sup>10,45</sup>.

Regarding the high-risk hypothesis, substances found to be more prevalent in our sample than in the Spanish general population (opiates and tranquilizers). Among patients reporting these consumptions, we could identify profiles corresponding to our daily practice impressions. In the case of opiate users, unemployment, low socioeconomic status, living alone, and flame or electric accidents may corresponded to current opiate consumers or patients in methadone maintenance treatment, performing risky behaviours usually related with illegal activities in the streets (e.g. copper theft). In our case, the fourteen patients with current or past opiate consumption met exactly this profile. The correct treatment of trauma patients with opiate consumption has been



widely stressed. In this regard, special treatments have been established for methadone maintained patients suffering from PTSD <sup>46</sup>. Fortunately, our team had an experienced clinical psychiatrist with a long experience in dual disorders and therefore, maintenance treatment could be established or continued controlling carefully the possible interactions with burn injury pharmacological treatment, based often in opioids.

The profile of tranquilizer users corresponded also with unemployment, loneliness and low socioeconomic status. However, in contrast to opiate misusers, they were more likely to be involved in accidents with no more injured people. Moreover, lower rates for electric and flame injuries were found among this group. Although the group of patients consuming tranquilizers was heterogeneous (some tranquilizer consuming patients also consumed opiates) these data may correspond to forgetful patients affected by tranquilizers' side effects.

The results of the susceptibility hypothesis showed moderate to low correlations between the COPE substance use subscale and some psychometric measures, especially at 30 and 90 days. We also found increased levels of symptomatology and negative emotions according to all psychometric measures analysed by regular tobacco use. For the latter, rates of PTSD at six months were higher and the evolution of posttraumatic symptomatology had a divergent evolution compared with the non-smokers group. Results according to lifetime substance misuse were much more modest, but also reflected a greater presence of symptoms. This constitutes a possible confirmation of this hypothesis in a very specific clinical context, which is in line with other recent epidemiological studies <sup>21</sup>.

Finally, although sample limitations prevented us from performing longitudinal analyses, correlations of symptomatology with substance use at six months reflect support for the self-medication hypothesis. Data on alcohol and tobacco may support

the theory that the use of substances among these patients is motivated by the levels of symptomatology. In this sense, substance use may be seen as a way of coping with symptoms. It is nonetheless interesting our results regarding cannabis use. The levels of cannabis consumption at six months did significantly and largely correlate with avoidance. Although a bigger sample and longitudinal analyses may yield more reliable results, the large effect size of this correlation, may correspond with people using cannabis as an additional avoidant strategy.

All these results underscore the importance of screening past and prospective substance use amongst burn, and more broadly, traumatised patients, due to the high rates of substance use and misuse in these patients and its prognostic implications. Also we should note the need of specialised treatments for patients using substances as a way to cope with symptoms.

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### **Declaration of interest**

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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