Original Article

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Development of a Predictive Score for Suicide Attempts in Patients with Treatment-Resistant Depression and Implementation for Suicide Prevention in Thailand

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Abstract:

Objective: This study aimed to identify predictors of suicide attempts in treatment-resistant depression (TRD) patients and develop a predictive scoring system for suicide risk assessment and prevention.

Material and Methods: This study involved patients aged 20–60 years who were diagnosed with TRD and attended psychiatric outpatient clinics in Bangkok, Thailand. Statistical analysis involved univariate logistic regression to identify potential predictors (p-value<0.05), followed by multivariable logistic regression with backward stepwise selection (p-value <0.01) to develop a predictive model; the model was implemented in a new patient cohort, and suicide attempt rates were compared pre- and post-implementation.

Results: Among 653 TRD patients, 221 had attempted suicide. Nine important predictors were found. The model was excellent at making predictions (area under the receiver operating characteristic (AuROC)=0.993, 95% confidence interval (CI): 0.989–0.997) and had strong internal validation (AuROC=0.98, 95% CI: 0.979–0.999). Risk scores categorized patients into low-, moderate-, and high-risk groups. After creating a predictive scoring system for assessing and preventing suicide risk, it was implemented in 185 new TRD patients. At 6 months and 1 year, there was a statistically significant reduction in suicide attempts (p-value<0.05).

Conclusion: The developed predictive score effectively stratifies suicide risk among TRD patients and informs tailored suicide prevention care plans. Its implementation resulted in a significant reduction in suicide attempts, underscoring its

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potential as a clinical tool for suicide prevention in TRD patients. Notably, protective factors identified in this study, such as good compliance and spiritual security, may also contribute to lowering suicide risk.

Keywords: depressive disorder, prediction, suicide attempted, suicide prevention, treatment-resistant

Introduction

Suicide represents a significant global public health concern, with approximately one million individuals reportedly dying by suicide each year. On average, one person succumbs to suicide approximately every 40 seconds. This issue is particularly alarming as suicide is the leading cause of death among adolescents and young adults[1]. In Thailand, the suicide mortality rate has seen a concerning rise in recent years. Between 2017 and 2022, an estimated 30% of deaths were from suicide. In 2023, there were 31,402 suicide attempts in Thailand[2]. The Department of Mental Health reported that in 2022, the suicide rate was approximately 7.37 per 100,000 people[3]. It is evident that suicide is a significant issue in Thailand, with a rising trend over time.

Depression is a significant contributor to the global burden of disease and a major risk factor for suicide. According to the World Health Organization (WHO)[1], individuals diagnosed with major depressive disorder (MDD) are at a substantially higher risk of suicide compared to the general population. A recent study highlighted that patients with MDD have more than double the all-cause mortality rate of those without depression, with suicide being a significant contributing factor[4]. The study has found that patients with MDD are 49.88 times more likely to have suicidal thoughts and 7.34 times more likely to attempt suicide compared to individuals without depression[5].

Beyond clinical populations, the mental health impact of the coronavirus disease 2019 (COVID-19) pandemic on the general Thai population post-COVID-19 has been profound. A nationwide survey of 1,133 adults aged 20 years and older revealed a prevalence of depressive symptoms at 19.4%, based on the Patient Health Questionnaire-9 (PHQ-9). When assessed using the Depression Anxiety Stress Scales–21 (DASS-21), the rates were even more striking regarding depression (32.4%)[6]. The situation is similarly concerning across Southeast Asia. A large-scale regional survey conducted in October 2021 involving 33,454 participants from Malaysia, Indonesia, Singapore, and Thailand found that 47% experienced severe depression, even 18 months after the pandemic's onset[7]. MDD represents a significant public health concern, particularly in the wake of the COVID-19 pandemic. In Thailand, a recent study conducted at a tertiary public hospital (Chulabhorn Hospital) found that 19.6% of MDD patients treated with antidepressants met the criteria for treatment-resistant depression (TRD)[8]; they were diagnosed with MDD following the Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-5), and failed to respond to at least 2 different antidepressant treatments administered at adequate doses and durations, with confirmed adherence to treatment. Patients continued to experience significant depressive symptoms despite appropriate pharmacological intervention[9,10].

Studies on patients with TRD currently estimate that at least 30% of people have depression[10]. The overall annual incidence of suicide among patients with TRD is 0.47%. Additionally, the rate of suicide attempts is reported to be 4.66 per 100 patients annually[11]. The incidence rates observed are, respectively, twice and 10 times higher than those recorded in non-resistant patients, with figures of 0.22 completed suicides and 0.43 attempted suicides per 100 patients per year[12]. Numerous studies have demonstrated that 30% of individuals diagnosed with TRD have

experienced one or more suicide attempts[13]. Patients with TRD have an overall mortality rate 1.35 times higher than individuals with MDD[14]. Several general and non-specific risk factors for suicide have been identified in patients with TRD, including substance use, psychiatric comorbidities[15], male gender, low socio-economic[16], social isolation, and cultural stigma[1]. This led to the conceptualization of this study aimed at identifying factors that can predict suicide attempts in patients with TRD. The goal was to develop a predictive scoring system to assess suicide risk in this population and to apply the score as a tool for suicide prevention.

Material and Methods

Study design and setting

This retrospective cohort study was conducted at Charoenkrung Pracharak Hospital, under the Bangkok Metropolitan Administration, Thailand. Data were collected from electronic medical records between 2021 and 2023. This study involved patients aged 20–60 years who were diagnosed with TRD and attended psychiatric outpatient clinics. Exclusion criteria comprised patients with MDD who did not meet TRD criteria, those lost to follow-up, pregnant women, and individuals with organic mental disorders, schizoaffective disorders, or bipolar disorders. The study protocol was approved by the Bangkok Metropolitan Administration Human Research Ethics Committee (approval number S014hc/66_EXP), in accordance with internationally recognized ethical standards for human research. Informed consent was obtained from all participants in compliance with ethical guidelines.

Study variables and outcomes

Data collected from the electronic medical records included demographic information and clinical characteristics of treatment-resistant depression (TRD), assessed using the 9Q questionnaire. Additional variables included the presence of psychotic symptoms, atypical depression, duration of illness, and related factors such as substance use, physical and mental comorbidities, a history of physical or sexual abuse, and poor treatment compliance defined as the failure or unwillingness to follow a prescribed medical plan, including missing medications for more than one month. Other psychosocial variables included social media addiction, defined as a behavioral addiction marked by excessive and compulsive use of social media that disrupts daily functioning, relationships, work, or mental health. And spiritual security, defined as a component of national security concerned with protecting the spiritual values, moral traditions, and religious beliefs of the population. The primary outcome was to identify predictors of suicide attempts in patients with TRD, in order to develop a valid and practical predictive score to support suicide prevention efforts. The secondary outcome was to design a care plan based on the stratified risk levels derived from the predictive score, and to evaluate its effectiveness in suicide prevention at Charoenkrung Pracharak Hospital through follow-up of suicidal behaviors at 6 months and 1 year after implementation.

Statistical analysis

The study involved participants diagnosed with TRD, who were categorized into 2 groups: those who had attempted suicide and those who had not. Comparisons between the 2 groups with suicidal attempts and those without were conducted utilizing a chi-square or Fisher's Exact test to assess any significant differences in characteristics (p-value). Predictors for each characteristic with a p-value of less than 0.05 were identified through univariable logistic regression. The process involved calculating the area under the receiver operating characteristic (AuROC) curve, together with its associated 95% confidence interval (95% CI). Predictors demonstrating a high AuROC curve and a p-value of less than 0.01 were subsequently selected for analysis using multivariable logistic regression with backward stepwise selection to ascertain the most significant

predictors. The discriminative performance of the model was evaluated through the AuROC curve. The predictors' regression coefficients were standardized by dividing each coefficient by the smallest coefficient present in the model. This process was undertaken to establish a comprehensive risk score. Calibration of the predictions was assessed via Hosmer–Lemeshow statistics. Internal validation was performed through a bootstrapping procedure involving 300 bootstrap samples to quantify any optimism present in the developed model. Risk scores were classified into distinct risk levels, and predicted probabilities for each risk score level were calculated accordingly. Post-implementation, the results were compared to the pre-implementation outcomes through a chi-square or Fisher's Exact test (p-value<0.05), risk ratio (RR), and 95% CI. All analyses were conducted using Stata statistical software, version 17.0. The dataset was complete, containing no missing values.

Results

The study encompassed 653 participants diagnosed with TRD who received services during the years 2021 and 2022. The participants were classified into 2 groups: 221 individuals who had attempted suicide and 432 individuals who had not. The characteristics of the TRD patients are shown in Table 1.

A total of 32 factors were examined to identify predictors of suicide attempts, including basic demographic variables, clinical symptom-related factors, past psychiatric

Table 1 Characteristics of the patients

Characteristics	Not suicide n=432	Suicide attempts n=221	p-value
Gender; n (%)			
Male	112 (25.93)	68 (30.77)	0.223
Female	320 (74.07)	153 (69.23)	
Age; mean±S.D.	36.34±14.29	29.67±11.65	<0.001
Age group; n (%)			
20–30 years	203 (46.95)	143 (64.71)	<0.001
>30 years	229 (53.01)	78 (35.29)	
Marital; n (%)			
Married	146 (33.80)	32 (14.48)	<0.001
Single	286 (66.20)	189 (85.52)	
Occupation; n (%)			
Employed	221 (51.16)	57 (25.79)	<0.001
Unemployed	211 (48.84)	164 (74.21)	
Education; n (%)			
No education	22 (5.09)	16 (7.24)	0.006
Low education	210 (48.61)	131 (59.28)	
High education	200 (46.30)	74 (33.48)	
Substance used; n (%)			
No	354 (81.94)	135 (61.09)	<0.001
Yes	78 (18.06)	86 (38.91)	
Physical illness; n (%)			
No	412 (95.37)	156 (70.59)	<0.001
Yes	20 (4.63)	65 (29.41)	
Psychiatric comorbid; n (%)			
No	314 (72.68)	129 (58.37)	<0.001
Yes	118 (27.32)	92 (41.63)	

S.D.=standard deviation

history, medical history, and family history. The analysis aimed to identify preliminary predictive factors associated with suicide attempts in patients with TRD using univariate analyses, with predictive ability measured by the AuROC. Predictors with a p-value of less than 0.05 were further analyzed using multivariable logistic regression with backward stepwise selection, applying a significance threshold of p-value<0.01. This analysis identified 9 statistically significant predictors out of the 32 factors examined. The predictive model, derived from these 9 predictors, was analyzed using multivariable logistic regression, producing adjusted odds ratios, 95% CI, and associated p-values. Further analysis involved calculating the coefficient for each variable, where the variable with the smallest coefficient value (3.14) was used as a divisor to normalize the coefficients of all other variables. The resulting quotients were then rounded to the nearest whole number, generating item scores ranging from 0 to 2. These scores were subsequently utilized in the development of the item score assignment, as illustrated in Table 2.

The performance of the predictive score was evaluated using the discrimination method. The findings in Figure 1 indicate that the score effectively distinguished between TRD patients who had attempted suicide and those who had not. Furthermore, the score exhibited a robust predictive capability for assessing suicide risk in patients with depression, with an AuROC of 0.993 (95% CI: 0.989–0.997), as shown in Figure 2.

The calibration process was assessed using the Hosmer-Lemeshow goodness-of-fit test, which yielded a p-value of 0.798. This result signifies a strong alignment between the predicted values and the actual observed values across various score levels. The subsequent phase involved the validation process, specifically internal validation, utilizing the full dataset for bootstrap validation. The results demonstrate that the score effectively forecasted the risk of suicide in patients with depression, achieving an AuROC of 0.98 (95% CI: 0.979–0.999) and a standard error of 0.005. This reinforces the high validation value and strong reliability of the dataset employed in the predictive modeling process. The prediction derived from the risk curve in Figure 3 indicates that the probability of suicide attempts among patients with TRD escalates as the scores increase, thereby allowing for the classification of risk levels based on predictive risk values.

Table 2 The predictors, adjusted odds ratio (OR), confidence interval (CI), coefficient, and item scores assignment

Predictors	Adjusted OR	95% CI	p-value	Coefficient	Score	Adjusted score
TRD with psychosis	31.86	3.13, 323.85	0.003	3.46	1.10	1
Atypical depressive symptoms	23.03	2.88, 184.44	0.003	3.14	1.00	1
Duration of depression more than 1 year before treatment	58.59	13.38, 256.47	<0.001	4.07	1.30	1
Poor compliance	153.47	31.94, 737.40	<0.001	5.03	1.60	2
Borderline personality disorder	29.57	3.18, 274.94	0.003	3.39	1.08	1
Suffering from physical illness	26.18	3.57, 191.87	0.001	3.27	1.04	1
Social media addiction	27.95	7.03, 111.06	<0.001	3.33	1.06	1
Physical or sexual abuse	26.31	7.20, 96.07	<0.001	3.27	1.04	1
Absence of spiritual security	28.40	7.12, 113.31	<0.001	3.35	1.07	1

TRD=treatment-resistant depression

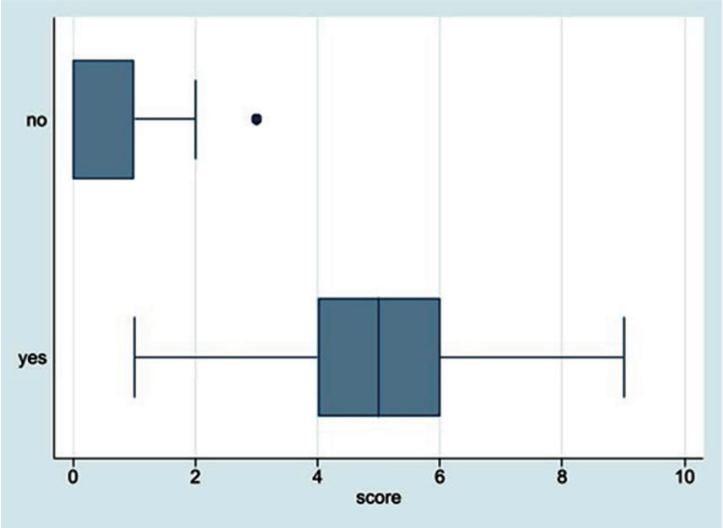

Figure 1 Discrimination of the scores of treatment-resistant depression (TRD) patients with suicide attempts vs not suicide

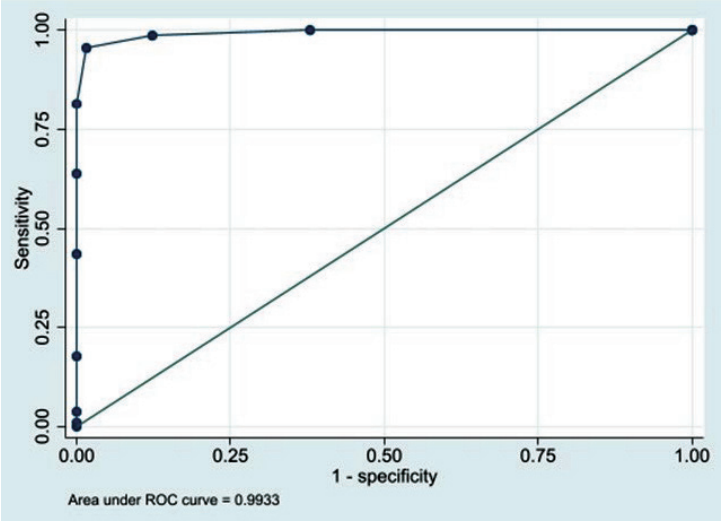

Figure 2 The area under the receiver operating characteristic (AuROC) for predictive capability for assessing suicide risk in treatment-resistant depression (TRD) patients

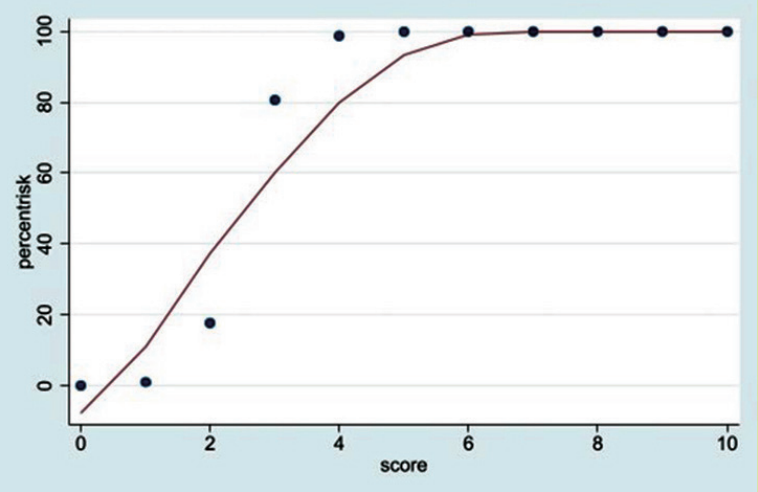

Figure 3 The risk curve score for predicting the risk of suicide attempts in treatment-resistant depression (TRD) patients

Specifically, a low risk of suicide attempts correlates with scores of 0, exhibiting a predictive risk of 0.1. A moderate risk corresponds to scores ranging from 1 to 2, reflecting a predictive risk between 1.1 and 17.8, while a high risk is indicated by scores of 3 or greater, with a predictive risk exceeding 80.6. The predictive capability of the score for suicide attempts in TRD patients was evaluated by categorizing the score into 3 levels based on the likelihood ratio of positive results. A pronounced distinction was observed between the levels, demonstrating that the predictive ability at each level is well-separated and effectively differentiates risk groups, as illustrated in Table 3.

The secondary outcome of this study pertains to the implementation of a predictive scoring system for a new cohort of patients with TRD receiving care in 2023. This cohort demonstrates demographic characteristics that are comparable to those of the comparator group, which consists of TRD patients treated between 2021 and 2022. The assessment of the study group will be conducted using the predictive score to evaluate the risk of suicide attempts and to formulate a suicide prevention care plan that corresponds to the risk level indicated by the score. A multidisciplinary team within the Psychiatric Department of Charoenkrung Pracharak Hospital will collaborate to establish the following treatment guidelines for suicidal prevention: Low-Risk Group: Patients identified as low risk will receive follow-up visits monthly. Medication adjustments will be tailored to the patient's symptoms, in addition to providing psychoeducation. Moderate-Risk Group: Patients categorized as moderate risk will undergo follow-up evaluations every 2 weeks. Medication adjustments will also be based on symptomatology, supplemented by individual psychotherapy. Hospitalization or referral may be considered based on clinical presentation and treatment response. High-Risk Group: Patients classified as high risk will be closely monitored on a weekly basis. Their treatment will involve medication adjustments coupled with individual psychotherapy and suicide precautions. Hospitalization or referral to a specialized psychiatric facility will be considered as required. Within the study sample of 185 patients, 72 were classified as low risk, 48 as moderate risk, and 65 as high risk. Outcomes will be assessed at 6 months and 1 year. The findings revealed that the incidence of suicide

attempts among the study group, all of whom were classified as high risk, exhibited a significant reduction compared to the comparator group. Conversely, the comparator group, which did not undergo the implementation of the predictive scoring system, demonstrated a significantly increased risk of suicide attempts, as evidenced by the RR presented in Table 4.

Discussion

Previous research has established a significant correlation between psychotic symptoms in patients with depression and an increased risk of suicide[17–19]. However, when this correlation was examined specifically within the context of TRD, no definitive association was identified[20–22]. In contrast, our study reveals that psychotic symptoms in individuals with TRD represent a notable risk factor for suicide attempts, underscoring a crucial distinction from earlier investigations. While there is a documented correlation between atypical depression and TRD, evidence linking it to suicide attempts remains lacking[23]. The prolonged duration of illness, both prior to and following treatment, has been clearly associated with TRD, but no significant correlation with suicide risk has been established[24]. Furthermore, non-adherence to medication is a well-documented risk factor for suicide among depressed patients; however, research specifically addressing this association in the context of TRD is limited[25]. Numerous studies have indicated that comorbid personality disorders

Table 3 Distribution of treatment-resistant depression (TRD) with suicide attempts vs TRD without suicide into low, moderate, and high probability categories, likelihood ratio of positive (LHR+) and 95% confidence interval (CI)

Probability categories	Score	TRD without suicide (n=432) n (%)	TRD with suicide attempts (n=221) n (%)	LHR+	95% CI	p-value
Low risk	0	268 (62.04)	0 (0.00)	0.00	0.00–0.02	<0.001
Moderate risk	1–2	46 (10.65)	7 (3.17)	0.37	0.18–0.74	0.001
High risk	>3	118 (27.31)	214 (96.83)	29.56	14.14–61.77	<0.001
Mean±S.D.		0.52±0.75	5.05±1.57			<0.001

S.D.=standard deviation

Table 4 Comparative suicide prevention implementation group within 6 month and 1 year vs comparator group, risk ratio (RR), and 95% confidence interval (CI)

Variable	Comparator group n=653	Implemented within 6 month group n=185	p-value	Risk ratio (95% CI)	Implemented within 1 year group n=185	p-value	Risk ratio (95% CI)
Suicide attempt	221	6	<0.001	1.38 (1.30–1.46)	11	<0.001	1.34 (1.26–1.42)
Not suicide	432	179			174		

are associated with an elevated suicide risk in patients with TRD[17,21]. with our findings particularly highlighting borderline personality disorder as the most significant comorbidity linked to suicide attempts in this population. Additionally, various physical illnesses, including chronic non-communicable diseases, cardiovascular conditions, chronic pain, and thyroid dysfunction, have been associated with increased suicide risk among patients with TRD[10,22,26]. This study explicitly emphasizes the detrimental impact of unstable physical illnesses that contribute significantly to patient suffering. Physical and sexual abuse are stressful events that can contribute to both depression and suicidal behavior[27,28]. This association led to the inclusion of this factor in our study on patients with TRD. The phenomenon of social media addiction is an intriguing factor that has not been extensively studied. There is still no conclusive evidence linking it to depression and suicide. Therefore, it was included as a noteworthy factor for investigation in this study[29,30]. The absence of spiritual security, particularly among individuals lacking spiritual beliefs or religious affiliations, introduces a challenging dimension to this study. Previous research suggests that spiritual security may play a critical role in psychological healing processes[31].

Based on the 9 predictor factors identified in this study, we developed a predictive score designed to effectively assess suicide risk in patients with TRD. This population presents considerable complexity, as it does not adhere to a standardized treatment protocol and involves multiple interrelated factors. Treatment outcomes are often difficult to predict, with suicide remaining a significant concern[22]. This predictive score was later implemented in real-world TRD patients, with a multidisciplinary team establishing suicide prevention risk-based patient care plans according to the score. The follow-up at 6 months and 1 year after implementing this assessment approach showed a statistically significant reduction in suicide attempts. A study from South Asia emphasized the urgent need for standardized data systems, culturally sensitive interventions, and strengthened public health strategies. Its cross-country perspective draws attention to both common challenges and opportunities for coordinated regional responses[32]. And suicide prevention in Southeast Asia faces unique challenges due to limited resources, strong social influences, low awareness, and high stigma. This study highlights key priorities, challenges, and opportunities identified during the first regional workshop to guide effective, collaborative, and evidence-informed prevention strategies in the region[33]. This led to the systematic integration of the predictive score into suicide prevention strategies for TRD patients. The researchers strongly hope that this approach will be widely adopted as a tool for suicide prevention in TRD patients. Additionally, it may serve as a foundation for future large-scale research in order to further explore and refine suicide risk assessment and intervention strategies.

However, this study has several limitations. It was conducted exclusively on patients in Bangkok, limiting its generalizability. Additionally, the follow-up period for assessing the effectiveness of the predictive score in combination with the care plan was only one year, which may not be sufficient to evaluate long-term outcomes. Moreover, the care plan may require continuous refinement and adaptation to remain relevant to changing circumstances and to enhance patient care efficiency. These limitations highlight opportunities for future research, including expanding the study to a multicenter approach to provide a broader national perspective and long-term follow-up studies to assess the use of predictive models alongside adaptive care plans that evolve throughout the entire course of patient treatment.

Conclusion

A study on predictors associated with suicide attempts in patients with TRD was conducted to develop a predictive model and create a predictive score. The model

incorporates 9 key factors, including: TRD accompanied by psychotic symptoms, atypical depression, duration of depression exceeding one year before treatment, poor treatment compliance, comorbid borderline personality disorder, the existence of physical illnesses, social media addiction, a history of physical or sexual abuse, and absence of spiritual security. The predictive score classifies patients into 3 risk levels: low risk, moderate risk, and high risk. Based on these risk levels, a risk-based suicide prevention care plan was implemented. The application of this model resulted in a statistically significant reduction in suicide attempts among TRD patients.

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Conflict of interest

The authors declare no conflict of interest.

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