Rest-activity rhythm and aggression in prisoners with a psychotic illness

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Abstract

Background. Mental disorders such as psychotic illnesses are more common in the prison population than in the general population. An important clinical hallmark of these disorders is aggression/agitation. Agitation correlates positively to a disturbed rest-activity rhythm, often caused by physical inactivity and nocturnal restlessness. Physical inactivity is widespread among people in detention.

Aims. The study objective was to ascertain whether there is a relationship between the rest-activity rhythm (i.e. the levels of physical activity during the day and night), and aggressive/agitated behaviour.

Method. Of 140 patients in the Penitentiary Psychiatric Centre (PPC), nineteen male patients with a psychotic illness were able to participate. Rest-activity rhythm was measured using actigraphy, with participants wearing an Actiwatch for 7 consecutive days. Aggression/agitation was measured by a staff observation scale.

Results. The results showed a disturbed rest-activity rhythm. In particular, nocturnal restlessness was a significant predictor of aggression/agitation (adjusted R^2= 0.33).

Conclusions. Future research should focus on intervention to reduce nocturnal restlessness in prisoners suffering from a psychotic illness.

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Introduction

More than 10.65 million people throughout the world are being held in some form of detention.[1] The USA has the highest ratio of prisoners per 100 000 head of population, with a ratio of 756 prisoners per 100 000, while the average ratio in Western Europe, for example, is 92 per 100 000.[1] In the Netherlands, this ratio is 87 per 100 000.[2] In 2010, there was an inflow of 11 736 detainees in the Netherlands. Of these, 51% were detained for violence-related offenses,[2] while 5% were detained in a separate psychiatric department.

Mental disorders are more common in the prison population than in the general population. Psychosis and schizophrenia, for example, were found to be highly prevalent in prisons.[3,4] A prevalence of 4% was found for psychotic illnesses (e.g. schizophrenia, schizophreniform disorder, psychosis and delusional disorder), against 1% in the general population. There is also a high prevalence of other disorders, such as major depression (10-12%) and various personality disorders (40-70%).[3]

In several prisons throughout the world, separate wards have been created for prisoners with psychiatric disorders. In the Netherlands, these wards are known as Penitentiary Psychiatric Centres (PPC). A major reason for confining prisoners to PPCs is that psychosis and schizophrenia are mental disorders that can give rise to aggressive behaviour.[5,6] Indeed, psychosis is associated with a 49%–68% increased likelihood of violence,[5] whereas schizophrenia is related to an increased risk of violent *crime* (10-15%).[6] It has been argued that aggressive behaviour results from a decline in impulse control.[7] A decline in impulse control is also a clinical hallmark of psychosis and schizophrenia.[8] Indeed, there is a positive relationship between the frequency of violent crimes committed by a given individual and a decline in impulse control.[9] A study of 29 Australian inmates and 58 controls indeed found that the prisoners scored lower in terms of impulse control than the healthy controls.[10]

Aerobic physical activity can have a beneficial effect on impulse control, as has been observed in children, adolescents, and adults.[11,12] Physical activity is considered a part of an enriched environment.[13] In contrast, physical *inactivity* (a feature of an impoverished environment) may reduce impulse control.[13] Significantly, a decrease in daytime physical activity will also be reflected in a disturbed rest-activity rhythm,[14,15] a phenomenon characteristic of patients with dementia.[15,16] The rest-activity rhythm is a nearly 24-hour circadian rhythm,[17] reflecting both the level of physical (in)activity during the day and the

level of (in)activity during the night.[15,17] Indeed, in patients with dementia in a closed nursing-home environment, physical inactivity and disturbance of the rest-activity rhythm are related to increased agitation.[18]

Prison, another example of an impoverished environment, is characterized by physical inactivity.[19–21] One notable finding, in a UK prison, was that prisoners tend to sit or lie on their beds for a striking average of 9.36 hours per day, in addition to the hours spend sleeping.[19] Among 612 Australian male prisoners and 107 Australian female prisoners, an average of only 73.2 minutes per week of physical activity was observed.[20] Another Australian study, which included 212 female prisoners in Queensland, reported that 29.5% of the prisoners were not physically active and that 22.7% were physically active for less than 150 minutes per week.[21] In the Netherlands, prisoners have the opportunity to engage in sporting activities for two 45-minute periods a week. Unfortunately, no data is available on the extent to which prisoners in the Netherlands actually make use of this opportunity.

The goal of the present study is to examine aggression/agitation in relation to the rest-activity rhythm in prisoners suffering from a psychotic illness who are imprisoned in a PPC. We focused purely on psychotic illnesses because, in this particular group of individuals, aggression/agitation greatly complicate the process of delivering appropriate care. Besides its obvious implications for the quality of patient care, this behaviour also places a greater burden on the staff. In conclusion, we focused on this group specifically because of their enormous impact on the quality of care and on the burden placed on staff. Since prison is characterized by physical inactivity, we hypothesize that this population will have a disturbed rest-activity rhythm, similar to that found in nursing-home patients with a neurological disease. We also hypothesize that the greater the disruption of the rest-activity rhythm, the greater the level of aggression displayed.

Method

Participants

The Penitentiary Psychiatric Centre Amsterdam houses 140 inmates in two towers, each of which can accommodate 70 patients. Of the total population of 140, 20 patients with a psychotic illness were eligible, willing and able to participate. One patient was eventually excluded during the data analysis stage of the study, because his diagnosis changed from *psychosis NAO* to a definitive diagnosis of *bipolar disorder*. His psychotic-like behaviour was explained as a symptom of extreme mania.

The final sample consisted of 19 male patients diagnosed with schizophrenia (N = 9), psychosis (N = 9) and schizoaffective disorder (N = 1), who were recruited in the PPC of the Penitentiary Institution Over-Amstel. The ages of the participants ranged from 19 to 54 (M = 33.2, SD = 9.4).

Medication. The following categories of medication were identified: antipsychotics (N = 10), benzodiazepines (N = 1) and antidepressants (N = 1).

Comorbidities. In addition to a psychotic illness, several comorbidities were found, such as substance abuse (N = 2), antisocial personality disorder (N = 2) and diabetes (N = 1). Most of the patients were either suspected of committing a violent crime or had been convicted of such an offence (N = 11), including five for murder and two for sexual abuse.

Informed consent. It was explained to the patients that participation was not obligatory and that they had the right to withdraw from the study at any time. Furthermore, the patients were informed about the purpose of the study and any questions that they had were answered. All patients signed informed consent, granting the researcher permission to publish anonymized results. Non-anonymized patient data was retained within the prison (PI Over-Amstel), in accordance with the regulations of the Custodial Institutions Agency (in Dutch: *Dienst Justitiële Inrichtingen*).

Material

Rest-activity rhythm. Rest-activity data was collected by means of an Actiwatch activity monitor (Cambridge Neurotechnology Ltd., Cambridge, England). Actiwatches are small activity monitors that are worn on the wrist, like a watch, 24 hours a day. The Actiwatch provides information on the (in)stability of the rest-activity rhythm from one day to another (Inter-daily Stability; IS), and on the fragmentation of the rest-activity rhythm within they day, i.e. changes from periods of rest to activity and vice versa (Intra-daily Variability; IV). It also indicates the difference between maximal activity and maximal rest (Relative Amplitude; RA), and provides data on the 10 most active hours (M10) and the 5 least active hours (L5) (for detailed information about these measurements, see the work of Van Someren and colleagues and Carvalho-Bos and colleagues).[22,23] The Actiwatch stores the movement data, which is retrieved later using a reader connected to a laptop. The device's wristwatch-like design reduces physical discomfort to a minimum.

Aggression. The Social Dysfunction and Aggression Scale (SDAS) is a behaviour observation scale that is filled in by the staff and is used to assess aggressive behaviour in the participants. The SDAS contains the following items: 1) non-directed verbal aggression; 2) directed verbal aggression; 3) irritability; 4) negativism/uncooperative behaviour; 5) dysphoric mood (feeling misunderstood); 6) socially disturbing/provocative behaviour; 7) physical violence towards staff; 8) physical violence towards other individuals; 9) automutilation; 10) physical violence against objects; 11) suicidal thoughts or behaviour; 12) withdrawal and 13) neglect of personal hygiene. The items are scored on a 5-point Likert scale, ranging from 0 (not present) to 4 (overtly present). Specific examples of behaviour are given per point on the scale for each item. It was possible to create a single aggression domain for the 9 items that measured aggression (Cronbach's alpha = 0.90), with a minimum score of 0 and a maximum of 36. Items 9), 11), 12) and 13) were not used in the current study, as they measure behaviour not addressed in this study, i.e. automutilation, suicidal thoughts or behaviour, (social) withdrawal, and neglect of personal hygiene.

Procedure

Each participant wore an Actiwatch on their dominant wrist for 7 consecutive days. After this period, the Actiwatch was collected by the researcher and the SDAS was immediately filled in by the staff. Thus, both the researcher and the staff were blind for the Actiwatch data at

the time the SDAS data was collected. The staff filled in the SDAS together, i.e. there was one SDAS per patient. The staff were instructed to limit their answers to the questions to the period of the past seven days. The researcher was on hand to answer questions or to give extra instructions when needed.

Statistical analysis

Actigraphic measurements were uploaded and analysed with Actiwatch Activity & Sleep Analysis 7, Version 7.23 (Cambridge Neurotechnology Ltd., Cambridge, England). This software was used to carry out Nonparametric Circadian Rhythm Analyses (NCPRA) for every participant, resulting in the various actigraphic measurements (L5, M10, IS, IV and RA). The amount of movement data obtained ranged from 144 hours to 168 hours.

Additional statistical analyses were performed with IBM® SPSS® Statistics version 20.0. Descriptive statistics were calculated to provide insight into the participants' actigraphic characteristics. Bivariate correlations were calculated to control for the possible influence of medication on actigraphy and aggression variables. A stepwise regression analysis was conducted with the aggression domain as a dependent variable and L5, M10, IV, IS and RA as independent variables. A minimum level of significance of $p < 0.05$ was used as the entry requirement. Both a linear model and a quadratic model were considered.

Results

Descriptive statistics

Descriptive statistics were calculated for the 5 actigraphy variables and for the aggression domain. These are displayed in the second column of Table 1.

Controlling for covariates

Firstly, we observed that age correlated neither with the aggression domain nor with the actigraphy variables (see table 2). We also controlled for various types of medication (i.e. antipsychotics, antidepressants or benzodiazepines), none of which showed any correlation with the aggression domain. The use of antipsychotics, however, did correlate with actigraphy variable IV, and was therefore considered to be a covariate.

Table 1. Actigraphy and aggression characteristics of the participants

Variable	Mean (SD)	Nursing-home populations	Patients with schizophrenia
L5	1378 (1195)		
M10	24302 (9635)		
IS	0.58 (0.13)	0.48 –0.65	0.47 – 0.53
IV	0.92 (0.25)	0.74 – 1.38	0.74 – 0.83
RA	0.89 (0.08)		
Aggression Domain	7.6 (7.6)		

L5 = 5 Least active hours; M10 = 10 most active hours; IS = Inter-daily Stability; IV = Intra-daily Variability; RA = Relative Amplitude

Table 2. Bivariate correlations between medication types and actigraphic measures and the aggression domain

		L5	M10	IS	IV	RA	Aggr.
Age	Correlation	-0.179	-0.326	0.135	0.316	-0.128	-0.370
	Sig. (2-tailed)	0.478	0.187	0.594	0.202	0.613	0.131
BD	Correlation	0.143	-0.161	-0.208	-0.091	-0.297	0.298
	Sig. (2-tailed)	0.559	0.510	0.392	0.712	0.217	0.215
AD	Correlation	-0.121	-0.270	0.100	-0.099	0.005	-0.211
	Sig. (2-tailed)	0.621	0.263	0.685	0.686	0.982	0.385
AP	Correlation	-0.019	0.249	0.344	-0.552*	0.216	0.124
	Sig. (2-tailed)	0.939	0.304	0.149	0.014	0.374	0.614

* = Correlation is significant at the 0.05 level (2-tailed); BD = Benzodiazepines; AD = Antidepressants; AP = Antipsychotics; L5 = 5 least active hours; M10 = 10 most active hours; IS = Inter-daily Stability; IV = Intra-daily Variability; RA = Relative Amplitude; Aggr. = Aggression Domain

Prediction of aggression by the rest-activity rhythm

A stepwise linear regression analysis was conducted with L5, M10, IV, IS and RA as independent variables and with the aggression domain as a dependent variable. Only L5 entered the regression with $p = 0.006$, resulting in a declared variance of $R^2 = 0.37$ (adjusted $R^2 = 0.33$). Since IV did not enter the regression, we did not covariate for the use of antipsychotics. In addition, a quadratic model was considered, which did not improve the declared variance significantly (adjusted R^2 change = 0.006, $p = 0.298$).

Discussion

The goal of the present study was to assess the rest-activity rhythm in prisoners with a psychotic illness and to ascertain whether a relationship exists between the rest-activity rhythm and aggressive behaviour.

The relationship between rest-activity rhythm and aggression/agitation

The main finding of the present study was the identification of a positive relationship between nocturnal restlessness and aggressive behaviour, i.e. the more restless behaviour at night, the more aggression/agitation during the day. It has recently been suggested that this relationship might be causal, as sleep deprivation results in reduced functioning of the prefrontal cortex, which is crucial to the inhibition of aggression.[24]

Clinical relevance of the actigraphy characteristics

To assess the clinical relevance of the participants' actigraphy characteristics, we compared the current group with patients suffering from other neurological disorders in a closed setting, i.e. nursing-home patients with dementia. Similar comparisons were made with community-dwelling persons, i.e. patients suffering from schizophrenia and individuals with ADHD. The results of these studies are presented in the third and fourth columns of Table 1.

The disturbances of the rest-activity rhythm found in the present study are indeed comparable to those observed in nursing-home populations. For example, our population had a mean IS of 0.57, while the literature reports IS values ranging from 0.48 to 0.65 for nursing-home patients with dementia.[25,23,16] Furthermore, we found a mean IV of 0.92 in the current group, compared to values ranging from 0.74 to 1.38 in nursing-home residents.[23,16] To our knowledge, no such data is available for patients with a psychotic illness in a *closed*

setting. However, data is available for community-dwelling and open-ward patients with schizophrenia. The studies in question report IS values of 0.47,[8] and 0.53,[26] and IV values of 0.74,[26] and 0.83.[8] We found no published work in which L5 for closed nursing-home settings or for patients with a psychotic illness was calculated in the same way as in the present study. However, a study of patients with ADHD,[27] a disorder characterized by, among others, disturbed sleep,[28] reported a mean L5 of 801. Interestingly, our prison group seems to display even more nocturnal restlessness than the latter group, with a mean L5 of 1378.

Limitations

One limitation was the relatively small sample size used in this study, even though a convincingly significant relation was found. The small sample size was not a result of the limited availability of prisoners with a psychotic illness, but rather of the delusional nature of their disorder. Many inmates refused to take part due to their distrust of the Actiwatch and of the investigator. Unfortunately, no data was collected with respect to the participation consent/refusal ratio, which could be useful in future studies for predicting a statistically powerful sample size.

Secondly, the current study does not include a healthy control group, which would have provided a better understanding of the level of disruption of the rest-activity rhythm.

Thirdly, the intention was to use the M10 measurement (i.e. the total amount of movement) as an objective measurement of the level of physical activity. However, restless behaviour during the day may have boosted M10 in certain subjects, making M10 an unreliable variable for the measurement of healthy physical activity, e.g. sport. Actigraphic devices specifically designed to measure physical activity (rather than the rest-activity rhythm), may be able to distinguish this restless behaviour from actual physical activity. In turn, they will provide insufficient data to analyse the rest-activity rhythm.

Recommendations

The results of the present study suggest that there is a need for further research into the relationship between disturbed sleep and aggressive behaviour in prisoners. If such work produces consistent findings, then interventions aimed at reducing nocturnal restlessness should be developed. For example, participation in an aerobic physical activity programme can benefit both sleep and impulse control.[11,12,29] We argue that any positive effects derived

from such interventions will benefit both prisoners and prison staff, as the latter will enjoy a safer working environment as a result. Ultimately, if the existence of long-term effects can be established, society at large may also benefit, as a reduction in aggressive behaviour may result in reduced recidivism.

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