



# Risk of mortality among adolescents and young adults following hospitalization from an intentional overdose

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## ABSTRACT

**Objective:** Previous self-harm attempts are a known risk factor for subsequent suicide completion in adults but is unestablished among adolescents and young adults. Our objective was to determine the mortality rate for patients 10–24 years of age following discharge from the hospital after a non-lethal, intentional overdose.

**Methods:** A retrospective cohort study was conducted of patients aged 10–24 years seen between 2017 and 2022 by the medical toxicology consultation service (MedTox) at a large tertiary care center who experienced a non-lethal, intentional overdose and survived this encounter. The National Death Index (NDI) was examined to determine whether any of these patients subsequently died. We characterized MedTox consultations by age, sex, and substances used. Among those who died, we descriptively characterized the patient's demographics, exposure, and clinical characteristics.

**Results:** There were 1295 consultations for 1147 patients. Females accounted for 71 % of encounters, and most consultations were for those aged 14–17 years (51 %), followed by those 18–21 years (25 %). Most commonly identified substances included acetaminophen (26 %), diphenhydramine (9 %), and ibuprofen (8 %). We identified 4 (<1 %) deaths identified from the NDI: two patients died by asphyxiation, one died by intentional overdose, and one died due to complications from chronic medical conditions.

**Conclusion:** Our observed mortality was lower compared to other studies (0.7 % - 13.3 %), which may have been due to protective factors (e.g., multidisciplinary evaluations) built into the institutional protocols at this center. Future studies will attempt to qualitatively and quantitatively identify individual- and system- level mechanisms in the pathway between self-harm and long-term health outcomes.

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## 1. Introduction

Suicide is a global public health concern, particularly among adolescents and young adults, with an increasing prevalence in these age groups. It is the third leading cause of death worldwide and ranks among the top three causes of death for individuals aged 10–24 years in the United States [1,2]. Between 1999 and 2019, suicide rates among adolescents rose by 35.3 %, with self-poisoning deaths more than tripling in the United States [3]. Previous studies have identified self-harm behaviors as the strongest predictors of future suicide, often associated with repeated attempts [4–9]. Tay et al. found that half of pediatric patients who engaged in intentional self-poisoning had recurring

incidents [10], while Finkelstein et al. discovered that individuals with repeat self-poisonings were 3.5 times more likely to complete suicide within the next year though this study was performed outside of the United States [11]. Early-life repeat self-harm attempts can lead to significant negative outcomes, such as long-term mental illness, substance use disorders, and low educational and occupational attainment [12]. Notably, self-poisoning is the most common form of self-harm, often resulting in hospital presentations [13] and pediatric intensive care unit admissions [14].

Self-poisoning typically necessitates evaluation in the emergency department and is often a non-lethal self-harm attempt [15]. However, many self-harm incidents do not result in hospital admissions, making early recognition and intervention challenging [16,17]. Prior studies have reported on self-harm incidents based mostly on hospital data, insurance claims, or state death records, all of which may exclude patients who died outside of a hospital or specific geographic area [4,18], potentially underrepresenting the future all-cause mortality risk.

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The COVID-19 pandemic has further exacerbated self-harm behaviors [19–21]. Given this growing public health crisis, it is crucial to identify modifiable risk factors that can reduce suicide completion rates. While patients who survive suicide attempts are at an increased risk of completing suicide in the future, the specific risk factors and the extent to which they elevate this risk remain largely unknown [22]. This population poses a unique challenge in identifying those at the highest risk and implementing effective interventions to reduce the likelihood of future suicide attempts.

The objective of this study was to determine the mortality rate for patients aged 10–24 years following discharge from the hospital after a non-lethal, intentional overdose who received a medical toxicology (MedTox) consult. Furthermore, the characteristics of these patients were described.

## 2. Methods

### 2.1. Study design, setting, participants

This was a retrospective cohort study conducted at a tertiary care center with a MedTox consult service that receives consultations for patients who have been poisoned. The MedTox consult service provides 24/7 care and advice for providers regarding the management of patients who have been poisoned (including recommendations for interfacility transfer) either by telephone or bedside. In this institution, it is generally accepted that MedTox is consulted for intentional overdoses, and this expectation was confirmed via personal correspondence with the directors of the emergency department and intensive care units. All encounters involving MedTox are documented in an internal database, which captures elements such as patient demographics, reason for consultation, and substances ingested. Information is included in this database by MedTox faculty. The senior author chart utilized the medical record number and encounter date to review every encounter for patients between the ages of 10–24 years of age to ensure an accurate cohort was identified.

For this study, we included patients between the ages of 10–24 years who received a MedTox consultation between 2017 and 2022. For those patients who received multiple MedTox consultations, we report on their first consultation. Intent of self-harm was determined via a chart review performed by the senior author by searching the chart for the terms “self-harm”, “intentional”, or “suicide.” We excluded patients who had confirmed non-self-harm ingestions or died during that hospital encounter. To obtain mortality data, we queried the National Death Index (NDI) [23], a national database maintained by the Centers for Disease Control and Prevention, which includes information documented on patients' death certificates, including patient demographics, date of death, and cause of death. This study was approved by our local institutional review board and is reported according to the Strengthening the Reporting of Observational Studies (STROBE) guidelines.

### 2.2. Study measures

Measures assessed for self-harm ingestion included sex (female, male, other), age (in years) at consultation, geography (rurality/urbanicity; captured by patient zip code and classified according to the Rural-Urban Commuting Area Codes) [24,25], and substances used for self-harm.

### 2.3. Outcomes

Our primary outcome was all-cause mortality within three years of the MedTox consultation. Our secondary outcomes were a subsequent MedTox consultation for a self-harm attempt, suicide-specific mortality, overdose-specific mortality, and pharmaceutical agents used for self-harm.

### 2.4. Analyses

We report descriptive statistics of demographic and clinical characteristics of patients for whom MedTox consultation was completed. We determined, a priori, that we would conduct descriptive assessments if the prevalence of our outcome was rare (<10%), while conducting multivariate logistic regression to identify demographic (sex, age at consultation, geography) and clinical characteristics (substances used for self-harm) if the prevalence of all- or cause-specific mortality was higher in this sample.

As a secondary analysis, we evaluated whether select pharmaceutical agent ingestions differed by age. For the most commonly occurring pharmaceutical agents, we evaluated the unadjusted odds ratio (uOR) and 95% confidence intervals (CI) associated with age group (10–17 years vs 18–24 years) and ingestion of these agents through logistic regression.

## 3. Results

Four patients (<1%) died within three years of the MedTox consult (Table 1); three died by suicide. Among these four, two died by asphyxiation, one died by intentional overdose, and one died secondary to complications from chronic medical conditions. Two of the patients who died by suicide previously used bupropion in a self-harm attempt. Between the index self-harm attempt resulting in the MedTox consultation and the completed suicide, one patient had a subsequent intentional overdose. These patients had a time to death between under 1 year to over 2 years after initial MedTox consult.

We included 1147 patients who had a total of 1295 consultations (Table 2). Females accounted for 71% of encounters. Patients aged 10–17 years accounted for 63% of the consults with ages 14–17 years making up the majority (51%) of consults. Over a third (36%) of patients ingested more than one substance. The most commonly identified substances during MedTox consultation included acetaminophen (26%), diphenhydramine (9%), and ibuprofen (8%). Forty percent of the substances reported are available without a prescription (e.g., acetaminophen, diphenhydramine, ibuprofen). When comparing the cases by age, 18–24-year-olds were more likely to ingest trazodone (uOR: 1.87; 95% CI: 1.15–3.05) and hydroxyzine (uOR: 2.10; 95% CI: 1.23–3.59; Fig. 1). There was no association between age group and other commonly identified pharmaceutical substances.

## 4. Discussion

In this study of suicide and suicide risk assessment among adolescents and young adults who received a MedTox consultation service in the hospital, mortality was rare (0.35%). “Most consultations received were for female patients and for patients between the ages 14 and 17 years, highlighting the most vulnerable populations within this study. A significant proportion (36%) of these overdoses were polysubstance, with the most commonly reported ingestion as acetaminophen (26%). Notably, of the patients who died, this was within three years of their index visit, only one of which had a repeated presentation to the hospital for a self-poisoning.

The observed mortality was lower compared to other studies that have explored rates of suicide completion after a self-harm attempt (0.7–13.3%) [5–9]. Although a relatively low mortality rate was observed and might suggest a favorable outcome in adolescents and young adults with self-poisoning events, younger age should not be perceived as a protective risk factor because our study did not evaluate the demographics of patients who did not present to the hospital and were not seen by the MedTox service but had a suicide attempt. In this study, the mortality rate was found to be lower than previously published studies; perhaps due to hospital factors such as how patients who commit self-harm are evaluated, counseled, and cared for after their initial

**Table 1**

Characteristics of patients who died among those who received a medical toxicology service consultation.

Patient	Gender	Age at encounter (yrs)	Age at death (yrs)	Patient transferred	Rural	Time to death from first encounter (yrs)	Subsequent encounters from first self-harm consult	Agents used*	Suicide death
1	F	10–13	10–13	Yes	No	<1	Yes	bupropion, hydroxyzine	Yes
2	M	18–24	18–24	No	No	2.3	No	acetaminophen, alprazolam, clonazepam, oxycodone	Yes
3	F	18–24	18–24	Yes	No	1.6	No	bupropion	Yes
4	F	14–17	14–17	Yes	Yes	1.8	No	aspirin, iron, mycophenolate, tacrolimus	No

\* Agents responsible for the medical toxicology consultation.

**Table 2**

Characteristics of patients presenting with self-harm.

Characteristics and Substances	n	%	n	%
Total <sup>a</sup>	1295	100.0		
Gender				
Females	922	71.2		
Males	350	27.0		
Other	23	1.8		
Age (Years)				
10–17	816	63	154	11.9
			662	51.1
18–24	479	37	326	25.2
			153	11.8
Substances <sup>b,c</sup>				
polysubstance	468	36.1		
acetaminophen	332	25.6		
diphenhydramine	110	8.5		
ibuprofen	102	7.9		
fluoxetine	96	7.4		
hydroxyzine	92	7.1		
sertraline	74	5.7		
bupropion	72	5.6		
trazodone	68	5.3		
escitalopram	62	4.8		
alcohol	61	4.7		
aspirin	61	4.7		
unknown	47	3.6		
quetiapine	34	2.6		
alprazolam	34	2.6		
lamotrigine	33	2.5		
aripiprazole	32	2.5		
venlafaxine	32	2.5		
dextromethorphan	30	2.3		
methylphenidate	27	2.1		
caffeine	26	2.0		
citalopram	21	1.6		
duloxetine	21	1.6		
buspirone	20	1.5		
hydrocodone	20	1.5		
naproxen	19	1.5		
guanfacine	18	1.4		
clonidine	18	1.4		
propranolol	17	1.3		
amitriptyline	17	1.3		
risperidone	16	1.2		
cyclobenzaprine	15	1.2		
lorazepam	15	1.2		
lisdexamfetamine	14	1.1		
marijuana	14	1.1		
oxcarbazepine	14	1.1		
prazosin	14	1.1		
valproic acid	14	1.1		
amphetamine-dextroamphetamine	13	1.0		
lithium	13	1.0		

<sup>a</sup> Total number of encounters. A patient may have more than one encounter.<sup>b</sup> Substances identified in at least 1 % of cases are listed and may include single or polysubstance ingestions.<sup>c</sup> Includes all encounters from a total of 1147 patients.

presentation. In this study, most patients who presented with an intentional overdose were evaluated by an emergency team, the MedTox service, and subsequently a psychiatric evaluation that either led to inpatient hospitalization or outpatient services. In addition to the immediate acute medical needs of the patient, medical toxicologists are available to educate the patient and family on medication safety, discuss strategies to reduce future risk, recommend lock boxes or other physical safety measures, and provide anticipatory interdisciplinary collaboration with primary providers and psychiatrists to identify medications that are comparatively less dangerous in a future overdose scenario. Social workers were available to help with facilitating these follow up appointments or provide resources for patients who were lacking the appropriate medical insurance coverage. This demonstrates a pivotal intervention point and necessitates a robust, ongoing care plan for those who suffer from suicidal ideation.

A considerable percentage of these patients used easily available, over-the-counter substances, suggesting that messaging to prescribers may play a limited part in future solutions to curb self-harm via intentional ingestion. Interestingly, there was also no significant change in the use of most prescription substances by age. We believe it is important to note that this cohort did not use different substances to self-harm as they entered adulthood where they presumably had more independence and a wider range of obtainable substances.

We believe this work may serve as a model for larger, multicenter studies investigating what might influence mortality risk in this population. For example, of the four patients who died, only one had repeat consultations with the MedTox service, suggesting that they may not seek help with future attempts or may not receive a subsequent medical evaluation before completion of suicide. Due to the small number of completed suicides in this study however, this is uncertain. Future studies should be aimed at exploring this relationship to see if this trend persists in a larger scale. The data reported here also suggests the groups who are at highest risk for consultation and would potentially benefit from early intervention to prevent an initial self-harm attempt; specifically, female patients and patients aged between the ages 14 and 17 years. Given that this prevalence continues to grow [19,21], a larger study would provide the benefit of evaluating whether this trend continues among those who go on to complete suicide.

One of the key strengths of this study was the use of the NDI database, which increased accuracy in outcome ascertainment. Without the use of these data, current research does not include individuals who die before arrival to the hospital, leading to an underreporting bias inherent to hospital-only datasets. Linking other patient cohorts with self-harm risk as reported in the NDI database may better identify completed suicides and obtain the most accurate data on those who are at highest risk.

#### 4.1. Limitations

Our study had some limitations. First, this study was conducted at a hospital with a MedTox consult service; the role of this service, available resources, and post-discharge follow-up instructions could vary across

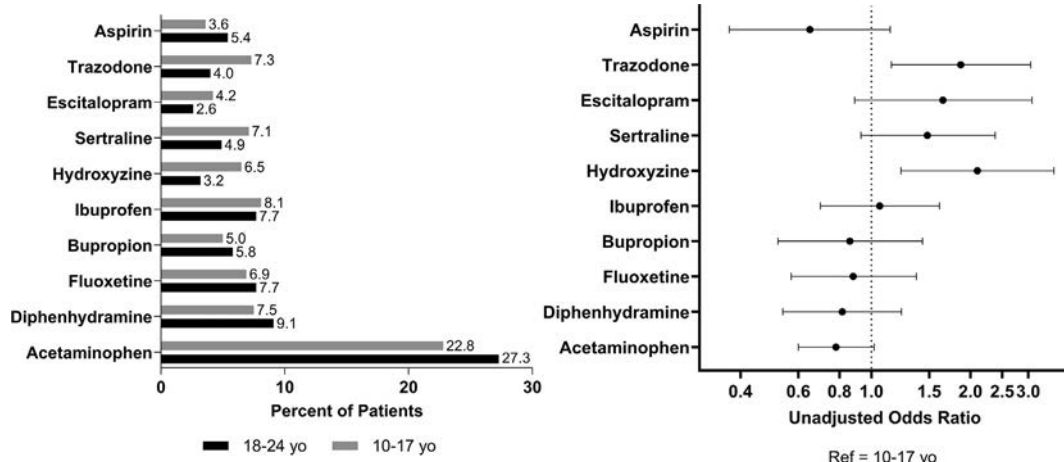


Fig. 1. Association between age (<18 years and ≥ 18 years) and ingestion of select pharmaceutical substance for self-harm.

institutions, which could subsequently impact findings. Second, as there are multiple layers of care provided to these patients at our institution, it remains unclear whether the low rate in future suicide completion resulted from the MedTox consultation or other factors. Third, even though it is expected that MedTox is consulted on self-harm attempts through poisoning at this institution, there may have been some cases where MedTox was not consulted. Fourth, the individual who determined cases to be for self-harm may have introduced some bias into the cohort. Attempts to reduce this were made by searching the chart for the terms “self-harm”, “intentional”, or “suicide.” Fifth, even though the NDI is the national repository for death reports, there could be some cases not reported to the NDI. Sixth, this was a retrospective review of an electronic database and medical record. This introduces limitations similar to any retrospective study. Finally, we were not able to stratify by self-harm intent at the time of MedTox consult. This is noteworthy, as at least one study by Rojas et al. found that the “lethality” (based on the Columbia-Suicide Severity Rating Scale) of an index self-harm attempt was associated with subsequent suicide completion in the future [26].

## 5. Conclusion

The rate of completed suicide was rare in this cohort of patients who survived an initial self-harm attempt and were evaluated by a medical toxicologist. As intentional self-poisonings often necessitate a medical evaluation, a presentation due to overdose can serve as an opportunity for providers across the United States to prevent future completed suicides by identifying those at highest risk. We believe the benefits associated with incorporating multidisciplinary services into the care of patients suffering from self-harm may have played a role in the low mortality in this patient population, though it is unclear at this time. Future studies should be conducted among larger populations to be able to appropriately sub-stratify those at the highest risk for future suicide completion. We also believe that future studies should compare outcomes between institutions with and without a MedTox consult service.

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## Consent of patients

This study was approved by Institutional Review Board at the University of Iowa.

## CRediT authorship contribution statement

**Michael Wallum:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **J. Priyanka Vakkalanka:** Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Sydney Krispin:** Writing – review & editing, Writing – original draft, Supervision, Project administration. **Daniel J. McCabe:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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