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Incidence and sociodemographic factors of mechanical restraints in the emergency department: a retrospective single-centre Swiss cohort

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Summary

STUDY AIMS: To determine the incidence of mechanical restraint in the emergency department (ED) of the University Hospital of Bern, Switzerland; To assess differences in restraint frequency and practice across patient groups (sex, age, alcohol involvement); To characterise triggers of aggression or agitation and restraint-related interventions including medication use; To examine temporal patterns, particularly the impact of the COVID-19 lockdown and pandemic.

METHODS: We included patients presenting at our institution between 1 January 2018 and 30 September 2022 who were subjected to mechanical restraint. Patients were identified through a keyword search followed by a comprehensive full-text review of the hospital database. Demographic and consultation characteristics, data about restraining circumstances and characteristics, as well as referral or discharge procedure were collected. Group comparisons were performed using the Wilcoxon rank-sum test or Kruskal–Wallis test, as appropriate. Categorical variables were compared using the chi-squared test. Incidence rate ratios across the three COVID-19 mitigation phases (pre, during, post) were estimated using Poisson regression.

RESULTS: We identified 285 patients who were subjected to mechanical restraint, corresponding to an incidence of 1.22 (95% CI: 1.08–1.37) per 1000 ED consultations during the study period. Men were overrepresented with 67.4% and the median age was 30 years (IQR: 23–41). Alcohol intoxication was the primary trigger of aggression in 35.4% of cases, with mixed intoxication present in 24.2%. The largest subgroup consisted of young men (≤40 years) under the influence of alcohol (31.6%). Compared to men, women were generally younger (28 vs 32 years, p <0.001) and had a higher prevalence of psychiatric comorbidities (43.0% vs 20.3%, p <0.001). Older patients were more likely to be intoxicated with alcohol (52.8% vs 29.6%, p <0.001), whereas younger patients had a higher rate of mixed intoxication (28.2% vs 12.5%, p = 0.007) and psychiatric disorders (31.9% vs 15.3%, p = 0.006). Mechanical restraint involving alcohol was more common in men (74.7%, p = 0.001), associated with risk of harm to others (69.8%, p <0.001) and addiction problems (76.4%, p <0.001). Pharmacological coercive measures were primarily administered using benzodiazepines (78.2%, typically intravenous and/or nasal application) and haloperidol (47.4% intravenous and/or intramuscular). The median duration of mechanical restraint was 258 minutes (IQR: 160–400). Alcohol-involved presentations were significantly associated with young men, non-Swiss nationality, acute risk of harm to others, night shift, addiction and longer restraint times (all p ≤0.001). The number of mechanical restraints increased until mid-2020, stabilising during the COVID-19 mitigation period, with a higher incidence of mechanical restraints during the pandemic (1.43 vs 1.02 per 1000 consultations pre-pandemic, p = 0.008).

CONCLUSION: The incidence of mechanical restraint was low (1.22 per 1000 visits). Predominantly, young, intoxicated men, presenting with risk of harm to others, were subject to mechanical restraint. Psychiatric comorbidities were more common in women, who were therefore more likely to pose a risk of self-harm. During the COVID-19 mitigation period, the incidence of mechanical restraint increased; however, the causal factors underlying this trend remain unclear.

Introduction

Coercive measures present an ongoing ethical dilemma for physicians. On the one hand, they conflict with the right to human dignity (Art. 7 of the Federal Constitution of the Swiss Confederation) and the right to personal liberty and physical freedom of movement (Art. 10 of the Federal Constitution of the Swiss Confederation) [1]. On the other hand, ensuring the safety of patients, staff and others in healthcare settings sometimes requires interventions that limit aggressive behaviour, including coercive measures. Each case requires careful individual assessment and prioritisation. The use of coercion can be traumatising for both patients and medical personnel [2]. Therefore, restraints should always be considered a measure of last resort to ensure safety [3, 4]. Due to this inherent ethical conflict, the application of coercive measures in the medical contexts is strictly regulated in Switzerland through various control mechanisms [2, 5, 6].

Although emergency department (ED) staff frequently encounter agitated patients requiring coercive measures, the literature on restraint use in EDs is scarce and often focused exclusively on patients with mental illness [7–10]. Moreover, data are inconsistently reported since "coercive measures" encompass a wide range of interventions, from observation and chemical seclusion to physical or mechanical restraint. Reported incidences vary considerably, ranging from 0.36% to 8.5% of all ED visits [11–15], whereas the 30-day prevalence of restraint use among hospitalised patients ranges from 8.7% to 11.8% [16, 17].

However, comparisons between studies remain difficult, due to differences in legislation, definitions and inclusion criteria.

The aims of the present study were: (1) to determine the incidence of mechanical restraint in a large Swiss university hospital ED, (2) to evaluate whether mechanical restraint is carried out more frequently and differently in specific patient groups (e.g. men vs women, younger vs older adults, and alcohol- vs no alcohol involvement), (3) to describe the triggers that led to aggression/agitation and the characteristics of mechanical restraint usage, particularly the medications used before and during restraint and, (4) to analyse temporal patterns, particularly the impact of the COVID-19 lockdown and pandemic on the number of mechanical restraints.

Materials and methods

This study is reported according to the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines for cohort studies to ensure comprehensive reporting [18].

The study was classified as a quality evaluation study by the Ethics Committee of the Canton of Bern, Switzerland. The need for informed consent was waived by the ethics committee (KEK-2019-00416).

Study design

This is a retrospective single-centre cohort study of emergency consultations in which patients were subjected to mechanical restraint due to aggressive or agitated behaviour.

Setting

The study was conducted between 1 January 2018 and 30 September 2022, in the adult ED of the University Hospital of Bern *(Inselspital)*, a certified level 1 university-affiliated adult trauma centre. It has a catchment population of 1.8 million inhabitants, corresponding to around 20% of the Swiss population, with more than 50,000 emergency consultations each year.

According to the Swiss government, the COVID-19 mitigation period lasted from March 2020 to February 2022 [19].

Patient identification and eligibility criteria

The medical records of all ED consultations during the study period are stored in digital full text in the clinical database system, E-Care ED v2.1.3.0 (Mesalvo Turnhout BV, Turnhout, Belgium). This medical database enables access to previous diagnostic reports, consultations and other pertinent medical documents. Cases were identified through a comprehensive full-text search algorithm using specific search terms "fixation" (which is the commonly used term in German for restraint), "fix*" and "aggression". The medical records obtained were extracted and assessed for eligibility, through manual full-text analysis by NH. All patients aged 16 years or older who presented to our ED during the specified period were included if they were initially assessed by an emergency physician (with psychiatric consultation upon request) and underwent mechanical restraint using a 5-point fixation bed for any reason (e.g. aggressive/agitated behaviour) during their ED stay. Patients were excluded if they did not undergo mechanical restraint or were directly assigned to the psychiatric emergency service. Direct referral to the psychiatric emergency service at our institution is determined by a triage nurse and is reserved for patients who do not require urgent pharmacological intervention (e.g. for seclusion), physical examination, laboratory testing, imaging studies and/or mechanical restraint.

Patients subjected to restraint more than once during the study period were listed as separate consultations. At the time of the study, a standard protocol for mechanical restraint was not yet operating at our ED.

Data collection and extraction

Medical reports of the ED, existing preclinical reports and other ED documentation (e.g. nursing notes) were analysed. Data were systematically extracted using a predefined extraction sheet, developed prior and included standardised fields for the following variables:

- Demographic and consultation characteristics (sex, age decade, nationality, month and day of consultation, time of arrival, length of consultation).
- Restraining circumstances and characteristics: preclinical restraint measures involving hand and/or foot restraints, assignment modality (police and/or ambulance, self-briefing), known concurrent psychiatric disorders documented in the electronic medical records (borderline personality disorder, post-traumatic stress disorder [PTSD], personality disorder [summarised as one group], schizophrenia spectrum disorder or substance use disorder), presence and type of intoxication (only alcohol; illicit drug use without alcohol; mixed intoxication [illicit drug use and alcohol]), acute risk of self-harm/harm to others, duration of restraint measures, and type and administration of intra-/peri-restraint medication.
- Referral or discharge procedure, i.e. inpatient psychiatry, inpatient medicine, inpatient intensive care, inpatient prison ward or outpatient treatment.

Intoxication was defined as positive blood alcohol testing (breath alcohol ≥0.05‰, blood alcohol ≥0.62 G/L), positive toxicological urine sampling and/or history positive for current intoxication, and/or clinical judgement/diagnosis by the treating physician. For urine analysis, Quidel Triage® TOX Drug Screen, 94600 (QuidelOrtho Corporation, San Diego, CA, USA) was used.

Quantitative variables

The time of patient arrival was categorised based on the type of shift: day shift (07:30–14:00), late shift (14:00–22:30) or night shift (22:30–07:30).

The pre- and post-COVID-19 phases were defined by the beginning of the first lockdown from 1 March 2020 [20] until almost all measures were lifted in February 2022 [21]. Age was treated as a continuous variable for comparisons between two groups. For analysis of sex-specific alcohol consumption, age was additionally dichotomised into young adults (≤40 years) and older adults (>40 years), reflecting changes in physiological, sociocultural and risk behaviour around this age [22]. Furthermore, the duration of mechanical restraint and total ED time were treated as continuous variables.

Bias

A comprehensive keyword search was conducted to ensure the identification of all eligible patients and minimise the risk of selection bias. Beside the medical reports, preclinical reports and other digital information (e.g. nurse documentation) were screened to reduce information and reporting bias as far as possible.

Study size

No formal study size calculation was performed as all eligible patients up to six months after the COVID-19 restrictions were included.

Statistical analysis

Data analysis was performed using Stata® 18.1 (StataCorp, The College Station, TX, USA). All categorical variables are reported in percentages and absolute numbers. The distributions of continuous variables are described by the median and the interquartile range (IQR). The 95% confidence interval (CI) of the incidence was calculated for different time groups using Stata's *cii proportion* command.

Comparisons of continuous variables between two groups (i.e. young vs older adults, women vs men) or among three/four groups (i.e. different COVID-19 mitigation phases and cause of mechanical restraint) were performed using the Wilcoxon rank-sum test or Kruskal–Wallis test, respectively. Categorical variables were compared by the chi-squared test. The significance level was set at an alpha of 0.01 to adjust for multiple testing.

A fractional-polynomial prediction plot with 95% CI was used to model the course of the absolute number of mechanical restraints per month/quarter over the study period and to describe the impact of COVID-19 mitigations on the course.

We estimated incidence rate ratios of mechanical restraints across the three COVID-19 mitigation phases (pre, during, post) using Poisson regression, with the total number of ED consultations as the exposure.

Open science

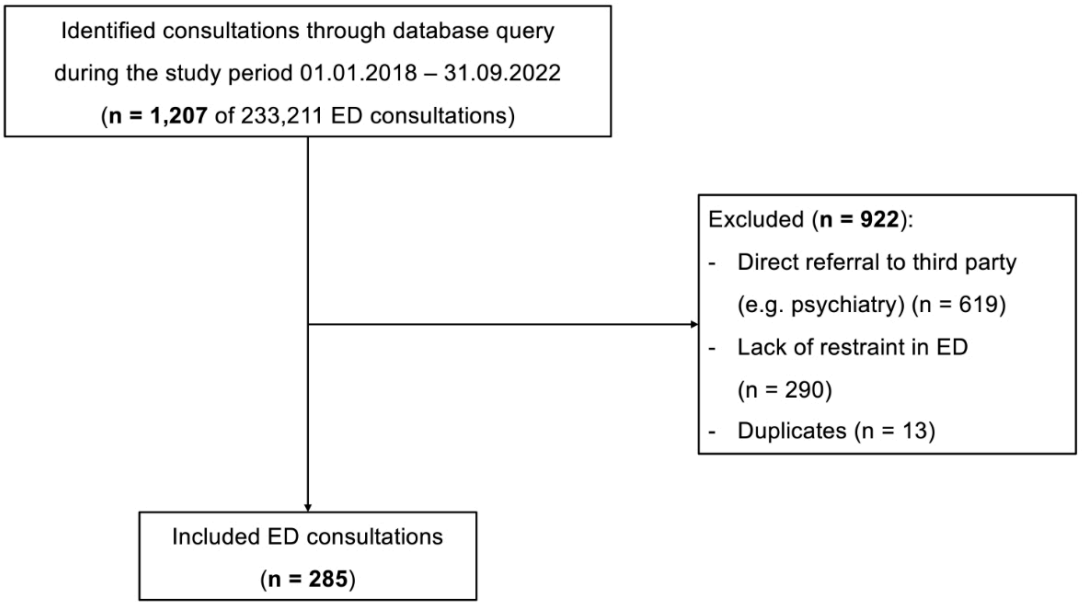
A study protocol was not prepared in advance. The analytical code can be made available upon reasonable request from the corresponding author.

Results

Incidence of mechanical restraints

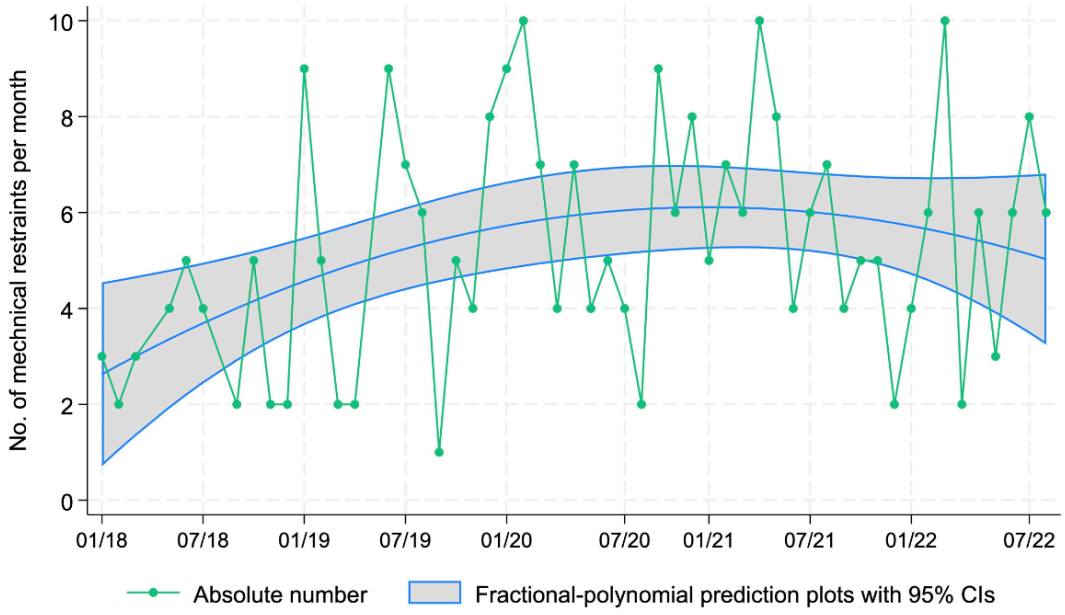
During the study period, we included 26.6% (n = 285) of all identified consultations through keyword search in the study (figure 1). With 233,211 consultations at our ED during the specified study period, this resulted in an incidence of 1.22 (95% CI: 1.08–1.37) mechanical restraints per 1000 ED consultations.

Figure 1: Study flowchart.



The monthly absolute numbers of mechanical restraints increased until the mid-2020, followed by a period of stabilisation then a slight decline over two years (figure 2).

Figure 2: Absolute number of restraints per month and year and a fractional-polynomial prediction plot with 95% CI over the course of the study, n = 285.



Characteristics of mechanical restraints

Most patients were men, young adults and of Swiss nationality, with a median age of 30 years (IQR: 23–41). The majority presented during late or night shifts, were brought in by ambulance or the police service, and had experienced preclinical mechanical restraint. In 62.8% of the consultations, restraint was required following intoxication, most commonly due to alcohol. More than half of the patients were mechanically restrained for ≥4 hours, corresponding to 79% of the total duration of ED stay. Only a minority of patients were discharged as outpatients.

The most frequently used intra- and peri-restraint medications were benzodiazepines administered intravenously. Haloperidol, given either intravenously or intramuscularly, was also commonly used. Neither alcohol intoxication nor mixed intoxication influenced the choice of seclusion drug (see appendix).

Men vs women

Compared to men, women were generally younger, more likely to be Swiss nationals, more frequently presented during the late shift and arrived more often by ambulance, whereas men were more likely to present during the night shift. Women also had a higher incidence of psychiatric comorbidities and were more likely to undergo compulsory admission for acute risk of self-harm without concurrent risk of harm to others. Furthermore, women had fewer documented preclinical restraints.

Regarding discharge outcomes, women were more often admitted to psychiatric inpatient care, whereas men were more frequently discharged to inpatient prison.

Young vs older adults

The older age group (>40 years) demonstrated a higher incidence of alcohol-involved intoxications and addiction. In contrast, the younger age group (≤40 years) showed a higher prevalence of psychiatric disorders, particularly borderline, PTSD and other personality disorders, and were more frequently discharged to prison. No significant differences were found regarding intra-/peri-restraint drugs or other characteristics.

Alcohol-involvement vs no alcohol-involvement

Besides identifying as men and non-Swiss nationality, alcohol-involvement presentations were significantly associated with acute risk of harm to others, night shift, addiction problems and longer mechanical restraint times as well as ED treatment duration and outpatient treatment.

Table 1: Sociodemographic, mechanical restraint and consultation characteristics, with subgroup analysis for sex, age and alcohol involvement in 285 ED patients undergoing mechanical restraint.

Variable	Total	Sex		p-value	Age		p-value	Alcohol involvement		p-value
		Women	Men		≤40y	>40y		No	Yes	
Sociodemographic										
Sex										
Women	93 (32.6%)	93 (100.0%)	0		76 (35.7%)	17 (23.6%)		50 (43.5%)	43 (25.3%)	
Men	192 (67.4%)	0	192 (100%)	<0.001	137 (64.3%)	55 (76.4%)	0.059	65 (56.5%)	127 (74.7%)	0.001
Age in years	30 (23–41)	28 (23–36)	32 (25–43)	0.035	27 (22–32)	50 (45–58)	<0.001	29 (23–39)	31 (24–42)	0.287
Nationality										
Non-Swiss	117 (41.1%)	19 (20.4%)	98 (51.0%)		87 (40.8%)	30 (41.7%)		34 (29.6%)	83 (48.8%)	
Swiss	168 (58.9%)	74 (79.6%)	94 (49.0%)	<0.001	126 (59.2%)	42 (58.3%)	0.902	81 (70.4%)	87 (51.2%)	0.001
Consultation										
Shift										
Day shift	43 (15.1%)	13 (14.0%)	30 (15.6%)	0.716	29 (13.6%)	14 (19.4%)	0.232	25 (21.7%)	18 (10.6%)	0.010
Late shift	131 (46.0%)	54 (58.1%)	77 (40.1%)	0.004	98 (46.0%)	33 (45.8%)	0.979	60 (52.2%)	71 (41.8%)	0.084
Night shift	111 (38.9%)	26 (28.0%)	85 (44.3%)	0.008	86 (40.4%)	25 (34.7%)	0.395	30 (26.1%)	81 (47.6%)	<0.001
Overall				0.012			0.437			<0.001
Discharge										
Outpatient	102 (35.8%)	20 (21.5%)	82 (42.7%)	<0.001	75 (35.2%)	27 (37.5%)	0.726	11 (9.6%)	91 (53.5%)	<0.001
Inpatient psychiatric	117 (41.1%)	59 (63.4%)	58 (30.2%)	<0.001	82 (38.5%)	35 (48.6%)	0.132	66 (57.4%)	51 (30.0%)	<0.001
Inpatient medicine	3 (1.1%)	2 (2.2%)	1 (0.5%)	0.206	0	3 (4.2%)	0.003	2 (1.7%)	1 (0.6%)	0.350
Inpatient prison	32 (11.2%)	0	32 (16.7%)	<0.001	31 (14.6%)	1 (1.4%)	0.002	17 (14.8%)	15 (8.8%)	0.118
Inpatient intensive care	31 (10.9%)	12 (12.9%)	19 (9.9%)	0.445	25 (11.7%)	6 (8.3%)	0.423	19 (16.5%)	12 (7.1%)	0.012
Overall				<0.001			0.001			<0.001
Duration of treatment in min	425 (278–577)	370 (258–498)	456 (282–623)	0.019	417 (267–560)	443 (308–676)	0.064	320 (223–526)	472 (348–603)	<0.001
Mechanical restraint										
Assignments										
Police	68 (23.9%)	16 (17.2%)	52 (27.1%)	0.067	54 (25.4%)	14 (19.4%)	0.309	30 (26.1%)	38 (22.4%)	0.468
Ambulance	68 (23.9%)	32 (34.4%)	36 (18.8%)	0.004	52 (24.4%)	16 (22.2%)	0.706	36 (31.3%)	32 (18.8%)	0.015
Both	146 (51.2%)	43 (46.2%)	103 (53.6%)	0.241	104 (48.8%)	42 (58.3%)	0.163	47 (40.9%)	99 (58.2%)	0.004
Self-briefing	3 (1.1%)	2 (2.2%)	1 (0.5%)	0.206	3 (1.4%)	0	0.311	2 (1.7%)	1 (0.6%)	0.350
Overall				0.010			0.414			0.021
Acute risk of harm to self or others										
Self	24 (8.4%)	15 (16.1%)	9 (4.7%)	0.001	21 (9.9%)	3 (4.2%)	0.133	21 (18.3%)	3 (1.8%)	<0.001
Others	179 (62.8%)	49 (52.7%)	130 (67.7%)	0.014	133 (62.4%)	46 (63.9%)	0.826	54 (47.0%)	125 (73.5%)	<0.001
Both	82 (28.8%)	29 (31.2%)	53 (27.6%)	0.532	59 (27.7%)	23 (31.9%)	0.492	40 (34.8%)	42 (24.7%)	0.065
Overall				0.002			0.297			<0.001
Preclinical mechanical restraint										
No	55 (19.3%)	28 (30.1%)	27 (14.1%)	0.001	41 (19.2%)	14 (19.4%)	0.971	30 (26.1%)	25 (14.7%)	0.017
Yes	156 (54.7%)	41 (44.1%)	115 (59.9%)	0.012	117 (54.9%)	39 (54.2%)	0.910	57 (49.6%)	99 (58.2%)	0.149
Unknown	74 (26.0%)	24 (25.8%)	50 (26.0%)	0.966	55 (25.8%)	19 (26.4%)	0.924	28 (24.3%)	46 (27.1%)	0.609
Overall				0.004			0.993			0.057
Diagnosis										
Alcohol	101 (35.4%)	28 (30.1%)	73 (38.0%)	0.190	63 (29.6%)	38 (52.8%)	<0.001	0	101 (59.4%)	<0.001
Drugs	9 (3.2%)	2 (2.2%)	7 (3.6%)	0.499	8 (3.8%)	1 (1.4%)	0.321	9 (7.8%)	0	<0.001
Mixed	69 (24.2%)	15 (16.1%)	54 (28.1%)	0.027	60 (28.2%)	9 (12.5%)	0.007	0	69 (40.6%)	<0.001
Psychiatric comorbidity	79 (27.7%)	40 (43.0%)	39 (20.3%)	<0.001	68 (31.9%)	11 (15.3%)	0.006	79 (68.7%)	0	<0.001
Other	27 (9.5%)	8 (8.6%)	19 (9.9%)	0.727	14 (6.6%)	13 (18.1%)	0.004	27 (23.5%)	0	<0.001
Overall				0.002			<0.001			<0.001
Psychiatric comorbidity										
None	113 (39.6%)	15 (16.1%)	98 (51.0%)	<0.001	84 (39.4%)	29 (40.3%)	0.900	26 (22.6%)	87 (51.2%)	<0.001
Borderline, PTSD, personality disorder	60 (21.1%)	44 (47.3%)	16 (8.3%)	<0.001	58 (27.2%)	2 (2.8%)	<0.001	47 (40.9%)	13 (7.6%)	<0.001

Schizophrenia	17 (6.0%)	6 (6.5%)	11 (5.7%)	0.809	12 (5.6%)	5 (6.9%)	0.685	15 (13.0%)	2 (1.2%)	<0.001
Autism	6 (2.1%)	1 (1.1%)	5 (2.6%)	0.399	4 (1.9%)	2 (2.8%)	0.646	6 (5.2%)	0	0.003
Addiction	89 (31.2%)	27 (29.0%)	62 (32.3%)	0.578	55 (25.8%)	34 (47.2%)	0.001	21 (18.3%)	68 (40.0%)	<0.001
Overall				<0.001			<0.001			<0.001
Duration of restraint in min	258 (160–400)	240 (149–341)	284 (168–423)	0.045	255 (148–400)	262 (180–394)	0.583	223 (121–329)	291 (189–419)	0.001
% mechanical restraint during ED stay	79 (43–100)	79 (39–100)	79 (45–100)	0.971	82 (44–100)	64 (39–100)	0.097	100 (41–100)	72 (43–100)	0.015

ED: emergency department; PTSD: post-traumatic stress disorder. Notes: Continuous variables are described with median (interquartile range), while categorical variables are shown with number (%) in each category.

Table 2: Intra- and peri-restraint medication usage and routes of administration in 285 ED patients undergoing mechanical restraint.

Intra- and peri-restraint drugs		**Total**
Benzodiazepine		223 (78.2%)
Admission benzodiazepine	None	62 (21.8%)
	i.v.	94 (33.0%)
	i.m.	9 (3.2%)
	Nasal	32 (11.2%)
	p.o.	12 (4.2%)
	i.v. and nasal	50 (17.5%)
	i.v. and sublingual	11 (3.9%)
	i.m. and nasal	2 (0.7%)
	i.m. and sublingual	1 (0.4%)
	i.v. and i.m.	4 (1.4%)
	Nasal and sublingual	4 (1.4%)
	i.v., i.m. and sublingual	1 (0.4%)
	i.v., i.m. and nasal	2 (0.7%)
	i.v., p.o. and nasal	1 (0.4%)
Haloperidol		135 (47.4%)
Admission haloperidol	None	150 (52.6%)
	i.v.	59 (20.7%)
	i.m.	52 (18.2%)
	p.o.	11 (3.9%)
	i.v. and sublingual	1 (0.4%)
	i.m. and sublingual	4 (1.4%)
	i.v. and i.m.	8 (2.8%)
Other medication	None	242 (84.9%)
	Morphine	2 (0.7%)
	Quetiapine	4 (1.4%)
	Ketamine	3 (1.1%)
	Methadone	1 (0.4%)
	Others	33 (11.6%)

ED: emergency department; i.m.: intramuscular; i.v.: intravenous; p.o.: per os (oral). Notes: Categorical variables are shown with count (%) in each category.

Mechanical restraint in special subgroups

Alcohol involvement was documented in 59.6% of restraint cases. Young men under the influence of alcohol (31.6%) constituted the largest subgroup, followed by young men without alcohol involvement (16.5%). Among cases involving alcohol, the men-to-women ratio was approximately 3:1 in young adults and 3.7:1 in older adults. In contrast, among cases without alcohol involvement, the corresponding ratios were lower (young adults 1:1, older adults 2.5:1).

Table 3: Breakdown of subgroup sizes by alcohol involvement, age group and sex.

Variables		Sex	
		Women	Men
Alcohol involvement	≤40 years	33 (19.4%)	90 (52.9%)
	>40 years	10 (5.9%)	37 (21.8%)
No alcohol involvement	≤40 years	43 (37.4%)	47 (40.9%)
	>40 years	7 (6.1%)	18 (15.7%)

Categorical variables are shown with count (%) in each category.

Temporal patterns and the impact of COVID-19

The number of mechanical restraints followed a circadian pattern: 15.1% of the restraints took place during the day shift (07:30–14:00), 46% during the late shift (14:00–22:30) and 38.9% during the night shift (22:30–07:30 (figure 3).

Figure 3: Mechanical restraint distribution over shifts, n = 285.

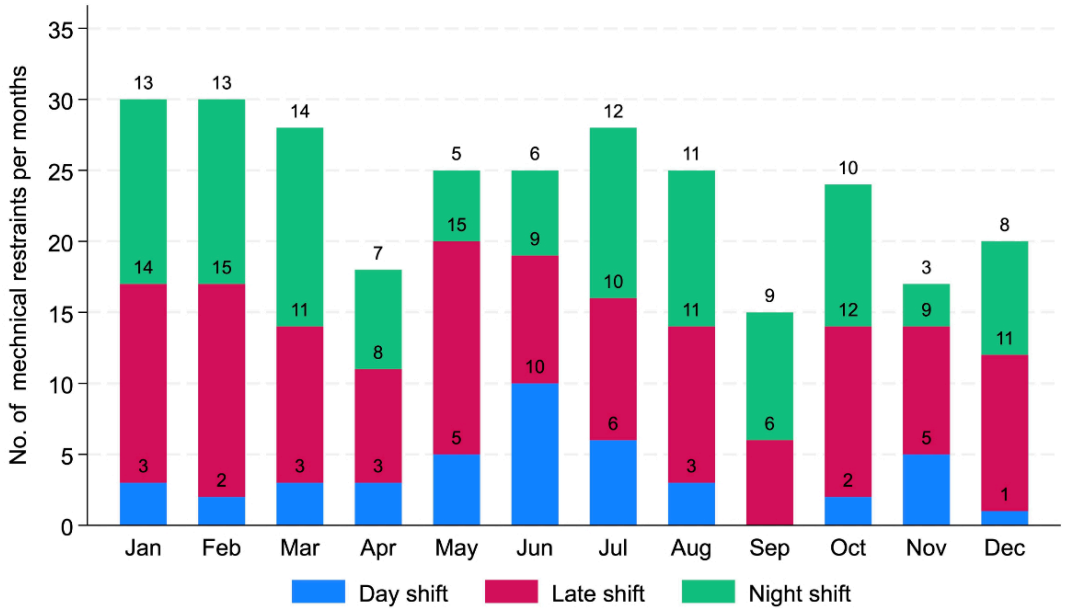


Table 4: Absolute numbers of patients and mechanical restraints, proportional incidence and incidence rate ratios in the three groups pre-, peri- and post-COVID-19 mitigations.

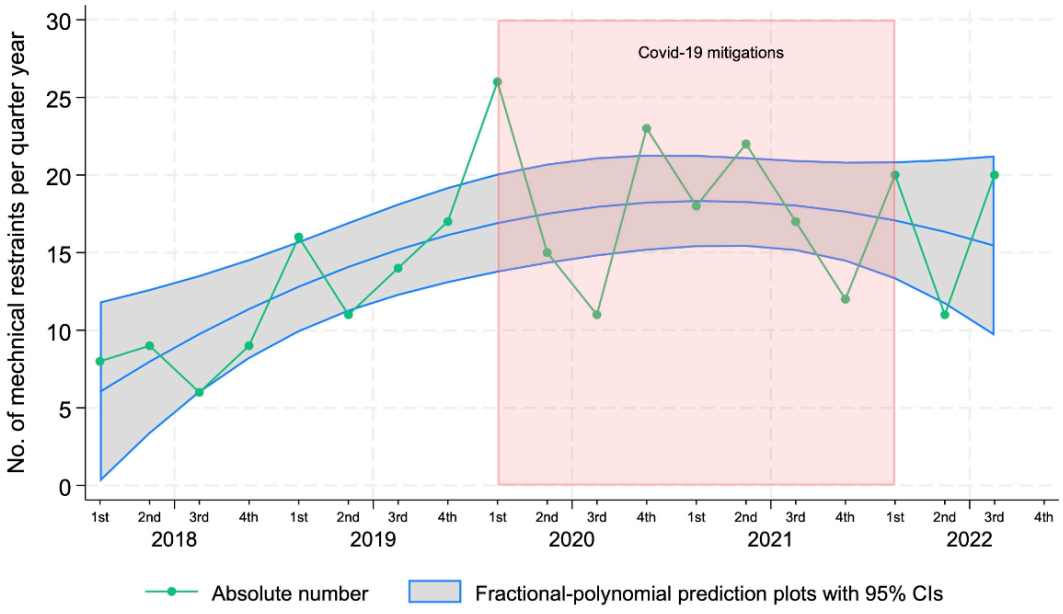
	N of ED patients	N of mechanical restraints	Proportional incidence (95% CI) per 1000 ED consultations*	IRR with 95% CI and p-value**	
Pre	107,091	109	1.02 (0.84–1.23)	0.71 (0.55–0.91)	0.008
Peri	94,196	135	1.43 (1.20–1.70)	1.00 (Baseline)	–
Post	31,934	41	1.28 (0.92–1.74)	0.90 (0.63–1.27)	0.537
Total	233,221	285	1.22 (1.08–1.37)		

* Obtained by Stata's *cii proportion* command. ** Incidence Rate Ratios (IRR) with 95% CI and p-values were obtained by Poisson regression.

The incidence was higher during COVID-19 mitigations with 1.43 (95% CI: 1.20–1.70) mechanical restraints per 1000 ED consultations vs pre-COVID-19: 1.02 (95% CI: 0.84–1.23) per 1000 ED consultations; the incidence rate ratios differed significantly (p = 0.008). No significant differences (p = 0.205) were observed comparing the incidence rate ratio during and after COVID-19 mitigations with an incidence post-COVID-19 of 1.28 (95% CI: 0.92–1.74) per 1000 ED consultations.

The temporal trend of mechanical restraints in the ED is presented in figure 4.

Figure 4: Mechanical restraints per quarter and the impact of COVID-19 mitigations, n = 285.



Overall, the number of restraints per quarter showed a steady increase from 2018 to 2020, followed by more marked fluctuations during the COVID-19 mitigation period in 2020 and 2021. The absolute number of restraints rose progressively, peaking in the 2nd and 3rd quarters of 2020, during the early phases of the pandemic response.

The fractional-polynomial prediction plot with 95% CI showed a similar trend, with an increase in mechanical restraints up until 2020, followed by a stabilisation or slight decrease in the subsequent years.

The characteristics of the three subgroups (before, during and after the COVID-19 mitigations) are shown in supplement 4. There was a significant association with compulsory admission due to acute risk of self-harm and risk of harm to others, with the latter being more prevalent during (71.2%), respectively post (65.9%) COVID-19 mitigations compared to the pre-mitigation period (51.4%). Additionally, there were fewer concomitant risks of harm during (23%) and post (19.5%) COVID-19 mitigation period, compared to the pre-mitigation phase (39.4%). Furthermore, significantly fewer cases of borderline personality disorders, PTSD and other personality disorders were found during the post-COVID-19 mitigation phase (4.9%) compared to the during (20.7%) and pre-mitigation (27.5%) phases.

No other relevant differences were found regarding sociodemographic or consultation characteristics other than the presenting shift between the different mitigation phases.

Discussion

Incidence and duration of mechanical restraints

During the study period (January 2018 – September 2022), a total of 285 patients were mechanically restrained. This corresponds to an incidence of 1.22 per 1000 consultations, which is substantially lower than previously reported in Lausanne, Switzerland [23]. We identified several possi-

ble factors that might explain the difference. First, in our institution, we almost exclusively use 5-point mechanical restraint. We generally refrain from partial mechanical restraint, opting instead for supervision by security personnel when necessary. In Lausanne, by contrast, partial mechanical restraint is used and was included in the analysis of Beysard et al. Second, the rate of violent offences is markedly higher in Lausanne, which could contribute to more presentations involving risk of harm to others [24]. Finally, violations of the Narcotics Act are more common in Lausanne than in our region, which may result in a greater number of presentations with aggressive behaviour, often associated with illicit drug use [25].

Due to variations in legal and practical definitions of mechanical restraints, as well as differences in healthcare organisation, comparing incidences across different countries is difficult. Nevertheless, our reported incidence is very low compared with published data of EDs in other countries. Krueger et al. reported that 12 per 100 patients were subject to at least one physical restraint. However, if restrictive bedrails were excluded, only 2 per 100 patients underwent restrictive measures [17]. In the state of Victoria in Australia, a multicentre retrospective analysis found that at least one restrictive intervention (physical restraint, mechanical restraint and/or chemical restraint) was applied in 0.36% of cases [13]. In contrast, a single-centre retrospective analysis in Brisbane reported a significantly higher rate of 2.5%, despite the presence of a round-the-clock, nurse-led team responding to occupational violence emergencies [14]. In Boston, Hayek and colleagues reported a rate of 1.4% 4-point mechanical restraints among all patients presenting to the ED [15].

These considerable differences may, at least partially, be explained by structural factors such as infrastructure specifically designed for aggressive patients, staff training in communication skills and the presence of dedicated security personnel in the ED.

The duration of mechanical restraint is reported inconsistently, making direct comparisons challenging, also due to differences in how healthcare systems are organised. However, our data show significantly longer restraint durations (258 minutes) compared to Australian data (180 minutes) [13]. Furthermore, the duration of ED stays in our population (425 min) was nearly twice as long as previously reported (232 min) [14], despite similar lengths of stay in EDs reported for Switzerland [26] and Australia [27].

Notably, patients intoxicated with alcohol were subject to the longest durations of mechanical restraint, but were also significantly more often managed as outpatients, likely due to the decrease in aggression levels as blood alcohol concentration declines.

Sex, demographic and sociocultural influences

We found significant demographic and clinical differences among patients who underwent mechanical restraint. Most restrained patients were young men (67.4%) and intoxication was common (62.8%), consistent with previous studies [13–15]. In contrast, Hayek et al. reported predominantly elderly patients, while Knott et al. found few intoxicated patients, but most cases related to mental illness [13, 15]. In our cohort, the majority of restrained patients were Swiss nationals (58.9%).

Throughout the study period, most intoxicated patients were men, aligning with evidence that men consume more alcohol and experience more related harms [28–32]. This higher consumption is associated with increased aggression [33], similar to patterns observed with illicit drug use [25]. Even without intoxication, men generally display higher aggression levels, contributing to greater involvement in violent crime and overrepresentation in correctional settings [34–37]. This disparity likely reflects social and behavioural factors, including deficits in social interaction and socialisation [38]. Hormonal factors such as elevated testosterone levels have not shown associations with aggression [39]. Additionally, the perception of men as more threatening may partly explain their higher exposure to mechanical restraints [40, 41].

Furthermore, significantly more women presented with diagnosed psychiatric conditions, consistent with epidemiological data [42]. This difference may reflect a gender gap in mental health service utilisation and the underdiagnosis of psychiatric disorders in men [43, 44].

In Switzerland, 26.6% of the population lacks Swiss citizenship [45]. This group was overrepresented in our cohort, particularly among young men. Contributing factors include experiences of discrimination and racism, which increase vulnerability to substance use and aggressive behaviour [46], the heightened risk of behavioural issues among young refugees [47] and the impact of insecure residency status on aggression [48]. Furthermore, racial bias among healthcare staff may influence clinical decision-making, potentially leading to disproportionate use of mechanical restraint in minority groups [49].

Seclusion drugs

The vast majority of patients were secluded with benzodiazepines, followed by haloperidol. No significant differences were observed in the choice of drugs used for coercive parenteral administration concerning the present intoxication. According to the recommendations by Hirsch et al., drugs with potential respiratory depressant effects should not be used in patients intoxicated with alcohol [50]. This discrepancy with internationally published guidelines may be partially attributed to the absence of standardised protocols for coercive measures, including specific guidelines for seclusion medication, at our institution during the study period. Another contributing factor could be the lack of standardised and/or continuous staff training.

Standardised protocols

Implementing standardised protocols in institutions regularly managing aggressive patient behaviour should be prioritised, not only to enhance adherence to international guidelines but also to reduce stress and traumatic experiences for both caregivers and patients [51]. These protocols should also include regular, critical reviews of the necessity of restraining measures and standardised documentation, such as the SOAS-R [52]. Future efforts should therefore focus on developing and evaluating institution-specific restraint protocols and structured staff training programmes to ensure both patient safety and ethical practice.

Influence of COVID-19 mitigations

We observed a significant increase in the incidence rate ratios of mechanical restraints, as well as point estimates from the fractional polynomial regression that significantly differed from zero, during the period of COVID-19 mitigation measures compared to the pre-COVID-19 period. This finding is consistent with other published data that also showed a rise of restrictive measures and seclusions during COVID-19 [53]. The significant increase in the subgroup of patients presenting with a risk of harm to others as the reason for mechanical restraint might be associated with increased alcohol consumption and generally increased aggression [54] during the COVID-19 mitigation phase [55–57]. Unexpectedly, there was no significant decrease in mechanical restraints after COVID-19 mitigations ended. However, we only analysed data for six months after the COVID-19 pandemic, which limits the scope of interpretation. Furthermore, a longer observation period is likely required for the normalisation of the mentioned effects and consequently the return to the baseline incidence of mechanical restraints as observed prior to the COVID-19 mitigation efforts.

Limitations

The retrospective nature of this study, the small sample size and the heterogeneous subgroups are the main limitations of this study. Data extraction was performed by a single author (NH), introducing a potential risk for observer bias, as interrater reliability could not be assessed. Furthermore, standardised protocols were not available during the study period at our institution; they were implemented only later. Since coercive measures including mechanical restraint were subject to the individual discretion of the supervising physician (e.g. different perception of threat level), case comparability might not always have been given. Lastly, as mentioned above, the observation period after the implemented COVID-19 mitigations was short and numbers of mechanical restraints per quarter were small and confidence intervals wide, which leads to limited comparability of the periods before and during COVID-19 mitigations and may introduce bias.

Conclusion

In our study cohort, mostly young, intoxicated men were subject to mechanical restraint. However, it is crucial to recognise the complexity of socially based stressors that contribute to aggressive behaviour. Women who underwent mechanical restraint predominantly presented with psychiatric comorbidities and were more likely to be at risk of self-harm rather than harm to others. During the period of COVID-19 mitigation measures, the incidence of mechanical restraint increased; however, the causality of this phenomenon is not yet fully understood.

Implementing standardised protocols in institutions managing aggressive patient behaviour is key to improving guideline adherence and reducing stress for both patients and staff.

Data sharing statement

Individual participant data that underlie the results reported in this article, after deidentification, will be available from the corresponding author, Basil Ryser, upon reasonable request, within five years of article publication.

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Variables	N	Total	Diagnosis					
		Total (n=285)	Alcohol (n=101)	Drugs (n=9)	Mixed (n=69)	omorbidity (n=79)	Other (n=27)	P-value
SOCIODEMOGRAPHICS								
Gender	285							
Women		93 [32.6]	28 [27.7]	2 [22.2]	15 [21.7]	40 [50.6]	8 [29.6]	
Men		192 [67.4]	73 [72.3]	7 [77.8]	54 [78.3]	39 [49.4]	19 [70.4]	0.002
Age [years]	285	30 [23; 41]	35 [25; 47]	28 [21; 38]	28 [23; 35]	28 [22; 36]	40 [29; 66]	<0.001
Age groups	285							
16-20		45 [15.8]	13 [12.9]	3 [33.3]	11 [15.9]	16 [20.3]	2 [7.4]	
21-25		55 [19.3]	13 [12.9]	1 [11.1]	17 [24.6]	23 [29.1]	1 [3.7]	
26-30		48 [16.8]	17 [16.8]	1 [11.1]	13 [18.8]	11 [13.9]	6 [22.2]	
31-35		34 [11.9]	9 [8.9]	0 [0.0]	13 [18.8]	10 [12.7]	2 [7.4]	
36-40		31 [10.9]	11 [10.9]	3 [33.3]	6 [8.7]	8 [10.1]	3 [11.1]	
41-45		20 [7.0]	9 [8.9]	1 [11.1]	4 [5.8]	4 [5.1]	2 [7.4]	
46-50		18 [6.3]	13 [12.9]	0 [0.0]	2 [2.9]	2 [2.5]	1 [3.7]	
51-59		18 [6.3]	10 [9.9]	0 [0.0]	3 [4.3]	3 [3.8]	2 [7.4]	
60-69		10 [3.5]	5 [5.0]	0 [0.0]	0 [0.0]	2 [2.5]	3 [11.1]	
70-79		6 [2.1]	1 [1.0]	0 [0.0]	0 [0.0]	0 [0.0]	5 [18.5]	<0.001
Young adults	285							
16-40 years		213 [74.7]	63 [62.4]	8 [88.9]	60 [87.0]	68 [86.1]	14 [51.9]	
>40 years		72 [25.3]	38 [37.6]	1 [11.1]	9 [13.0]	11 [13.9]	13 [48.1]	<0.001
Nationality	285							
Others		117 [41.1]	52 [51.5]	2 [22.2]	31 [44.9]	21 [26.6]	11 [40.7]	
Switzerland		168 [58.9]	49 [48.5]	7 [77.8]	38 [55.1]	58 [73.4]	16 [59.3]	0.011
CONSULTATION CHARACTERISTICS								
Year of consultation	285							
2018		32 [11.2]	14 [13.9]	2 [22.2]	7 [10.1]	5 [6.3]	4 [14.8]	
2019		58 [20.4]	18 [17.8]	0 [0.0]	16 [23.2]	20 [25.3]	4 [14.8]	
2020		75 [26.3]	23 [22.8]	1 [11.1]	18 [26.1]	26 [32.9]	7 [25.9]	
2021		69 [24.2]	25 [24.8]	1 [11.1]	19 [27.5]	15 [19.0]	9 [33.3]	
2022		51 [17.9]	21 [20.8]	5 [55.6]	9 [13.0]	13 [16.5]	3 [11.1]	0.140
Months	285							
Jan		30 [10.5]	11 [10.9]	3 [33.3]	7 [10.1]	9 [11.4]	0 [0.0]	
Feb		30 [10.5]	14 [13.9]	1 [11.1]	2 [2.9]	10 [12.7]	3 [11.1]	
Mar		28 [9.8]	8 [7.9]	3 [33.3]	8 [11.6]	7 [8.9]	2 [7.4]	
Apr		18 [6.3]	7 [6.9]	1 [11.1]	3 [4.3]	4 [5.1]	3 [11.1]	
May		25 [8.8]	8 [7.9]	0 [0.0]	6 [8.7]	5 [6.3]	6 [22.2]	
Jun		25 [8.8]	4 [4.0]	1 [11.1]	12 [17.4]	6 [7.6]	2 [7.4]	
Jul		28 [9.8]	7 [6.9]	0 [0.0]	6 [8.7]	10 [12.7]	5 [18.5]	
Aug		25 [8.8]	11 [10.9]	0 [0.0]	4 [5.8]	7 [8.9]	3 [11.1]	
Sep		15 [5.3]	7 [6.9]	0 [0.0]	4 [5.8]	2 [2.5]	2 [7.4]	
Oct		24 [8.4]	9 [8.9]	0 [0.0]	7 [10.1]	8 [10.1]	0 [0.0]	
Nov		17 [6.0]	7 [6.9]	0 [0.0]	6 [8.7]	3 [3.8]	1 [3.7]	
Dec		20 [7.0]	8 [7.9]	0 [0.0]	4 [5.8]	8 [10.1]	0 [0.0]	0.120
Shift	285							
Day shift		43 [15.1]	5 [5.0]	0 [0.0]	13 [18.8]	15 [19.0]	10 [37.0]	
Late shift		131 [46.0]	49 [48.5]	6 [66.7]	22 [31.9]	42 [53.2]	12 [44.4]	
Night shift		111 [38.9]	47 [46.5]	3 [33.3]	34 [49.3]	22 [27.8]	5 [18.5]	<0.001
COERCIVE MEASURES CHARACTERISTICS								
Assignments	285							
Police		68 [23.9]	18 [17.8]	2 [22.2]	20 [29.0]	20 [25.3]	8 [29.6]	
Ambulance		68 [23.9]	21 [20.8]	2 [22.2]	11 [15.9]	24 [30.4]	10 [37.0]	
Both		146 [51.2]	61 [60.4]	5 [55.6]	38 [55.1]	33 [41.8]	9 [33.3]	
Self-Briefing		3 [1.1]	1 [1.0]	0 [0.0]	0 [0.0]	2 [2.5]	0 [0.0]	0.188
Self and external warranty	285							
Self		24 [8.4]	2 [2.0]	1 [11.1]	1 [1.4]	18 [22.8]	2 [7.4]	
External		179 [62.8]	76 [75.2]	5 [55.6]	49 [71.0]	27 [34.2]	22 [81.5]	
Both		82 [28.8]	23 [22.8]	3 [33.3]	19 [27.5]	34 [43.0]	3 [11.1]	<0.001
Preclinical fixation	285							
No		55 [19.3]	16 [15.8]	1 [11.1]	9 [13.0]	25 [31.6]	4 [14.8]	
Yes		156 [54.7]	58 [57.4]	6 [66.7]	41 [59.4]	35 [44.3]	16 [59.3]	
Unknown		74 [26.0]	27 [26.7]	2 [22.2]	19 [27.5]	19 [24.1]	7 [25.9]	0.179
Diagnosis	285							
Alcohol		101 [35.4]	101 [100.0]	0 [0.0]	0 [0.0]	0 [0.0]	0 [0.0]	
Drugs		9 [3.2]	0 [0.0]	9 [100.0]	0 [0.0]	0 [0.0]	0 [0.0]	
Mixed		69 [24.2]	0 [0.0]	0 [0.0]	69 [100.0]	0 [0.0]	0 [0.0]	
Psychiatric comorbidity		79 [27.7]	0 [0.0]	0 [0.0]	0 [0.0]	79 [100.0]	0 [0.0]	
Other		27 [9.5]	0 [0.0]	0 [0.0]	0 [0.0]	0 [0.0]	27 [100.0]	<0.001
Psychiatric comorbidity	285							
None		113 [39.6]	50 [49.5]	2 [22.2]	37 [53.6]	11 [13.9]	13 [48.1]	
Borderline/PTSD/Person. disorder		60 [21.1]	8 [7.9]	3 [33.3]	5 [7.2]	42 [53.2]	2 [7.4]	
Schizophrenia		17 [6.0]	2 [2.0]	0 [0.0]	0 [0.0]	11 [13.9]	4 [14.8]	
Autism		6 [2.1]	0 [0.0]	0 [0.0]	0 [0.0]	4 [5.1]	2 [7.4]	
Addiction		89 [31.2]	41 [40.6]	4 [44.4]	27 [39.1]	11 [13.9]	6 [22.2]	<0.001
Duration of fixation [min]	285	258 [160; 400]	264 [180; 412]	223 [157; 329]	302 [211; 435]	202 [121; 287]	300 [71; 487]	0.001
Percent fixation of ED stay	285	79 [43; 100]	62 [40; 100]	82 [65; 100]	79 [49; 100]	100 [40; 100]	89 [28; 100]	0.131
INTRA-/PERI-FIXATION DRUGS								
Benzodiazepine	285	223 [78.2]	79 [78.2]	9 [100.0]	57 [82.6]	58 [73.4]	20 [74.1]	0.327
Admission benzodiazepine	285							
None		62 [21.8]	22 [21.8]	0 [0.0]	12 [17.4]	21 [26.6]	7 [25.9]	
IV		94 [33.0]	27 [26.7]	6 [66.7]	27 [39.1]	27 [34.2]	7 [25.9]	
IM		9 [3.2]	2 [2.0]	1 [11.1]	1 [1.4]	4 [5.1]	1 [3.7]	
NA		32 [11.2]	16 [15.8]	0 [0.0]	8 [11.6]	6 [7.6]	2 [7.4]	
PO		12 [4.2]	2 [2.0]	0 [0.0]	3 [4.3]	4 [5.1]	3 [11.1]	
IV & NA		50 [17.5]	21 [20.8]	1 [11.1]	14 [20.3]	9 [11.4]	5 [18.5]	
IV & SL		11 [3.9]	6 [5.9]	0 [0.0]	0 [0.0]	4 [5.1]	1 [3.7]	
IM & NA		2 [0.7]	1 [1.0]	0 [0.0]	0 [0.0]	1 [1.3]	0 [0.0]	
IM & SL		1 [0.4]	0 [0.0]	0 [0.0]	0 [0.0]	1 [1.3]	0 [0.0]	
IV & IM		4 [1.4]	1 [1.0]	1 [11.1]	2 [2.9]	0 [0.0]	0 [0.0]	
NA & SL		4 [1.4]	2 [2.0]	0 [0.0]	1 [1.4]	0 [0.0]	1 [3.7]	
IV & IM & SL		1 [0.4]	0 [0.0]	0 [0.0]	0 [0.0]	1 [1.3]	0 [0.0]	
IV & IM & NA		2 [0.7]	1 [1.0]	0 [0.0]	0 [0.0]	1 [1.3]	0 [0.0]	
IV & PO & NA		1 [0.4]	0 [0.0]	0 [0.0]	1 [1.4]	0 [0.0]	0 [0.0]	0.504
Haloperdiol	285	135 [47.4]	49 [48.5]	4 [44.4]	36 [52.2]	34 [43.0]	12 [44.4]	0.842
Admission haloperidol	285							
None		150 [52.6]	52 [51.5]	5 [55.6]	33 [47.8]	45 [57.0]	15 [55.6]	
IV		59 [20.7]	22 [21.8]	3 [33.3]	18 [26.1]	11 [13.9]	5 [18.5]	
IM		52 [18.2]	19 [18.8]	1 [11.1]	15 [21.7]	12 [15.2]	5 [18.5]	
PO		11 [3.9]	1 [1.0]	0 [0.0]	1 [1.4]	7 [8.9]	2 [7.4]	
IV & SL		1 [0.4]	1 [1.0]	0 [0.0]	0 [0.0]	0 [0.0]	0 [0.0]	
IM & SL		4 [1.4]	1 [1.0]	0 [0.0]	0 [0.0]	3 [3.8]	0 [0.0]	
IV & IM		8 [2.8]	5 [5.0]	0 [0.0]	2 [2.9]	1 [1.3]	0 [0.0]	0.414
Other medication	285							
None		242 [84.9]	96 [95.0]	8 [88.9]	63 [91.3]	54 [68.4]	21 [77.8]	
Morphine		2 [0.7]	0 [0.0]	0 [0.0]	0 [0.0]	0 [0.0]	2 [7.4]	
Quetiapine		4 [1.4]	2 [2.0]	0 [0.0]	0 [0.0]	1 [1.3]	1 [3.7]	
Ketamine		3 [1.1]	0 [0.0]	0 [0.0]	1 [1.4]	2 [2.5]	0 [0.0]	
Methadone		1 [0.4]	0 [0.0]	0 [0.0]	1 [1.4]	0 [0.0]	0 [0.0]	
Others		33 [11.6]	3 [3.0]	1 [11.1]	4 [5.8]	22 [27.8]	3 [11.1]	<0.001
CONSULTATION CHARACTERISTICS								
Discharge	285							
Outpatient		102 [35.8]	57 [56.4]	2 [22.2]	34 [49.3]	4 [5.1]	5 [18.5]	
Inpatient psychiatric		117 [41.1]	36 [35.6]	3 [33.3]	15 [21.7]	52 [65.8]	11 [40.7]	
Inpatient medicine		3 [1.1]	1 [1.0]	0 [0.0]	0 [0.0]	0 [0.0]	2 [7.4]	
Inpatient prison		32 [11.2]	4 [4.0]	1 [11.1]	11 [15.9]	10 [12.7]	6 [22.2]	
Inpatient intensive care		31 [10.9]	3 [3.0]	3 [33.3]	9 [13.0]	13 [16.5]	3 [11.1]	<0.001
Duration of treatment [min]	285	425 [278; 577]	476 [363; 570]	348 [248; 508]	466 [348; 636]	306 [202; 442]	430 [273; 635]	<0.001

Variables	N	Total	Intoxication		
		Total (n=285)	Alcohol + (n=246) mixed	Other (n=155)	P-value
INTRA-/PERI-FIXATION DRUGS	285				
Benzodiazepine		223 [78.2]	145 [65.0]	78 [35.0]	0.11
Haloperidole		135 [47.4]	89 [65.9]	46 [34.1]	0.22
Morphine		2 [0.7]	0 [0.0]	2 [100.0]	0.15
Quetiapine		4 [1.4]	2 [50.0]	2 [50.0]	0.64
Ketamine		3 [1.1]	1 [33.3]	2 [66.7]	0.56
Methadone		1 [0.4]	1 [100.0]	0 [0.0]	1
Other		33 [11.6]	8 [24.2]	25 [75.8]	<0.001