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Exploring substance use as rule-violating behaviour during inpatient treatment of offender patients with schizophrenia

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Abstract

Background: Rule-violating behaviour in the form of substance misuse has been studied primarily within the context of prison settings, but not in forensic psychiatric settings.

Aims: Our aim was to explore factors that are associated with substance misuse during hospitalisation in patients among those patients in a Swiss forensic psychiatric inpatient unit who were suffering from a disorder along the schizophrenia spectrum.

Methods: From a database of demographic, clinical and offending data on all residents at any time between 1982 and 2016 in the forensic psychiatric hospital in Zurich, 364 cases fulfilled diagnostic criteria for schizophrenia or a schizophrenia-like illness and formed our sample. Any confirmed use of alcohol or illicit substances during admission (yes/no) was the dependent variable. Its relationship to all 507 other variables was explored by machine learning. To counteract overfitting, data were divided into training and validation set. The best model from the training set was tested on the validation set.

Johannes Kirchebner and Martina Sonnweber contributed equally to the work presented here and should therefore be regarded as equivalent authors.

Results: Substance use as a secure hospital inpatient was unusual (15, 14%). Prior substance use disorder accounted for so much of the variance (AUC 0.92) that it was noted but excluded from further models. In the resulting model of best fit, variables related to rule breaking, younger age overall and at onset of schizophrenia and nature of offending behaviour, substance misuse as a minor and having records of complications in prior psychiatric treatment were associated with substance misuse during hospitalisation, as was length of inpatient treatment. In the initial model the AUC was 0.92. Even after removal of substance use disorder from the final model, performance indicators were meaningful with a balanced accuracy of 67.95, an AUC of 0.735, a sensitivity of 81.48% and a specificity of 57.58%.

Conclusions: Substance misuse in secure forensic psychiatric hospitals is unusual but worthy of clinical and research consideration because of its association with other rule violations and longer hospitalisation. More knowledge is needed about effective interventions and rehabilitation for this group.

KEYWORDS
rule-violations, schizophrenia, substance misuse

1 | INTRODUCTION

Rule-violating behaviour in the form of substance misuse has been studied primarily within the context of prison settings (Houser, Belenko & Brennan, 2012; Jiang, Fisher-Giorlando & Mo, 2005) with prevalence of in-prison substance misuse ranging from 2% to 56% (EMCDDA, 2012; Mjåland, 2016). Most studies on rule-violating behaviour in forensic psychiatric hospitals have focused on either absconding (Watson & Choo, 2020) or violence (Hildebrand, De Ruiter & Nijman, 2004). To our knowledge, there is no previous study of substance misuse as a rule-breaking behaviour among inpatients with a disorder along the schizophrenia spectrum (schizophrenia spectrum disorder) in a forensic psychiatric hospital setting.

First, we consider important conceptual and practical terms in more detail. There is no single definition of rule-violating behaviour within the institutional context (Jeandarme et al., 2017). We adopt the definition of Main and Gudjonsson (2006), who included consumption of illicit substances or alcohol as well as absconding, violence towards staff or patients, property damage, and arson into their description of rule violations. A "substance" is defined as any psychoactive chemical compound potentially causing health and social problems. Such substances may be legal (e.g. alcohol, tobacco), illegal (e.g. heroin, cocaine), or controlled for medical purposes by licenced prescribers but misused (e.g. benzodiazepines) (McLellan, 2017). Furthermore, a distinction must be made between "use", "misuse" and "substance use disorder". While "use" of substances applies to legal "recreational" consumption, "misuse" refers to the use of a substance for a purpose that does not conform to legal or medical guidelines. Repeated use of

substances in high doses and/or frequency that substantially impairs health and function and requires treatment is referred to as "substance use disorder" (McLellan, 2017).

The association of substance misuse (alcohol or illicit drugs) and offending in persons suffering from severe mental illness (Elbogen & Johnson, 2009; Pickard & Fazel, 2013) and especially in those along the schizophrenia spectrum (Fazel et al., 2009; Swanson et al., 2006; Volavka & Citrome, 2011) is well established. Considering this, a higher prevalence of history of substance misuse and comorbid substance use disorder has been found in forensic psychiatric populations (Elbogen & Johnson, 2009; Schaefer, Daffern & Ferguson, 2011; Whyte, Scott & Maden, 2004). Further, patients with an existing diagnosis of substance misuse or substance use disorder were reported to be younger at initial admission to a psychiatric facility, to have longer psychiatric hospitalisations, to have more severe and complex criminal histories, and to be more likely to have a history of self-injurious and suicidal behaviour (Mueser et al., 2000; Ogloff, Lemphers & Dwyer, 2004). In this context it is surprising that there has been little research on the misuse of substances as a form of rule violation *during* the placement of offender patients with schizophrenia spectrum disorders in forensic psychiatric hospitals.

Rule-violating behaviour during forensic psychiatric hospitalisation leads to concerns about the safety of other inpatients and staff, appropriate treatment methods, length of stay, and reintegration into the community after discharge (Houser et al., 2012). Violent incidents or substance misuse may result in injuries to other patients and staff, overdosing and health complications, leading to increased healthcare costs as well as the direct harms. At the individual level, records related to rule-violations may be critical factors in discharge decisions and may prolong the length of time hospitalised or influence security-level placements.

While illicit substances are known to enter secure forensic psychiatric hospitals, research indicates that the quantity is small and below that entering jails (D'silva & Ferriter, 2003; Schaefer et al., 2011). When patients are not (or scarcely) using during hospitalisation, this may mislead to an assumption that they no longer have a substance use disorder or at least a substance misuse problem when it is only access that has changed (Schaefer et al., 2011). Because of the high prevalence of substance use disorder in the forensic context, the question arises as to whether patients who misuse substances during hospitalisation share any other characteristics that differentiate them from those who do not misuse in these circumstances.

1.1 | Aims for this study

Our primary aim was to identify factors that distinguish between inpatients suffering from a schizophrenia spectrum disorder who engage in the rule-violating behaviour of substance misuse during forensic psychiatric hospitalisation, and those who do not. The secondary aim was thus to help clinicians and researchers to identify patients at risk of substance misuse in forensic psychiatric care settings earlier and understand their needs better and thus design treatment strategies with optimal fit.

2 | METHODS

2.1 | Ethics

The study was reviewed and approved by the Cantonal Ethics committee of Zurich, Switzerland (Ref.-No. KEK-ZH-NR 2014-0480).

2.2 | Source of data and measures

The clinical files of all inpatients who were admitted to the Centre for Inpatient Forensic Therapies at the Zurich University Hospital for Psychiatry between 1982 and 2016 were searched. Among these 1694 files 370 (most, 296, of the latter after 296 after 2000) were included providing that the clinician's recorded diagnosis was along the schizophrenia spectrum as defined in ICD-9 (World Health Organization, 1978) or ICD-10 (World Health Organization, 2016) and the inpatient had sustained an index criminal conviction. The forensic facility in this hospital has a total of 79 beds and provides inpatient treatment for court-ordered mentally disturbed offenders and incarcerated offenders in need of short-term intervention. Treatment goals include therapy for the mental disorder, consistent reduction of individual risk, and appropriate social rehabilitation. The database from which we drew for this study contains over 650 different variables, has already been used in other studies and is part of a larger project in which the medical records of forensic inpatients have been used to study relationships between disorders along the schizophrenia spectrum and criminal behaviour more generally.

For data extraction from the records, we used a structured protocol based on Seifert's extended list of criteria (Habermeyer et al., 2010; Kutscher, Schiffer & Seifert, 2009). These multidisciplinary patient records generated during the patients' hospitalisation (e.g. forensic psychiatric reports, indictments, court judgements, nursing reports, risk assessment reports, discharge reports, medication, etc.) were systematically reviewed and coded by a trained independent physician or psychologist.

The variables cover the following domains: social-demographic data, childhood/teenage experiences, psychiatric history, past criminal history, social and sexual functioning, details of the offence leading to forensic hospitalisation (the index offence), prison data, particularities of the current hospitalisation and psychopathological symptoms and signs according to the positive and negative syndrome scale (PANSS), a 30-item scale; the latter was rated by the study physician or psychologist from the medical records and simplified into three points for each item (completely absent, discreetly present or substantially present). Full details on data collection and processing can be found in Kirchebner, Gunther & Lau (2020).

2.3 | Planned analyses

Due to the exploratory nature of the study and the large number of possible predictor variables, machine learning (ML) seemed most appropriate for statistical analysis as it is particularly suitable for reducing variables to the most important ones, for recognising patterns and ultimately constructing models based on these patterns. The statistical approach differed only in the definition of the outcome variable. For a detailed description of ML and the rationale behind our steps see Günther, Kirchebner & Lau (2020) and the overview in Figure 1.

All steps were performed using R version 3.6.3. and the MLR (Machine learning in R) package v2.171 with its default hyperparameters (Bischl et al., 2016). Confidence intervals (CI) calculations of the balanced accuracy were conducted using MATLAB R2019a (MATLAB & Statistics Toolbox Release, 2012, The MathWorks, Inc., Natick, Massachusetts, United States) with the add-on "computing the posterior balanced accuracy" v1.0 (Brodersen et al., 2010).

The dependent variable – use of a psychoactive substance during current hospitalisation – was dichotomised into (1) *patient with any confirmed substance misuse* and (2) *patient without detected substance misuse*. The definition of any confirmed use was any intake of alcohol or illegal drugs detected through breath alcohol test or urine sample testing during the forensic hospitalisation.

To avoid overfitting and to obtain the most reliable performance parameters, we split the data into a training (70%) and validation (30%) dataset, the latter remaining artificially unmanipulated except for the imputation of the stored weights from the training dataset. Next, the training dataset was used to perform a nested resampling approach in order to keep the steps of artificial data modification and ML model creation separate from model selection and to further reduce overfitting. In this approach, an inner loop is formed in which the missing values are

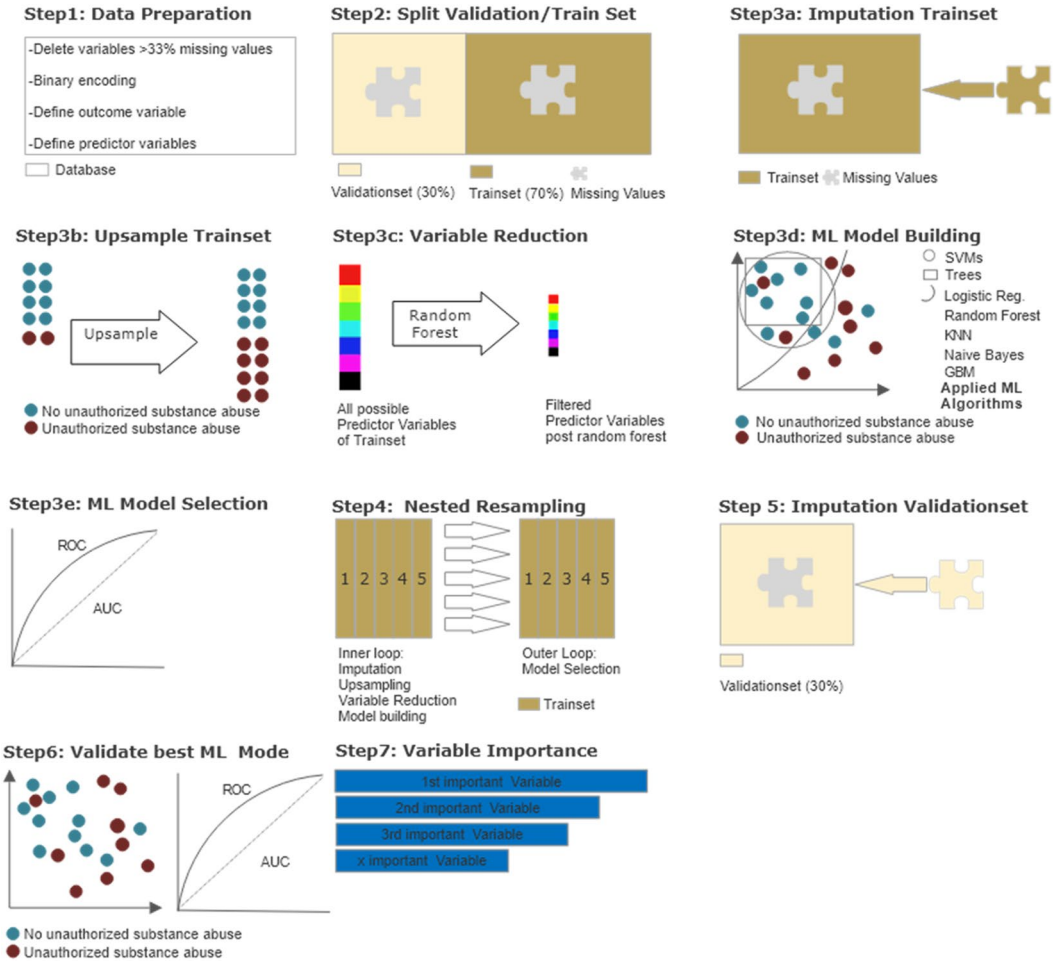

FIGURE 1 Overview of statistical procedures. *Step 1 – Data Preparation*: Multiple categorical variables were converted to binary code. Continuous and ordinal variables were not manipulated. Outcome variable substance misuse /no substance misuse and 561 predictor variables were defined. *Step 2 – Datasplitting*: Split into 70% training dataset and 30% validation dataset. *Step 3 a, b, c, d, e – Model building and testing on training data I*: Imputation by mean/mode; upsampling of outcome "substance misuse" x7; variable reduction via random forest; model building via ML algorithms - logistic regression, trees, random forest, gradient boosting, KNN (k-nearest neighbour), support vector machines (SVM), and naive bayes; testing (selection) of best ML algorithm via ROC parameters. *Step 4 – Model building and testing on training data II*: Nested resampling with imputation, upsampling, variable reduction and model building in inner loop and model testing on outer loop. *Step 5 – Model building and testing on validation data I*: Imputation with stored weights from Step 3a. *Step6 - Model building and testing on validation data II*: Best model identified in Step 3e applied on imputed validation dataset and evaluated via ROC parameters. *Step7*: Test for multicollinearity and ranking of variables by indicative power [Colour figure can be viewed at wileyonlinelibrary.com]

imputed by mean and mode, the unequal outcome variable is randomly up balanced 7-fold, the initial 561 predictor variables are reduced to 10 variables using a random forest algorithm and finally different ML models (logistic regression, trees, random forest, gbm, svm, kkn and naive Bayes) are created. Then, these ML models are tested in an outer loop and the model with the best AUC is selected for validation. Both the inner loop and the outer loop were embedded in a 5-fold-cross-validation, a technique to artificially create different subsamples of a dataset (Browne, 2000). Finally, the selected ML algorithm was applied to the previously split validation dataset to calculate the performance parameters for the final model.

To check for artifacts due to any changing pattern of drug misuse over time, we calculated two additional models for the pre- and post-2000 periods. However, except for the algorithm, which was changed from gradient boosting to Naive Bayes, and a lower AUC after 2000 (0.87 pre-2000 vs. 0.82 post-2000), the influential variables did not change. Thus, it can be assumed that the data collection period of 34 years has no effect on model performance.

3 | RESULTS

3.1 | General description of the sample

Over the 34 years studied, 370 patients fitted the study criteria, but after removing cases with missing values in the areas of interest, 364 patients remained for analysis. Of these patients, 51 (14%) were involved in an event of illicit substance use (machine learning analysis positive) and 313 (86%) were not (ML negative). Table 1 shows the distribution of demographic, substance use history and index offence characteristics of the sample. At the bivariate level, there was no difference between those who did or did not use substances as an inpatient in sex, age, some offence types (multiple answers possible) PANSS or country of birth. It is striking that only about half of the patients in this

TABLE 1 General characteristics of the sample of inpatients in a secure forensic psychiatric hospital with schizophrenia-like illnesses

	Substance misuse		No substance misuse	
Variable description	***n*/*N* (%)**	**Mean (SD)**	***n*/*N* (%)**	**Mean (SD)**
Demographical data				
Male sex	47/51 (92.2)		287/313 (91.7)	
Age at admission		32.02 (9.2)		32.02 (9.2)
Native country Switzerland	27/51 (52.9)		137/313 (43.8)	
Clinical data				
Substance misuse/SUD in patient history:	44/49 (89.8)		156/273 (57.1)	
Alcohol misuse	44/51 (86.3)		175/313 (55.9)	
Cannabis misuse	49/51 (96.1)		215/312 (68.9)	
Other drug misuse (including cannabis)	49/51 (96.1)		215/312 (68.9)	
PANSS total score at admission		25.47 (12.3)		23.72 (12.8)
PANSS total score at discharge		11.33 (10.1)		11.05 (10.2)
Criminal data				
Index offence: (Attempted) homicide[a]	15/51 (29.4)		92/312 (29.5)	
Index offence: Assault	18/51 (35.3)		128/312 (41)	
Index offence: Rape	5/51 (9.9)		25/312 (8)	
Index offence: Threat	11/51 (21.6)		96/312 (30.8)	
Index offence: Other	14/51 (27.5)		71/312 (22.8)	

Abbreviations: PANSS, Positive and negative syndrome scale; SD, Standard deviation; SUD, Substance use disorder.

[a]Offence categories in this table are not necessarily mutually exclusive.

Swiss Clinic were Swiss born. In regard to a co-diagnosed substance misuse disorder, the two groups differed significantly which was also detected by the ML algorithm (see results below).

The initial ML algorithms identified a diagnosis of substance use disorder which had already existed prior to the current hospitalisation as the single most influencing variable among over 650 others, accounting for the difference between inpatient use of substances or not with an Area Under the Curve (AUC) of 0.92 (Receiver Operating characteristics). Since this single variable dominated the model to such an extent that it overshadowed all other potentially important variables and thus limited the chances of any other findings, it was omitted for further model building.

Table 2 shows an overview of the performance parameters of the different calculated algorithms/models during the nested resampling procedure with the 10 most important predictor variables once pre-existing substance misuse disorder had been excluded. The gradient boosting algorithm yielded the best model, accounting for 74% of the accurate associations and with an AUC of 0.87.

The absolute and relative distribution of the 10 variables accounting for most variation in the model identified during nested resampling, which were subsequently used for model building, can be seen in Table 3. The identified

TABLE 2 Machine learning models and performance in nested cross-validation on training dataset – substance misuse versus no substance misuse

Statistical procedure	Balanced Accuracy (%)	AUC	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Logistic regression	64.69	0.7381	72.55	56.83	92.12	23.94
Tree	66.97	0.6978	80.81	53.17	92.57	29.69
Random forest	58.29	0.6787	94.13	22.45	89.23	38.33
Gradient boosting	74.03	0.8653	86.96	61.11	82.09	39.57
KNN	59.03	0.6653	82.46	35.61	89.79	23.31
SVM	58.69	0.6227	78.72	42.43	90.22	25.86
Naive Bayes	68.03	0.7115	61.29	74.76	94.30	23.88

Abbreviations: AUC, area under the curve (level of discrimination); KNN, k-nearest neighbours; NPV, negative predictive value; PPV, positive predictive value; SVM, support vector machines.

TABLE 3 Absolute and relative distribution of indicative variables on complete dataset – substance misuse versus no substance misuse

	Substance misuse		No substance misuse	
Variable description	n/N (%)	Mean (SD)	n/N (%)	Mean (SD)
Age at admission		32.02 (9.2)		34.55 (10.2)
Substance use as minors	30/46 (65.3)		77/238 (32.4)	
Age at first diagnosis of SSD		25.66 (7.9)		28.54 (9.4)
Age at first documented symptoms of SSD		21.67 (6.5)		24.57 (8.6)
Time period between release out of last inpatient treatment and index offence (in weeks)		6.48 (11.5)		14.71 (33.1)
Antisocial behaviour during current hospitalisation	38/51 (74.5)		131/312 (42)	
Events of rule breaking during current hospitalisation	35/50 (70)		66/313 (21.1)	
Rule breaking on temporary leaves	30/41 (73.2)		33/201 (16.4)	
Age of patient at index offence		29.65 (8.9)		32.43 (9.9)
Time spent in current forensic hospitalisation (in weeks)		163.06 (184.6)		105.04 (123.8)

Abbreviations: SD, Standard deviation; SSD, schizophrenia spectrum disorder.

variables can be grouped in terms of age, with younger age of onset or recognition of a range of problems in the misuse group; presenting with other problematic behaviours during the current hospitalisation, with significantly more rule breaking generally in the misuse group; and hospitalisation, with time between the index hospitalisation and the immediate previous one much shorter and length of the index hospitalisation much longer among the in-patient substance users.

The quality of the final model was assessed in a validation step, shown in Table 4. As expected, the balanced accuracy of 67.95 and AUC of 0.735 were lower than in the initial training model, but still meaningful. With a sensitivity of over 81%, over three-quarters of patients who did not show unauthorised substance use were identified correctly. With a specificity of nearly 58%, over the half of patients who misused a psychoactive substance during the current hospitalisation were detected correctly.

The distribution of variable importance of the final validation model is presented in Figure 2. Length of index hospitalisation and other inpatient rule-breaking behaviours dominated the final model as the factors most distinguishing between those using and those not using substances in the hospital.

4 | DISCUSSION

Our study adds to the sparse literature on rule-violating incidents in forensic psychiatric hospitals by examining substance misuse during such hospitalisation of people with disorders along the schizophrenia spectrum. Even after exclusion of substance use disorder as a variable in the computation, the final model was highly sensitive (82%) and had moderate specificity (58%). It is thus likely to be clinically useful for identifying patients at risk for inpatient substance misuse. These offender patients who misused psychoactive substances during forensic psychiatric hospitalisation spent more time in the current residency, violated more of the other rules during inpatient treatment (as defined by Main & Gudjonsson, 2006) and during temporary furloughs, were younger at admission, diagnosis and first symptoms of schizophrenia or similar, had misused substances as minors, were younger when they committed their first offence, had received inpatient treatment shortly before committing the index offence, and had exhibited dissocial behaviour during current inpatient treatment. From a clinical perspective, these findings underscore the importance of collecting detailed information about the life-course of both the psychosis and the substance use in order to identify patients most at risk for substance misuse during hospitalisation earlier. Failure to do so may raise a risk of cross-addiction through inappropriate prescribing or inappropriate monitoring of the use of addictive substances such as benzodiazepines, commonly prescribed for agitation and aggression control for patients with schizophrenia or similar (Citrome & Volavka, 2011; Haw & Stubbs, 2007). Cross-addiction refers to developing dependency on another substance by someone already suffering from substance use disorder, in turn risking relapse to the original substance misused (Gendel, 2006).

TABLE 4 Final gradient boosting model performance measures on validation dataset - substance misuse versus no substance misuse

Performance measures	%	95% confidence interval
Balanced accuracy	67.95	[51.08, 83.68]
AUC	0.7350	[0.5058, 0.9642]
Sensitivity	81.48	[66.39, 91.01]
Specificity	57.58	[19.67, 89.01]
PPV	92.78	[78.59, 98.26]
NPV	31.67	[10.30, 63.13]

Abbreviations: AUC, area under the curve; NPV, negative predictive value; PPV, positive predictive value.

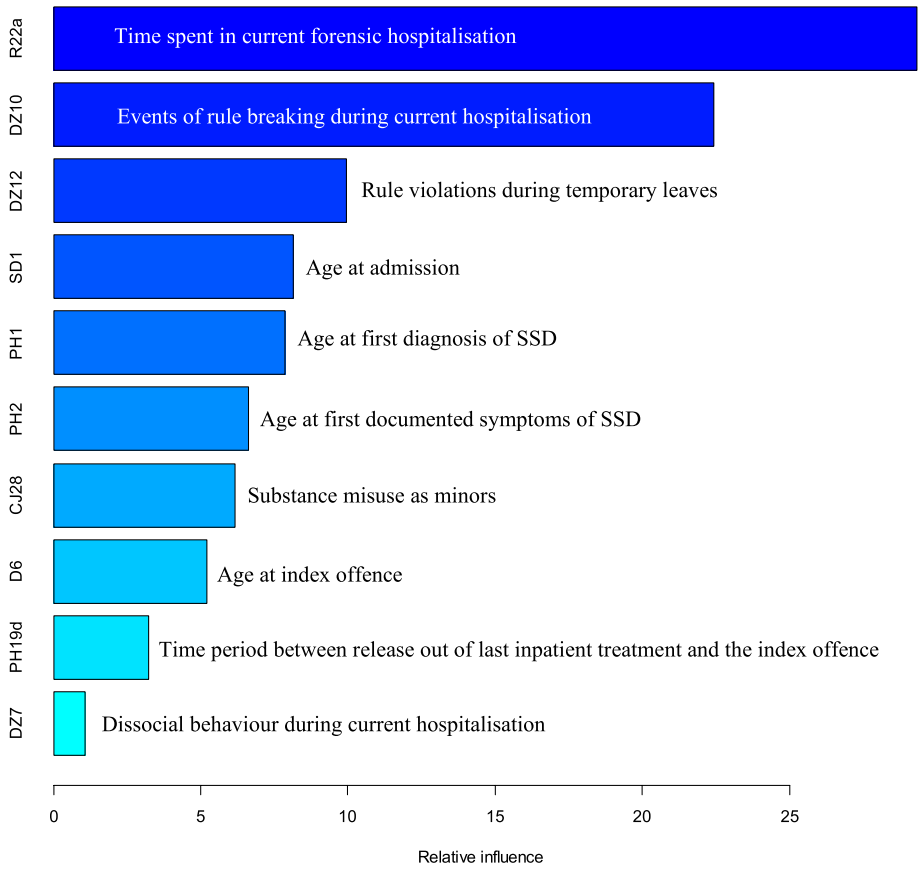

FIGURE 2 Variable importance of final model substance misuse versus no substance misuse. SSD, Schizophrenia spectrum disorder [Colour figure can be viewed at wileyonlinelibrary.com]

Inpatients, who misuse substances during hospitalisation appear to be at risk for longer and, thus, more costly stay with an increased burden on inpatient care providers in other respects too, including making them have to manage more rule violations generally.

Our results are consistent with other studies that have shown that younger age is associated with greater likelihood of other rule-violating behaviour while an inpatient in a forensic psychiatric hospital (Scott et al., 2004). Our finding of, essentially, a group of early onset problems among the inpatient substance users including earlier onset of criminal behaviours and earlier diagnosis of schizophrenia-like illness and earlier hospitalisation for it raises the possibility that inpatient rule violators may be the subset of patients with such illness who first have conduct disorder described by Hodgins, Tiihonen & Ross (2005).

One difficulty in treating substance misuse and substance use disorder arises from a dissonance between some mental health professionals and patients about the extent to which substance use disorders are true disorders, notwithstanding their appearance in disease classification systems and development at least in some countries of recognised addiction specialties. There is a risk that clinicians see illness as a legitimate case for treatment as beyond the patient's control and substance misuse as more a function of choice. The patients, however, do not experience themselves as having much control over any aspect of their problems (Gendel, 2006; Whyte et al., 2004).

Another difficulty is identifying and treating substance misuse in forensic psychiatric inpatient settings under conditions of enforced abstinence. Recent research suggests more open inpatient psychiatric treatment settings for patients with substance use disorders with (Marlowe, 2003) and without (Walters & Rotgers, 2011) offending

behaviour. This calls for a commitment to exploring new treatment methods and models and evaluating them appropriately, since there is limited evidence on which substance misuse programmes actually work in forensic psychiatric settings (Scott et al., 2004; Whyte et al., 2004) and especially for patients who also have a psychotic illness. Although the provision of drug treatment in European correctional settings has expanded in recent years, particularly with regard to opioid substitution treatment, drug treatment in institutions is still not on a par with that available in community settings (EMCDDA, 2012). Regulators should consider ways to allow forensic psychiatric inpatient treatment settings to implement newer treatment approaches which encourage more liberal substitution and moderation. Better staff training should also be noted here, as this can be seen as a foundation for treatment success. It is recognised that increased expertise and knowledge contribute significantly to higher quality of psychiatric treatment for mentally disordered offenders, as well as better assessments and interventions to reduce re-offending and substance misuse (Ogloff et al., 2004). Staff need to understand the special needs of this population. Motivational strategies (e.g. Rollnick, Miller & Butler, 2008) rather than confrontational ones are likely to help most. Developing a coordinated education programme that meets the diverse needs of patients with substance use disorders is essential for full effectiveness (Ogloff et al., 2015).

Exploration of the reasons for substance use while an inpatient is also important. While it may be just one of a cluster of rule violations, there are other explanations too. Patients may choose self-medication when prescribed treatments are not fully effective at reducing symptoms of psychosis. They may be trying to relieve boredom. It is not easy to be a resident in a secure hospital, so rule-violating drugs may be for anxiety reduction or to increase social confidence (Schaefer et al., 2011). All possibilities should also be taken into account in treatment.

4.1 | Strengths and limitations

Our data were from a single forensic psychiatric hospital in Switzerland, so findings may not be generalisable to other treatment settings, especially in other countries. Our sample of 364 patients was a small group for analysis, although use of machine learning strategies helped mitigate this. This study is the first attempt to apply this methodology to this research question so the identified model should be tested in further studies, preferably in prospective study designs.

5 | CONCLUSIONS

Our main findings are first that substance misuse in secure forensic psychiatric hospitals is unusual but worthy of clinical and research consideration because of its association with other rule violations and longer hospitalisation. People who abuse substances while in forensic psychiatric hospitals are characterised by younger age during admission, at first diagnosis of psychosis, first hospitalisation for it, first use of substances and first offending. More knowledge is needed about effective interventions and rehabilitation for this group. The development and evaluation of interventions for offenders with schizophrenia spectrum disorder who also suffer from a substance use disorder is an important area with room for improvement in terms of effective interventions.

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CONFLICT OF INTEREST

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

ETHICS STATEMENT

The study was reviewed and approved by the Cantonal Ethics committee of Zurich, Switzerland (Ref. No. KEK-ZH-NR 2014-0480).

DATA AVAILABILITY STATEMENT

Research data are not shared.

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