

# Factors Predicting Successful Suicide Among Adolescents: Multiple Attempts And Index Methods, A Retrospective Cohort Study

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## Research Article

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# Abstract

**Background:** While suicide among adolescents has emerged as a significant social problem, few studies have examined the relationship between changes in suicide methods and suicide success following multiple attempts. This study aimed to investigate the relationship between changing suicide methods and successful suicide among adolescents after repeated attempts.

**Methods:** This retrospective study analyzed the psychiatric history of patients (n=227) between 10 and 18 years of age who visited a pediatric emergency center between January 2007 and February 2021 for suicide attempts.

**Results:** Out of a total of 227 patients, 80 achieved successful suicide attempts, including emergency hospitalization or death. A significant association was observed between successful suicide in patients with multiple attempts who chose drug intoxication (DI) as the index method ( $p=0.010$ ) and patients with multiple attempts who chose DI as a suicide method ( $p=0.001$ ). No statistically significant outcomes for changing methods and number of suicide attempts were evident.

**Conclusions:** This study emphasizes the importance of identifying index methods as well as suicide methods among adolescent patients with multiple suicide attempts. This study identified predictors affecting the successful suicide of adolescents. Identifying the index method and the changed method among adolescent patients with multiple suicide attempts are significant predictors of successful suicide. Identifying the index method and changed method of suicide is expected to help in interviewing adolescents with multiple suicide attempts.

## Background

As one of the leading causes of pediatric deaths worldwide, suicide requires a mature cognition to intentionally decide to kill oneself. In the context of adolescent death, suicide and self-harm have emerged as important public health issues [1, 2]. A World Health Organization (WHO) report found that 62,000 adolescents died by suicide in 2020, and it was the third leading cause of death in older adolescents [3].

The number of patients who visit the pediatric emergency department (pED) with suicidal ideation or attempts has also increased [4, 5]. While admission is highly recommended for young patients who have attempted suicide in order to prevent recurrence, every patient cannot be admitted for various reasons, including circumstances and/or limited or unavailable resources [6]. Therefore, it is necessary to determine the need for admission based on priority.

Previous suicide attempts are known to be the strongest risk factors for recurrent attempts [7]. The greater the repetition rate, the higher the risk of recurrence, which may lead to death [8, 9]. However, young adults tend to repeat suicide attempts with non-fatal methods, such as superficial wrist cutting, alleviating an unstable psychiatric situation rather than exact suicidal situation, depending on the special

circumstances of the adolescents. This situation of suicidal attempts among adolescents includes limitations of available methods and higher impulsive tendencies, which differ from suicide attempts among adults [6, 10–12]. Thus, many studies exist on predictive factors for suicide attempts in young patients that distinguish them from those of adults; previous suicide attempts are one of the specific predictive factors [6, 10, 13–17].

Several studies on adults have examined the effect of changing the suicide method. One study found that changing the suicide method did not increase the mortality rate and that most people with a history of recurrent suicide attempts commit suicide using the same method [18]. Another study showed that changing the suicide method increases the success rate of completed suicide [19].

One of multiple studies on the recurrence of suicide in young adults [15–17, 20] states that changes in the self-harm method are highly likely to occur in young male patients with intentional drug overdose, however, its association with mortality is unclear [20]. Thus, there is a shortage of studies focusing on the success rate of suicide that consider its severity with change, irrespective of the rate of recurrence by young adults.

The purpose of this study is to investigate the predictive factors that affect the severity of suicide among adolescents by focusing on individual suicide methods and repetition with or without changing methods.

## Methods

### Study design and outcomes

This study used a retrospective cohort design. This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Severance Hospital Ethical Committee (Severance Hospital IRB number: 4-2021-0693). This study was approved by the Severance hospital ethical committee's institutional review board for a written informed consent waiver.

The initial selection of patients comprised adolescents and teenagers from 10 to 18 years old who visited the pediatric Emergency Department of Severance Hospital from January 2007 to February 2021. There were no intentional suicide attempts among patients below 10 years of age; those under 18 years of age were classified as pediatric patients following the policy of the hospital. Only initial successful suicide attempts were considered valid data for multiple visits. The definition of a successful suicide attempt is based on the outcome. A “meaningful suicide attempt” refers to a significant injury which disturbs the patient’s usual lifestyle, such as unstable vital signs, mental changes, or psychiatric emergency status. Patients received the following diagnosis: Patients identified with a clear intentional suicide attempt received a diagnosis of “suicidal ideation” (R45.8), “self-harm” (T76), “drug intoxication” (T28, T36–40, T42–46, T49–56, T60, T62, T65, T88), “hanging” (W76, X70), or “dead on arrival” (R98), based on the ICD-10 codes. We also reviewed the medical histories of these patients to identify those who did not have “suicidal ideation” as a co-diagnosis to exclude the cases of unintentional self-harm. Subsequently, 364 individuals, all of whom had intention of suicide, were chosen as the primary selection. After further

consideration, 16 people with insufficient records of psychiatric history, 59 people with only suicidal ideation without attempt, and 62 people with accidental injury without suicidal intention, were excluded. Finally, 227 patients were selected as the final participants (Fig. 1).

To analyze the characteristics of the final participants, gender, age at which suicide was attempted, mental health history such as depression, suicide method, total number of suicide attempts, presence of suicide method changes, and number of changing suicide methods were investigated. Even if the kinds of drugs were changed or the location or intensity of self-harm was changed, it was regarded as the same method and classified as drug intoxication (DI) or self-harm.

Emergency hospitalization, “transport to other hospital to admission,” and “death” were classified as successful and meaningful suicide attempts. “Discharge” and “voluntary discharge” were classified as failure of suicide attempt.

## Analyses And Statistical Methods

This study used SPSS ver. 26.0 for Windows (IBM Corp., Armonk, NY, USA) for the statistical analysis. Categorical variables were expressed as numbers and percentages (%). The patients’ characteristic data were analyzed using Fisher’s exact test and the Chi-square test for trend, and relationship between various subjects. Success of suicidal attempts were analyzed using multi-logistic regression. Additionally, we re-set the population to multiple suicide attempt patients and used multi-logistic regression to determine the relationship between suicide method changes and successful suicide attempts. Odds ratio was expressed with 95% confidence interval (CI) and *P* value. Statistical significance was judged when the *p* value was less than 0.05. All numbers are rounded to the second decimal place.

## Results

Of the 227 patients, characteristic factors included age, sex, and history of past psychiatric issues. According to the data, 47 (21.1%) were males and 180 (78.9%) were females. A total of 63 patients (27.8%) were younger than 15 years old (YO), 41 (18.1%) were 15 YO, 56 (24.7%) were 16 YO, and 67 (29.5%) were older than 17 YO. A total of 130 patients (57.3%) had psychiatric histories, 104 (45.8%) had depression disorder, and 26 (11.5%) had other psychiatric problems. A total of 123 patients (54.2%) selected DI as their suicide method, 48 (21.1%) selected self-harm, and 27 (11.9%) selected falling, in order of frequency. A total of 109 patients (48.0%) attempted suicide only once, while 118 (52.0%) attempted multiple times. Forty-six (42.2%) of the 109 single attempt patients and 34 (28.8%) of the 118 multiple attempt patients achieved meaningful attempts ( $p=0.038$ ). Among the 118 patients with multiple attempts, 86 (72.9%) changed their suicide method when they attempted suicide again, while 32 (27.1%) did not (Table 1).

Table 1  
Characteristics of patients

Variables	Total (n=227) n (%)	Fail (n=147) n (%)	Success (n=80) n (%)	p value	$\chi^2$
Sex					
Male	47 (21.1)	30 (20.4)	17 (21.3)	0.881	0.022
Female	180 (78.9)	117 (79.6)	63 (78.7)		
Age					
– 15 YO	63 (33.9)	41 (27.9)	22 (27.5)	0.153	5.267
15 YO	41 (18.1)	27 (18.4)	14 (17.5)		
16 YO	56 (24.7)	42 (28.6)	14 (17.5)		
17 YO –	67 (29.5)	37 (25.2)	30 (37.5)		
Psychiatric history					
No history	97 (42.7)	61 (41.5)	36 (45.0)	0.874	0.268
w/ depression	104 (45.8)	69 (46.9)	35 (43.8)		
w/o depression	26 (11.5)	17 (11.6)	9 (11.3)		
Methods of suicide					
DI	123 (54.2)	79 (53.7)	44 (55.0)	0.502	21.586
Falling	27 (11.9)	10 (6.8)	17 (21.3)		
Self-harm	48 (21.1)	40 (27.2)	8 (10.0)		
Hanging	11 (4.8)	4 (2.7)	7 (8.8)		
Others	18 (7.9)	14 (9.5)	4 (5.0)		
Number of suicidal attempts					
One time	109 (48.0)	63 (42.9)	46 (57.5)	0.038	4.450
Multiples times	118 (52.0)	84 (57.1)	34 (42.5)		
Changing methods of suicide attempts in multiple suicide attempt patients					
None	32 (27.1)	24 (28.6)	8 (23.5)	0.512	6.284
One time	72 (61.0)	53 (63.1)	19 (55.9)		
More than two times	14 (11.9)	7 (8.3)	7 (20.6)		
YO: years old; w/: with; w/o: without; DI: drug intoxication					

Analysis of the relationship between each subject and the outcome of the suicide attempt, determined that sex, age, psychiatric history, and number of suicide attempts had no significant relationship with successful attempts. Regarding the index of the suicide method, patients who selected DI tended to significantly increase the success rate ( $P$  value = 0.01). The odds ratio (OR) of patients who selected falling as an index method, compared with patients who selected DI, was 6.14 (95% CI: 1.60–23.45;  $P$  value = 0.008), while the OR of patients who selected self-harm as an index method, compared with patients who selected DI, was 0.40 (95% CI: 0.17–0.92;  $P$  value 0.020). Regarding suicide method differences, patients who selected DI tended to significantly increase the success rate ( $P$  value = 0.001). The OR of patients who selected falling, compared with patients who selected DI, was 3.08 (95% CI: 1.27–7.48;  $P$  value = 0.013), while the OR of patients who selected self-harm as their index method, compared with patients who selected DI, was 0.38 (95% CI: 0.86–12.19;  $P$  value =0.38). Hanging and other methods were not statistically significant with a successful outcome. Among 118 multiple suicide attempt patients, the number of method changes had no significant relationship with successful suicide attempts. However, the success rate tended to increase among patients who changed their method in comparison to those who did not. The OR of patients who changed their method one time compared with patients who did not in multiple attempts was 2.79 (OR 2.79; 95% CI: 0.87–9.00;  $P$  value = 0.086) (Table 2).

Table 2  
The relationship between each patient and the successful suicide attempts

Variables	Univariate	
	OR (95% CI)	Pvalue
Sex	1.23 (0.57, 2.39)	0.598
Female (vs. male)		
Age		
– 15 YO	1	0.941
15 YO (vs. – 15 YO)	0.86 (0.34, 2.14)	0.737
16 YO (vs. – 15 YO)	1.07 (0.45, 2.53)	0.880
17 YO – (vs. – 15 YO)	1.05 (0.31, 3.60)	0.941
Psychiatric history		
No history	1	0.971
w/ depression (vs. no history)	0.91 (0.40, 2.08)	0.817
w/o depression (vs. no history)	0.97 (0.32, 2.89)	0.949
Index methods of suicide		
DI	1	0.010*
Falling (vs. DI)	6.13 (1.60, 23.45)	0.008*
Self-harm (vs. DI)	0.40 (0.17, 0.92)	0.020*
Hanging (vs. DI)	1.06 (0.26, 4.28)	0.940
Others (vs. DI)	0.00 (0.00, 0.00)	0.999
Methods of suicide		
DI	1	0.001*
Falling (vs. DI)	3.08 (1.27, 7.48)	0.013*
Self-harm (vs. DI)	0.38 (0.16, 0.89)	0.025*
Hanging (vs. DI)	3.25 (0.86, 12.19)	0.081
Others (vs. DI)	0.58 (0.18, 1.90)	0.364
Number of changing methods in multiple suicide attempt patients		

YO: years old; w/: with; w/o: without; DI: drug intoxication; OR: odd ratio; CI: confidence interval

Variables	Univariate	
	OR (95% CI)	Pvalue
None	1	0.193
One time (vs. none)	2.79 (0.87, 9.00)	0.086
≥ two times (vs. none)	0.93 (0.36, 2.42)	0.881

YO: years old; w/: with; w/o: without; DI: drug intoxication; OR: odd ratio; CI: confidence interval

A sub-analysis of 80 patients who achieved a successful suicide attempt determined that 46 (57.6%) achieved success in their first attempt, while 34 (42.5%) were successful after multiple attempts. Among patients with multiple suicide attempts, 8 (23.5%) did not change the method and 26 (76.5%) changed methods. Among the eight patients who did not change their suicide method in multiple attempts, 6 (75.0%) selected self-harm and 2 (25.0%) selected DI. Among the 26 patients who changed their methods in multiple attempts, 24 (92.3%) selected self-harm as the index method. The most common (50%) method of self-harm was DI. Among those with single suicide attempts, the most successful methods were DI 29 patients [63.0%], falling (13 [28.3%]), and hanging (4 [8.7%]). Patients who selected falling or hanging as index methods did not attempt suicide multiple times. The average number of patients who attempted suicide without changing methods was 2.1, while 2.5 changed methods. There was no statistical significance.

## Discussion

Suicide in adolescents is a worldwide issue, and there is an obvious need to predict risk factors for suicidal ideation or attempt [2]. Previous suicide attempts can be used as important predictive factors of recurrence, while additional studies are needed to predict subsequent harmful attempts which affect the maintenance of adolescents' normal lives.

This study aimed to evaluate whether differences in suicide methods and changing suicide methods in multiple attempts can be used as predictive factors of later serious suicide attempts. Four main methods were identified in this study: falling and hanging (both classified as fatal methods), and DI and self-harm with suicidal ideation (both classified as non-fatal methods) [19].

Unlike previous studies, the current study found that recurrent suicide attempts did not increase the success rate [8, 9] and that changing methods and the number of methods used did not have a significant relationship with meaningful outcome. This may be because many previous studies [6–10, 13–17] focused on the recurrence rate of suicide attempts, and not the severity of each attempt. However, unlike adults, young adults tend to be impulsive when choosing to attempt suicide and do not prepare their methods, or they tend to choose available or easily accessible non-fatal methods that are less severe [6, 10]. Thus, using adolescents' histories of previous suicide attempts as predictive factors of severity provides a weaker correlation than using the same for adults.

In this study, no clear relationship between sex, age, psychiatric history, or number of suicide attempts and successful suicide attempts was evident. However, methods of suicide attempts were statistically significant with outcomes. Patients who chose DI as a method achieved successful suicide ( $P$  value  $<0.001$ ), while patients who selected self-harm achieved successful suicide 0.38 times less than DI ( $P$  value 0.025). This result contradicts that of previous studies [18] and differs from previous works in its definition of meaningful attempts, i.e., when an individual expires. However, we define lethality of suicide attempts more broadly so that we can focus on providing specific care for patients before they actually achieve suicide

It is obvious that fatal methods have more lethality than non-fatal methods [21]. According to this study's research, patients who successfully attempted suicide eventually selected DI instead of self-harm among non-fatal methods. Moreover, patients who selected DI as an index method or present method had a significantly higher success rate than patients who chose self-harm. Historically, DI has been a more fatal method than self-harm among non-fatal methods. Therefore, both the number of previous suicide attempts and a change in method to DI must be considered as important factors by clinicians when making decisions regarding emergency hospitalization in pED (although they are not absolute predictive factors).

This study has a few limitations. First, previous psychiatric histories can vary when records are based solely on patients' memories. Therefore, some data may have been missed and confounding factors, such as family composition, may not have been included. Second, there was a single center bias where there was a tendency to admit patients more readily when they had previously visited psychiatric outpatient clinics, regardless of severity. Third, prospective cases with long term output, including post-accident care, should be included in future studies. It was difficult to determine methods of subsequent suicide attempts after pED visits because later contact was lost due to the retrospective study design. Of the 69 (30.4%) patients connected with the social care service team (of 227 patients total), only 21(30.4%) agreed to follow ups, and only 11 completed case management a total of four times or re-connected to other social care service teams, while others refused or could not participate in post-accident care. Several studies have reported that the mortality and recurrence rate of suicide significantly decreased in patients who underwent follow-up care compared with those who did not [17, 20]. Thus, because the prospective study design does not include long term output, mortality would increase. Fourth, the term DI should be clarified in more detail. In this study, all types and amounts of drugs were regarded as potentially lethal. However, previous studies distinguished between different types of drugs and found that specific drugs carried higher risks. Additionally, young adults tend to acquire over-the-counter drugs because many other drugs are not easily acquired [20]. Thus, future studies should consider kinds and amounts of drugs based upon adolescents' characteristics. Finally, social issues should be considered. In this study, the success rate of suicide was especially evident among the 17 YO age group, a time when adolescents can experience extensive stress in high school. Several studies also mentioned the specific circumstances of adolescents [15] and how hypercompetitive educational circumstances can lead to an exponential increase in suicide [11, 12]. Future studies should consider social circumstances when examining suicide methods and success rates.

## Conclusion

This study aimed to identify predictors of successful suicide in young adults. Unlike previous studies, it determined that repeated suicide attempts are not a significant factor and cannot be used as a predictor of suicide success. This study determined that methods of suicide and index methods were correlated with successful suicide in adolescents who attempted suicide multiple times. Therefore, it is important to consider the index method as well as the changed method when treating adolescent patients with multiple suicide attempts.

## Declarations

### Ethics approval and consent to participate

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Severance Hospital Ethical Committee (Severance Hospital IRB number: 4-2021-0693). This study was approved by the Severance hospital ethical committee's institutional review board for a written informed consent waiver.

### Consent for publication

Not applicable.

### Availability for data and materials

All data generated or analysed during this study are included in this published article and its supplementary information files.

### Competing Interests

The authors declare no competing interests.

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### Author's contributions

C.Koo and G.E Bae designed the study. G.E Bae collected and analysed the study data. C.Koo supervised the data collection and the conduct of the study. H.S.Chung provided statistical advice on study design and data analysing. G.E Bae wrote the original draft. H.J. Kim and S.H. Eun prepared figure 1 and table 1-2. S.H. Yoon, M.K. Kim and H.E. Kwon contributed in manuscript revision. All authors reviewed and edited. All authors contributed equally to data interpretation and literature search. C.Koo takes responsibility for the paper as a whole.

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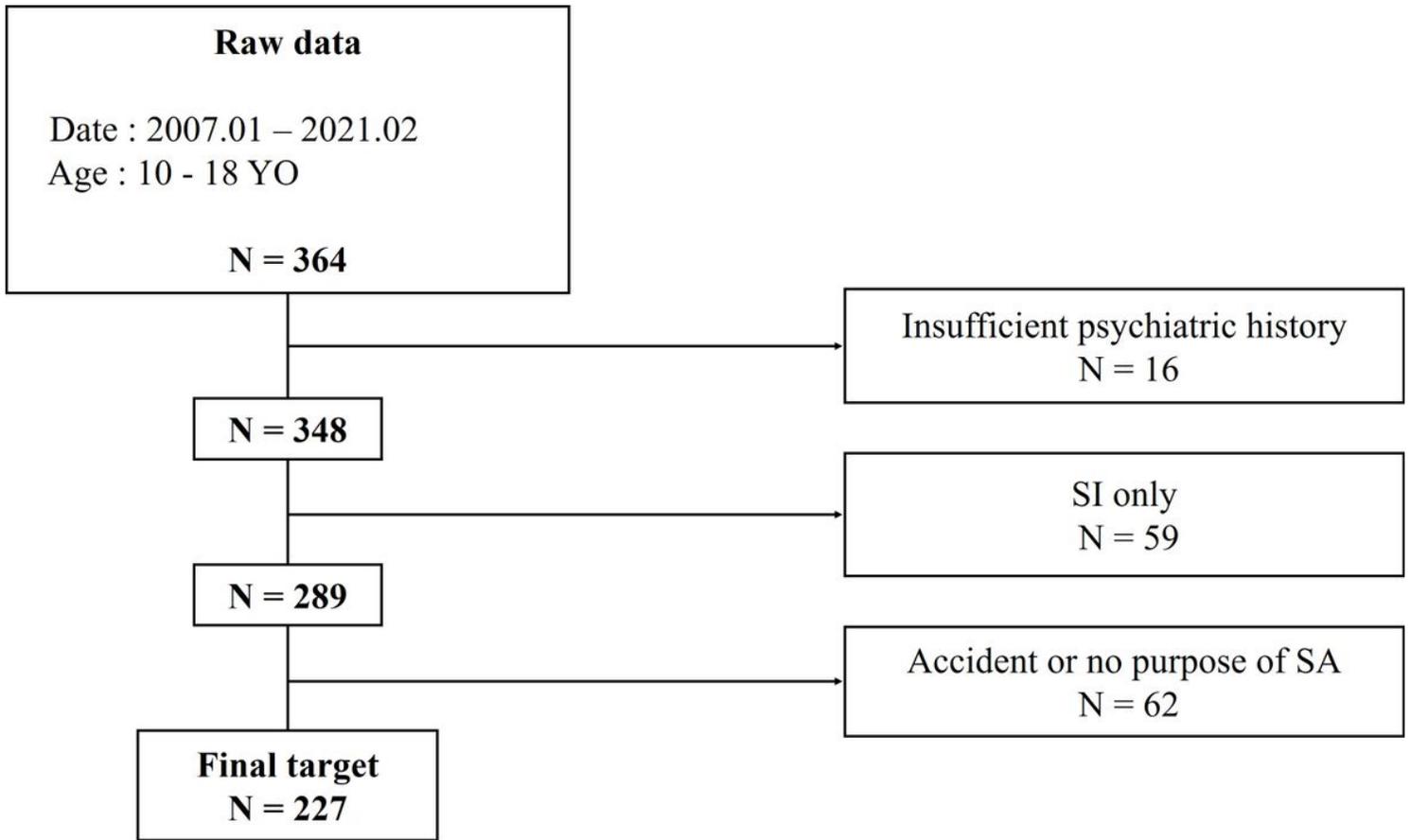
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## Figures



**Figure 1**

Flow chart depicting final participants

## Supplementary Files

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- [rawdata.xlsx](#)