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The relation between sleep and violent aggression

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Chapter 4

The relation between poor sleep, impulsivity and aggression in forensic psychiatric patients

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ABSTRACT

Psychiatric disorders are often associated with disturbed sleep. Poor sleep can attenuate emotional control, including the regulation of aggression, and thus, may increase the risk of impulsive, aggressive acts. This cross-sectional study aimed to investigate the potential contribution of sleep problems to subjective and objective aggressiveness and impulsivity in a forensic psychiatric population. Questionnaires on sleep quality (Pittsburgh Sleep Quality Index), chronic severe insomnia (Sleep Diagnosis List), aggressiveness (Aggression Questionnaire) and impulsivity (Barrat Impulsiveness Scale-11) were completed by 96 forensic psychiatric inpatients, admitted to two forensic facilities in the Netherlands. To obtain more objective measurements of aggression and impulsivity, observational scores on a professional instrument to assess the risk of future aggression (Historical Clinical Future-30) and reported aggressive incidents were collected from files. Results showed that a worse sleep quality and higher insomnia scores were significantly associated with self-reported aggression and impulsivity, clinician-rated hostility and involvement in aggressive incidents within the facility. Whether a participant was professionally judged as impulsive could not be predicted by sleep quality or the insomnia score. To a large extent the results of this study support the hypothesis that poor sleep is related to impulsive, aggressive behavior in forensic psychiatric patients. It is worthwhile to examine the protective effect of treatment of sleep difficulties on aggressive reactivity in (forensic) psychiatric populations.

INTRODUCTION

The role of sleep in the regulation of emotions is a growing area of research. Sleep loss seems to reduce affective stability and increase emotional reactivity (Franzen et al., 2009; Anderson and Platten, 2011). Possible symptoms of an elevated tendency to respond emotionally may be short-temperedness, irritability and angriness. Indeed, poor sleep has been shown to be associated with aggressive behavior, hostility and angriness in multiple studies in children (Chervin et al., 2003; Velten-Schurian et al., 2010; O'Brien et al., 2011) and adults (Schubert, 1977; Pilcher et al., 1997; Shin et al., 2005; Granö et al., 2008). Sleep deprivation studies found that sleep loss affects prefrontal cortical functioning, which could result in a failure of behavioral response inhibition (Horne, 1993; Franzen et al., 2009; Kahn-Greene et al., 2006; Yoo et al., 2007; Anderson and Platten, 2011). This may lead to augmented impulsivity and reactive aggression, thus increasing the risk of verbal and/or physical aggressive responses and violent behavior (Kamphuis et al., 2012). Although not systematically investigated, treatment of sleep disorders seems to reduce aggressive behavior, as reported by multiple case reports and small observational studies (Pakyurek et al., 2002; Booth et al., 2006; Haynes et al., 2006).

Sleep problems are highly prevalent in psychiatric patients. For example, sleep disturbances are present in 30-80% of patients with schizophrenia (Cohrs, 2008), more than 55% of patients with a substance abuse disorder (Mahfoud et al., 2009; Liao et al., 2011) and approximately 90% of individuals with a major depressive disorder (Tsuno et al., 2006). Considering the potential disturbing effects of poor sleep on emotional and aggression control, it may be that the high prevalence rates of sleep problems in psychiatric patients are partially responsible for the relatively high incidence of anger and aggressive/violent acts in psychiatric populations (Hodgins et al., 1992; Nijman et al., 1997; Eronen et al., 1998; Posternak and Zimmerman, 2002; Foster et al., 2007). Forensic psychiatric patients may be most at risk, as they often have a poor impulse control already. This poor impulse control has been linked to anatomical and functional impairments in the prefrontal area of such individuals (Raine et al., 2000; Blair, 2010; Gansler et al., 2011; Keune et al., 2012). Possibly, sleep problems in these individuals may worsen the lack of prefrontal behavioral inhibition of impulsive aggression. A recent study in the Netherlands indicated that nearly 50% of forensic psychiatric inpatients have problems with regard to their sleep quality and approximately 20% suffer from severe, chronic insomnia (Kamphuis et al., 2013). These figures are high, especially considering their intensive and long-term psychiatric treatment.

Because *i*) sleep complaints are common in (forensic) psychiatric patients, *ii*) sleep loss may have an impact on emotion regulating capacities and hypothetically (further) impairs prefrontal inhibition of aggressive impulses, and *iii*) treatment of sleep disorders may have an aggression-reducing effect, understanding the relation between sleep and impulsive aggression in forensic psychiatric patients is clinically relevant.

In the present study we examined the relationship between sleep problems and self-rated aggression and impulsivity in a sample of forensic psychiatric patients from two forensic hospitals in the Netherlands. We also examined the association between sleep complaints and the professional judgement of hostility and impulsivity, as well as the occurrence of inpatient aggressive incidents. We hypothesized that a worse sleep quality and higher insomnia scores are related to higher self-reported and professional scores on aggression and impulsivity and to increased aggressive incidents within the hospital.

MATERIAL AND METHODS

Participants

Participants were recruited from two forensic treatment facilities in the Netherlands, the Forensic Psychiatric Hospital (FPH) in Assen and the Forensic Psychiatric Centre (FPC) Dr. S. Van Mesdag in Groningen. These facilities treat patients who committed a crime or are at risk of committing a crime under the influence of mental disorders.

The research proposal was approved by the local ethics committee (Hospital Ethics Committee of the Isala Clinics in Zwolle, Netherlands). After full verbal and written information about the study, written informed consent was obtained from participating patients. Participants completed both the sleep questionnaires as well as the aggression and impulsivity questionnaires. Information concerning socio-demographic data, mental health, medication, risk assessment and aggressive incidents in the facility was collected from administrative files. Participants received 5 euro's as a financial compensation.

Two hundred five patients were approached (200 males; 5 females); 113 were willing to participate (total response rate 55.1%). Data for all parameters were complete for 96 participants. Sociodemographic characteristics and mental health status of the participants are shown in Table 1. Most participants were male (96.9%). The sample had a mean age of 36.9±10.4 (SD) years, ranging from 21-77 years. The majority was convicted for a violent offence (93.8%), such as (attempted) murder or manslaughter or (aggravated) assault. In most cases a personality disorder (PD) was diagnosed (71.9%), antisocial traits/PD were the most prevalent (61.5%).

Table 1. Descriptive characteristics of the study group (*N* = 96).

	n (%)
Sociodemographic characteristics	
Male gender	93 (96.9%)
Convicted for a violent offence	90 (93.8%)
Admitted under the criminal legal system	90 (93.8%)
Western European origin	73 (76.0%)
Marital status single	81 (84.4%)
No high school degree	42 (43.8%)
Mental health status	
Major mental health disorder as primary diagnosis	63 (65.6%)
Disorder from the schizophreniaspectrum	41 (42.7%)
Autism spectrum disorder	22 (22.9%)
Attention deficit hyperactivity disorder	13 (13.5%)
Pedophilia	12 (12.5%)
(Co-morbid) history of substance abuse disorder	67 (69.8%)
Personality disorder (PD; not just traits)	69 (71.9%
Borderline traits/PD	29 (30.2%)
Antisocial traits/PD	59 (61.5%)
Narcissistic traits/PD	29 (30.2%)
Histrionic traits/PD	4 (4.2%)

Instruments

Sleep parameters

The Pittsburgh Sleep Quality Index (PSQI) was used to assess subjective sleep quality over the preceding month. The PSQI consists of 19 items that are grouped to 7 component scores. All component scores are summed to generate a global score between 0 and 21, with higher global scores indicating worse sleep quality. A PSQI>5 is generally used as a cut-off score to identify individuals who are dissatisfied with their sleep, the so-called poor sleepers. The PSQI has been shown to be a reliable and valid instrument to assess subjective sleep quality in psychiatric populations: Crohnbachs α=.83 and diagnostic sensitivity and specificity respectively, 89.6% and 86.5% (Buysse et al., 1989).

The Sleep Diagnosis List (SDL) (Sweere et al., 1998) was used to assess chronic insomnia. The SDL has been derived from the Sleep Diagnostic Questionnaire (Douglass et al., 1994) and consists of 75 randomly distributed questions about specific sleep disorders and sleep related problems during the last 6 months. Fifteen questions are related to insomnia. The questions are answered on a 5-point scale ranging from 1 (never) to 5 (very often or always). Maximum total SDL insomnia score is 5 and a score ≥ 3 is generally used as a cut-off score (Douglass et al., 1994). The SDL has been validated in Dutch subjects with sleep disorders (Sweere et al., 1998). The factor insomnia showed a Crohnbachs α=.93 (Sweere et al., 1998).

Subjective measurements of aggression and impulsivity

The Dutch translation of the Aggression Questionnaire (AQ) (Buss and Perry, 1992) was used to assess self-rated aggressiveness. The AQ consists of 29 items, scored on a 5-point scale ranging from 1 (extremely uncharacteristic for me) to 5 (extremely characteristic for me). A higher total AQ indicates higher aggressiveness. Maximum score is 145. Impulsive aggressive individuals have been found to score 97±12 on average, whereas controls have been found to score approximately 56±12 (Houston and Stanford, 2001). The Dutch version of the AQ has been validated in university students and shown to be reliable (Crohnbachs α=.84) (Meester et al., 1996).

The Dutch translation of the validated 11th version of the Barrat Impulsiveness Scale (BIS-11) (Patton et al., 1995) was used to assess self-rated impulsivity. The BIS-11 contains a total of 30 items, each of which is answered on a 4-point scale ranging from 1 (rarely/never) to 4 (almost always/always). The BIS-11 measures 3 types of impulsivity defined as attentional impulsiveness, motor impulsiveness en nonplanning impulsiveness (Patton et al., 1995). Maximum total BIS-11 score is 120. Higher scores indicate higher levels of impulsiveness. A previous study showed average scores of 74±9 for an impulsive aggressive group and 55±8 for controls (Houston and Stanford, 2001). The BIS-11 has been validated in psychiatric patients, substance-abuse patients and prisoners. Crohnbachs α (.79-.83) indicated an acceptable internal consistency (Patton et al., 1995).

Objective measurements of aggression and impulsivity

Professional judgement: For the professional judgement of aggression and impulsivity, scores on the risk assessment instrument Historical Clinical Future-30 (Dutch abbreviation: HKT-30) were collected (Projectgroup Risk Assessment in Forensic Psychiatry, 2003). The HKT-30 is used to assess the risk of future violence in adult mentally-disordered offenders

and is validated in Dutch forensic psychiatric patients (Canton et al., 2004; Hildebrand et al., 2005). The HKT-30 is based on the Historical Clinical Risk-20 (Douglas et al., 1999). The HKT-30 comprises 11 static, historical and 19 dynamic, risk factors that are scored from 0 to 4, with higher scores indicating higher risk. The HKT-30 is filled out yearly, based on the observations during the preceding 12 months. In the present study 2 of the dynamic risk factors were used from the most recent completed HKT-30: impulsivity and hostility. Scores were dichotomized for statistical purposes with scores between 0-2 indicating 'no/minor impulsivity or hostility' and scores between 3-4 'major impulsivity or hostility'.

Aggressive incidents: For each participant the number and nature of inpatient aggressive incidents during 6 months preceding and 6 months following the completion of the questionnaires were collected from the central administration in the two facilities. Incidents were categorized as: verbal aggression (e.g. shouting or making clear threats of violence to others), physical aggression against objects (e.g. throwing or breaking objects, slamming doors), physical aggression against others (e.g. threatening gestures, hitting, kicking or injuring others) or self-harm / suicide attempts (e.g. cutting in own body, taking overdoses of medication).

Confounders

To correct for confounders potentially influencing the relation between poor sleep and aggressiveness, we included several variables. These confounders were chosen based on their theoretically known independent associations with sleep quality and/or aggression (Gursky and Krahn, 2000; Johnson et al., 2000; Boles and Miottoa, 2003; Krystal et al., 2008). The following 4 confounder variables were selected: presence of so-called cluster B personality traits/PD (yes/no) - meaning the presence of borderline, antisocial, narcissistic and/or histrionic traits/PD -, history of substance abuse (yes/no) and current use of psychiatric medication with sleep disrupting (yes/no) or sleep promoting (yes/no) side effects (such as effects on sleep initiation and/or maintenance). We considered serotonin-reuptake inhibitors and stimulant drugs (e.g. methylphenidate, dextroamphetamine) as sleep disruptive (Efron et al., 1997; Gursky and Krahn, 2000; Wilson and Argyropoulos, 2005; Krystal et al., 2008) and benzodiazepines, the so-called Z-drugs (zolpidem and zopiclone), antipsychotics and antidepressants with sedating properties (such as clozapine, risperidone, olanzapine, quetiapine and mirtazapine) as sleep promoting medications (Gursky and Krahn, 2000; Monti and Monti, 2004; Krystal et al., 2008). All of these variables were extracted from medical files at the time participants filled out the questionnaires. For statistical purposes they were dichotomised.

A total of 68 participants (70.8%) had cluster B personality traits/PD, 67 participants (69.8%) had a history of a substance abuse disorder. The majority of the study group used sleep promoting medications (n=54; 56.3%), most often an antipsychotic with sedating properties (n=47; 49.0%). Sleep disrupting drugs were used by 27 participants (28.1%).

Statistical analyses

First, descriptive analyses were done to describe the study group and their scores on the sleep, aggression and impulsivity parameters. Second, multiple regression analyses were conducted to investigate the relation between sleep quality (global PSQI score) or chronic insomnia (SDL insomnia score) and subjective aggression variables (total AQ and total BIS-11). Third, to analyse the relation between sleep quality and the objective aggression variables, logistic regression analyses were performed with the following dichotomous outcome variables: professional judgment on the presence (yes/no) of major hostility and impulsivity (HKT-30), and occurrence (yes/no) of inpatient aggression. For the multiple regression and the logistic regression analyses, a manual backward stepwise regression procedure was used. All variables, including one of the predictor variables (global PSQI score or SDL insomnia score) and the 4 confounder variables, were initially offered into the model. Variables with the highest *p*-values ≥.10 were eliminated one at a time, until all included variables had $p<.10$. Alpha levels of $p<.05$ were used to define statistical significance. All analyses were performed with PASW Statistics 18 for Windows program.

RESULTS

Descriptives

Mean scores on both the sleep and aggression questionnaires are shown in Table 2. Of the participants, 50.0% had a PSQI>5, indicating that they considered themselves to be poor sleepers. Nineteen participants (19.8%) suffered from insomnia (SDL insomnia score ≥3).

Table 2. Scores on questionnaires (*N* = 96).

	Mean ± SD	min-max
PSQI global score	7.3 ± 4.8	0-19
SDL insomnia score	2.2 ± 0.9	1.0-4.6
AQ total score	73.8 ± 22.3	18-132
BIS-11 total score	62.4 ± 1.2	38-97

SD = standard deviation

With regard to the objectively measured aggression, data from the HKT-30 revealed that 22 participants (22.9%) were considered as severely hostile and 22 (22.9%) as severely impulsive. Fourteen participants fell into both categories. Inpatient aggressive incidents were reported for 17 participants (17.7%). The incident rate ranged from 0 to 42 aggressive incidents per participant. Verbal aggression was scored for 11 of these 17 participants, physical aggression against objects for 1, physical aggression against others for 4 and self-harm/suicidal behavior in 1 participant.

Relation between sleep and subjective aggression and impulsivity

Sleep quality significantly predicted both self-rated aggression and impulsivity (Table 3), with higher scores on the PSQI predicting higher aggression and impulsivity scores. Of the pre-selected confounders, a history of substance abuse was the only one remaining in the final model as a significant independent predictor of aggression and impulsivity levels. The interaction term between history of substance abuse and global PSQI score was not

Table 3. Final model of multiple regression analysis for sleep quality and insomnia predicting self-reported aggression and impulsivity (*N* = 96).

	Aggression (total AQ)			Impulsivity (total BIS-11)		
	B	**SE B**	β	**B**	**SE B**	β
Sleep quality (PSQI)	1.89	0.42	0.41***	0.92	0.21	0.40***
History of substance abuse	10.46	4.41	0.22*	6.10	2.21	0.25**
adjusted R^2		0.23			0.22	
F for ΔR^2		13.57***			14.09***	
	B	**SE B**	β	**B**	**SE B**	β
Insomnia (SDL)	13.22	2.01	0.55***	6.26	1.03	0.52***
History of substance abuse	9.26	4.02	0.19*	5.51	2.05	0.23**
adjusted R^2		0.35			0.33	
F for ΔR^2		26.05***			24.03***	

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

significant for both outcome variables. Explained variation (adjusted R^2) in the AQ and BIS-11 scores was 23% and 22%, respectively.

Chronic insomnia significantly predicted subjective aggression and impulsivity, with higher SDL insomnia scores predicting higher aggression- and impulsivity rates (Table 3). Also in this analysis, a history of substance abuse was a significant predictor. The interaction term between SDL insomnia score and history of substance abuse was not significant for these outcome variables. This indicates that chronic insomnia is an independent predictor of self-rated aggression and impulsivity. The explained variation in AQ and BIS-11 scores was higher in comparison to the analysis where global PSQI score was the predictor: 35% of the variation in the AQ scores and 33% in the BIS-11 scores was accounted for by the model with SDL insomnia as a predictor variable..

Sleep and objective aggression and impulsivity

Logistic regression analyses showed that sleep quality significantly predicted whether or not a participant was judged as severely hostile (HKT-hostility) by their clinician (Table 4). Results indicate that for each one point increase in global PSQI score (which can vary between 0-21), the odds of being evaluated as seriously hostile significantly increase with 12%. During the stepwise regression procedure, use of sleep promoting medication and a history of substance abuse were removed as variables. The remaining of the confounder

Table 4. Final model after stepwise logistic regression analysis for the relation between sleep quality/insomnia and clinician-rated hostility (*N* = 96).

	HKT-30 hostility	
	B	**Odds Ratio (95% CI)**
Sleep quality (PSQI)	0.12	1.12 (1.01-1.25)*
Sleep disrupting medication	1.61	5.00 (1.64-15.29)**
Cluster B traits / PD	1.79	5.98 (1.14-31.23)*
Insomnia (SDL)	0.53	1.69 (0.95-3.00)#
Sleep disrupting medication	1.61	5.01 (1.65-15.19)**
Cluster B traits / PD	1.83	6.23 (1.20-32.42)*

-2 Log likelihood for analysis with PSQI global score as predictor = 82.31
-2 Log likelihood for analysis with SDL insomnia score as predictor = 83.52
* $p < .05$
** $p < .01$
# $p < .1$

variables, namely use of sleep disrupting medication and cluster B traits/PD showed high significant odds ratios, especially compared to the odds ratio found for the global PSQI score (Table 4). For the interpretation of these odds ratios it is important to remember that these are dichotomous variables, as opposed to the global PSQI score, which was included as a continuous variable in the model. The interaction terms between global PSQI score and use of sleep disrupting medication and cluster B traits/PD were not significant. Thus, although they are also significant predictors of HKT-hostility they do not influence the effect of sleep quality on the HKT-hostility score. In the analysis with SDL insomnia score as a predictor the *p*-value of the odds ratio was not significant, but reached the level of a tendency (<.10). The use of sleep disrupting medication and cluster B traits/PD were also here significant predictors. The interaction terms between them and SDL insomnia were not significant.

Impulsivity as assessed by the HKT-30 could not be significantly predicted by the sleep parameters. Global PSQI score and SDL insomnia score were both removed during the manual backward regression procedures, in respectively, the first and second step. The remaining variables in the best fit model were the presence of cluster B traits/PD and the presence of sleep promoting medication. These variables significantly increased the odds of being judged as very impulsive (data not shown).

During stepwise logistic regression analysis with occurrence of inpatient aggression as an outcome variable all 4 confounder variables were removed based on their *p*-values ≥.10. PSQI global score and SDL insomnia score were the only variables kept in the final models (Table 5).

Sleep quality and chronic insomnia significantly predicted whether a participant had been involved in aggressive incidents, with a one point increase in PSQI global score and SDL insomnia score increasing the odds with 12% and 79%, respectively.

Table 5. Final model after stepwise logistic regression analysis for the relation between sleep quality/insomnia and inpatient aggression (*N* = 96).

	B	**Odds Ratio (95% CI)**
Sleep quality (PSQI)	0.11	1.12 (1.01-1.24)*
Insomnia (SDL)	0.58	1.79 (1.03-3.10)*

-2 Log likelihood for analysis with PSQI global score as predictor = 85.35
-2 Log likelihood for analysis with SDL insomnia score as predictor = 85.34
* $p < .05$

DISCUSSION

This is the first study investigating the relation between sleep, aggression and impulsivity in a clinical forensic psychiatric population, using both subjective and objective measures of aggression.

This study demonstrates that sleep disturbances in forensic psychiatric patients are partially predictive of their self-rated aggression and impulsivity levels. Apparently, patients who experience sleep problems consider themselves to be more irritable, less tolerant to frustrations and less able to control impulsive, aggressive tendencies. These results are in line with the few earlier findings in somewhat comparable populations, namely in imprisoned adolescent offenders (Ireland and Culpin, 2006) and male militaries with an antisocial PD (Semiz et al., 2008).

Having sleep problems also increased the chance of a patient to be judged as severely hostile by his or her clinician. Unlike our hypothesis, this was not true for the professional assessment of impulsivity. It seems that the impulsivity experienced by the participants themselves represents something else than what their clinicians score in the HKT-30 risk factor impulsivity. Indeed, there is merely a weak correlation between self-rated aggression / impulsivity levels and clinician ratings / occurrence of actual aggressive acts (Buss et al., 1962; Gothelf et al., 1997). Self-report questionnaires measure feelings and attitudes considered relevant to aggressiveness and impulsivity. Evaluations from clinicians and registration of aggressive incidents deal more with the overt behavior. Another aspect which is worth considering, is the timing of the measurements. In the present study, the sleep questionnaires and self-rated aggression and impulsivity questionnaires were completed in the same time period. Because the HKT-30 is only filled out once a year, the timing of the sleep measurements and the professional judgment of hostility and impulsivity were on average 5.1±4.6 months apart. Aggression levels are well known to fluctuate considerably over time (Silver and Yudofsky, 1991). It is highly probable that a period of good sleep reduces the heightened risk of aggressive outbursts. It may therefore be crucial to measure sleep and aggression levels around the same time point. In this light, it is remarkable that we did find a significant association between sleep disturbances and clinician-rated hostility.

With regard to the occurrence of inpatient aggression, poor sleep quality and chronic insomnia were significant predictors. This may indicate that there is a direct relation between sleep problems and aggressive outbursts. However, the number of reported aggressive incidents may be less reliable for actual aggressive behavior of our participants

than expected. In our study group the number of patients who were reported to act aggressively during the period of one year (n=17) is relatively low. For comparison, when staff is instructed to score every incident on a special scale for the aim of scientific research, Nicholls et al. (2009) found that approximately 60% of forensic inpatients were involved in one or more aggressive incidents over the same time interval. In normal daily practice underreporting is a well-known problem in incident registration (Lion et al., 1981; Owen et al., 1998), especially for minor incidents (Infantino and Musingo, 1985; Owen et al., 1998). What has to be taken into account is that in a forensic hospital environment the majority of incidents are presumably not that severe. Staff is trained to employ de-escalating interventions (such as a time out, a supportive talk, medication or isolation) in an early phase in order to prevent severe aggressive behavior. That despite these limitations we found sleep quality and chronic insomnia to be significant predictors of aggressive incidents is noteworthy.

Previous and current data support the hypothesis that poor sleep is a risk factor for aggressive behavior. One of the most important goals of forensic psychiatric treatment is to reduce the risk of violence. Therefore, accurate estimation of recidivism risk is extremely important in forensic practice. Risk assessment instruments, such as the HKT-30, are generally used for this. So far, sleep problems are not included in any of these instruments. Most sleep problems can be adequately treated. Therefore, treatment of (comorbid) sleep disturbances may provide a relatively rapid and effective component of forensic psychiatric treatment in general, especially compared to the treatment of other risk factors, such as active substance abuse or antisocial traits/PD. Furthermore, sleep loss may not only be a potential risk factor for aggressive behavior. The remission of sleep disorders and the improvement of sleep quality may also exert positive and protective effects. Adequate sleep may not only improve the aggression regulating capacities, but also positively affect the course of psychiatric symptoms due to larger responses to psychopharmacological drugs (Smith et al., 2005; Fava et al., 2006). Thus, mental health workers should be on the alert for sleep disturbances when they assess the risk of aggressive behavior in an individual (forensic) psychiatric patient. When a patient complains of sleep problems the first step is to perform careful diagnostics, in order to identify all factors that are causing or maintaining poor sleep in that particular patient. Examples are: presence of sleep disorders such as sleep apnea syndrome, poor sleep hygiene habits and side effects of medications. After this, focused interventions to treat or improve all these factors should be started.

Our hypothesis is that sleep problems contribute to aggression and impulsivity due to a detrimental effect of sleep loss on the prefrontal cortex causing behavioral disinhibition. However, statements on causal direction can not be made based on the cross-sectional data in the current study. In fact, animal studies suggest that aggressive interactions itself can also cause immediate changes in sleep architecture, namely increased slow wave activity (Meerlo et al., 1997; Meerlo and Turek, 2001) and short-term suppression of rapid eye movement (REM)-sleep (Meerlo and Turek, 2001). Furthermore, one study found that mentally disturbed violent offenders have increased slow wave sleep compared to healthy controls (Lindberg et al., 2003). Another possibility is that sleep and aggression are not at all causally related, but simply reflect the severity of underlying psychopathology. Future studies should focus on unravelling the direction of the relation between poor sleep and aggression. Options are prospective treatment studies to investigate whether improvement of sleep reduces the number and/or severity of aggressive incidents and psychiatric symptomatology in (forensic) psychiatric patients. Animal studies investigating the direct effect of sleep deprivation on aggressive and impulsive behavior should also be pursued. For future studies, is important not to solely focus on forensic psychiatric patients, but also consider the effect of insufficient sleep on emotion and aggression regulating capacities in other populations 'at risk', such patients admitted to general psychiatric wards and inmates in prisons.

Strengths of this study are the combination of self-rated and more objective measures of inpatient aggressiveness and the use of two questionnaires to assess sleep disturbances. A limitation is the percentage of non-responders (44.9%). Observations during the group meetings where patients received oral information, revealed a broad spectrum of arguments, for example "do not feel like it" and "not willing to permit researchers to extract data from medical file". By offering a financial compensation we attempted to avoid that only patients experiencing sleep problems would participate. Unfortunately, we do not know whether the non-responders represent a group with significantly different levels of aggression and/or amount of sleep problems. Although we found fairly strong associations, this uncertainty should be taken into account when interpreting our results. Another limitation is the absence of an objective measure for sleep problems, such as actigraphy or polysomnography. This may give more detailed information on which aspect of poor sleep is associated with aggressiveness and impulsivity, for example increased night time awakenings or changes in slow wave sleep. Finally, a limitation concerns the quality of the objective aggression measures, namely the uncertainty whether or not the scores on the HKT-30 are good representatives of the professional judgment on current aggression and impulsivity levels and the probable

underreporting of aggressive incidents. For a follow-up study, it may be worthwhile to include physiological measures of aggressive reactivity, such as heart rate or skin conductance.

CONCLUSION

Sleep difficulties and chronic insomnia are independent predictors of self-rated aggression and impulsivity, clinician-rated hostility and inpatient aggression in clinical forensic psychiatric patients. A robust relationship between sleep problems and the professional assessment of impulsivity could not be confirmed with these data. Better measures of objectively assessed aggression are needed. These results support the hypothesis that poor sleep is a risk factor for aggressive behavior.

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