IMPORTANCE  Suicide is the tenth leading cause of death in the United States, and its rate has risen by 16% in the past decade. Deliberate self-poisoning is the leading method of attempted suicide. Unlike more violent methods, which are almost universally fatal, survival following self-poisoning is common, providing an opportunity for secondary prevention. However, the long-term risk of suicide following a first episode of self-poisoning is unknown.

OBJECTIVE  To determine the risk of suicide and mortality from other causes following a first self-poisoning episode.

DESIGN, SETTING, AND PARTICIPANTS  Population-based cohort study using multiple linked health care databases. We identified all individuals with a first self-poisoning episode in Ontario, Canada, from April 1, 2002, through December 31, 2010, and followed up all surviving participants until December 31, 2011, or death, whichever occurred first. For each individual with a deliberate self-poisoning episode, we randomly selected 1 control from the same population with no such history, matched for age (within 3 months), sex, and calendar year.

MAIN OUTCOMES AND MEASURES  The primary analysis examined the risk of suicide following discharge after self-poisoning. The secondary analyses explored factors associated with suicide and examined the risk of death caused by accidents or any other cause.

RESULTS  We identified 65,784 patients (18,482 [28.1%] younger than 20 years) who were discharged after a first self-poisoning episode. During a median follow-up of 5.3 years (interquartile range, 3.1-7.6 years), 4176 died, including 976 (23.4%) by suicide. The risk of suicide following self-poisoning was markedly increased relative to controls (hazard ratio, 41.96; 95% CI, 27.75-63.44), corresponding to a suicide rate of 278 vs 7 per 100,000 person-years, respectively. The median time from hospital discharge to completed suicide was 585 days (interquartile range, 147-1301 days). Older age, male sex, multiple intervening self-poisoning episodes, higher socioeconomic status, depression, and recent psychiatric care were strongly associated with suicide. Patients with a self-poisoning episode were also more likely to die because of accidents (hazard ratio, 10.45; 95% CI, 8.10-13.47) and all causes combined (hazard ratio, 5.55; 95% CI, 5.12-6.02).

CONCLUSIONS AND RELEVANCE  A first self-poisoning episode is a strong predictor of subsequent suicide and premature death. Most suicides occur long after the index poisoning, emphasizing the importance of longitudinal, sustained secondary prevention initiatives.
Suicide is a global public health concern, claiming more than 1 million lives each year. In the United States, suicide rates have increased by more than 16% during the past decade, suggesting that current prevention strategies have limited effect. Suicide accounts for more than 38,000 deaths and approximately 1.5 million years of life lost annually and is the tenth leading cause of death in the United States, ahead of traffic fatalities, liver disease, and sepsis. In Canada, suicide is the second leading cause of death in individuals aged 15 to 35 years, comparable with rates in the United States (0.8 and 12.7 per 100,000 persons, respectively). Worldwide, there are approximately 20 attempts for every completed suicide. Aside from the loss of life, suicide can have devastating consequences for the family, friends, and community of the deceased.

Deliberate self-poisoning is the most common method of attempted suicide, accounting for 85% to 95% of suicide-related hospital admissions. Although the intent of lethality varies widely, self-poisoning accounts for roughly 1 in 300 visits to North American emergency departments and generates substantial costs to the health care system. Surviving patients are at risk for repeated suicide attempts using more violent means, which are frequently fatal. However, the magnitude and temporal course of this risk have not been well characterized.

Limited understanding of the risk factors and motivation for self-harm makes suicide prevention one of the most challenging areas in clinical practice, leading some experts to suggest that suicide prevention is an elusive public health goal. Screening instruments for suicide often fail to predict completed suicide, and optimal follow-up recommendations for at-risk patients have not been established. Yet health care professionals, psychiatrists in particular, are often called on to predict and, by extension, prevent suicide, particularly in patients who have previously harmed themselves. Evidence regarding risk factors for suicide after a self-harm episode is sparse.

Because little is known about the long-term outcomes of patients who have self-poisoned, attention has traditionally focused on the immediate postattempt period. We sought to determine the risk of suicide and other causes of mortality following a first self-poisoning episode in a large population over a decade.

**Methods**

**Setting**

Using multiple linked health care databases, we conducted a population-based cohort study of all residents of Ontario, Canada’s most populous province. Our roughly 13 million residents have access to universal health care, including physicians’ services and hospital care. The study was approved by the Research Ethics Board of Sunnybrook Health Sciences Centre and the requirement for patient consent was waived.

**Data Sources**

We identified all emergency department visits and hospitalizations for deliberate self-poisoning using the National Ambulatory Case Reporting System and the Canadian Institute for Health Information Discharge Abstract Database, respectively. We obtained physician claims data from the Ontario Health Insurance Plan database and demographic information from the Registered Persons Database. We ascertained vital statistics using the Ontario Registrar General-Death database, which contains the manner and cause of death of all fatalities up to December 31, 2011. For Ontarians who die of unnatural causes, including suicide, a coroner’s investigation determines the official cause of death and is registered in this database. These databases were linked in an anonymous fashion using encrypted identifiers and are routinely used to study health outcomes at the population level.

**Study Participants**

We identified all individuals who attended an emergency department or were admitted to the hospital for a first episode of deliberate self-poisoning in Ontario between April 1, 2002, and December 31, 2010. All surviving participants were followed up until death or the end of the study period (December 31, 2011), whichever occurred first. Volition of self-poisoning was determined using external cause-of-injury codes (codes X60–X69) in the *International Classification of Diseases, Tenth Revision*. To focus exclusively on the first episode, we restricted our analysis to patients with a first self-poisoning episode.
Results

During the 10-year study period, we identified 72,509 individuals who presented to the hospital with deliberate self-poisoning. We excluded 60,479 (8.3%) with a previous episode of self-poisoning in the preceding 10 years as well as 128 non-Ontarians and 26 individuals with incomplete data. Of the remaining 66,308 patients, 28,732 (43.3%) were hospitalized, most (18,151 [62.2%]) in critical care units. Overall, 5,241 patients (0.7%) died in the hospital following their first self-poisoning episode.

Our remaining analyses focused on the 65,784 patients who survived until hospital discharge. The median age at discharge following a first self-poisoning episode was 32 years (interquartile range, 20-45 years) and almost two-thirds (61.7%) were women. These patients were followed up for a median of 5.3 years (interquartile range, 3.4-7.6 years) and a cumulative follow-up of 349,904 person-years. The characteristics of the cohort are shown in Table 1.

Suicide Following Discharge After Self-poisoning

Of the 65,784 patients discharged following self-poisoning, 4,176 died during follow-up, including 976 (23.4%) of all deaths who committed suicide. The risk of suicide following self-poisoning was more than 40-fold higher than among population-based controls (hazard ratio, 41.96; 95% CI, 27.75-63.44), corresponding to a suicide rate of 278 per 100,000 person-years vs 7 per 100,000 person-years, respectively (Table 2 and Figure 1). The median time from hospital discharge to completed suicide was 585 days (interquartile range, 147-1,301 days). Of the 976 suicide deaths, 107 were teenagers, representing most of the 188 fatalities in this age group, with a median time of 789 days (interquartile range, 388-1,529 days) between the first self-poisoning episode and suicide. Of 107 suicides by teenagers following a self-poisoning episode, 21 (19.6%) eventually committed suicide by overdose. In contrast, only 1 suicide and 34 total deaths were recorded in the respective teenage control group. Overall, in 40.9% (n = 399) of completed suicides following a first self-poisoning episode, overdose was the eventual mechanism (eTable 1 in the Supplement). Most (371 [93.0%]) died in the prehospital setting.

Predictors of Suicide

The strongest predictor of eventual suicide following deliberate self-poisoning was advanced age, with risk increasing in a monotonic fashion across each decade of adult life (P < .001).
Other risk factors included male sex, multiple intervening self-poisoning episodes, higher socioeconomic status, a formal diagnosis of depression, and psychiatric care in the year preceding the first self-poisoning episode. A diagnosis of alcohol dependence was not independently associated with suicide (Table 3).

Overall Mortality
All-cause mortality following self-poisoning was 1107 per 100,000 person-years compared with 237 per 100,000 person-years in the control group (hazard ratio, 5.55; 95% CI, 5.12-6.02) (Figure 2). Nearly half (1885 [45.1%]) of all deaths following self-poisoning resulted from suicides, accidents, or undetermined intent (Table 2). Of note, the risk of accidental death was more than considerably higher among self-poisoning survivors relative to controls (hazard ratio, 10.45; 95% CI, 8.10-13.47) (Table 2), as was the risk of death caused by natural progression of disease (Table 2). eTables 1 and 2 in the Supplement detail the specific mechanisms of suicidal and accidental death in both cohorts.

Discussion
In this population-based study, we found that a first hospital presentation for self-poisoning is a powerful predictor of subsequent suicide and premature death. The interval from the first self-poisoning episode to suicide was longer than 18 months in most cases. While nearly all individuals survive their first hospital presentation for self-poisoning, the risk of subsequent suicide was more than 40-fold higher in these patients than among population-based controls. Suicide accounted for one-fourth of all fatalities in this group during the following decade, suggesting a major opportunity for secondary prevention. Older age, male sex, multiple self-poisoning episodes, higher income, depression, and prior psychiatric care were strong predictors of suicide following a first self-poisoning episode. A recent review of suicide studies not restricted to self-poisoning reported that older age, suicidal ideation, and previous suicide attempts were the strongest predictors of completed suicide, while living alone, male sex, and alcohol abuse were weaker predictors.

We also found that self-poisoning was associated with a markedly increased risk of accidental death, which, together with suicide, accounted for nearly half of all deaths in the following decade. We suspect that some accidental deaths or deaths of undetermined intent are, in fact, suicides that were not classified as such by investigating coroners in the absence of definitive proof of intent. Examples include falls from height or motor vehicle collisions without a suicide note. In addition, we observed an increased rate of death caused by progression of underlying disease in the self-poisoning cohort (Table 3). Previous research suggests that social deprivation and underuse of medical care contribute to this observation in patients who survive self-poisoning and other types

Table 3. Factors Associated With Suicide Following a Deliberate Self-poisoning Episode

<table>
<thead>
<tr>
<th>Variable</th>
<th>Adjusted Hazard Ratio (95% CI)^a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recurrent self-poisoning</td>
<td>1 [Reference]</td>
</tr>
<tr>
<td>Yesb</td>
<td>2.85 (2.45-3.32)</td>
</tr>
<tr>
<td>Age group, y</td>
<td></td>
</tr>
<tr>
<td>≤20</td>
<td>1 [Reference]</td>
</tr>
<tr>
<td>21-30</td>
<td>1.71 (1.32-2.20)</td>
</tr>
<tr>
<td>31-40</td>
<td>2.57 (2.02-3.25)</td>
</tr>
<tr>
<td>41-50</td>
<td>3.09 (2.45-3.89)</td>
</tr>
<tr>
<td>51-60</td>
<td>4.60 (3.60-5.88)</td>
</tr>
<tr>
<td>61-70</td>
<td>4.85 (3.52-6.68)</td>
</tr>
<tr>
<td>&gt;70</td>
<td>5.10 (3.56-7.31)</td>
</tr>
<tr>
<td>Male sex</td>
<td>1.87 (1.64-2.13)</td>
</tr>
<tr>
<td>Income quintile</td>
<td></td>
</tr>
<tr>
<td>1 (Lowest)</td>
<td>1 [Reference]</td>
</tr>
<tr>
<td>2</td>
<td>1.18 (0.98-1.42)</td>
</tr>
<tr>
<td>3</td>
<td>1.24 (1.02-1.50)</td>
</tr>
<tr>
<td>4</td>
<td>1.29 (1.06-1.57)</td>
</tr>
<tr>
<td>5 (Highest)</td>
<td>1.36 (1.11-1.66)</td>
</tr>
<tr>
<td>Rural residence</td>
<td>1.02 (0.84-1.24)</td>
</tr>
<tr>
<td>Diagnosis of depression</td>
<td>1.15 (1.01-1.32)</td>
</tr>
<tr>
<td>Psychiatrist visit in previous year</td>
<td>1.65 (1.43-1.89)</td>
</tr>
<tr>
<td>Alcohol use disorder in previous year</td>
<td>0.98 (0.83-1.15)</td>
</tr>
</tbody>
</table>

^a Adjusted for recurrent self-poisoning, age, sex, income quintile, rurality, psychiatrist visit in the previous year, alcohol use, and diagnosis of depression.

^b Time-varying covariate.
of self-harm,26 but various unmeasured determinants of health may also play a role.

Our finding that suicide risk persists long after the initial self-poisoning episode is of particular importance because it emphasizes the need for longitudinal surveillance and sustained secondary prevention initiatives in this high-risk population. Review evidence suggests that ongoing communication with patients following self-poisoning substantially reduces the subsequent risk of attempted and completed suicide.27,28 In contrast, short-term interventions have been largely unsuccessful at reducing suicide rates, particularly when guided by patient reports of suicidal intent.29 Self-reported suicide motivation is often unreliable, as evidenced by the high rate of suicide among psychiatric patients shortly after hospital discharge.30-33 Conversely, the predictors of suicide identified in our study are objective. Although some have been previously documented, those predictors can facilitate risk stratification following a first self-poisoning episode to better target prevention efforts.

Existing publications regarding the temporality and risk of suicide following deliberate self-harm are encumbered by limitations by examining a large population of patients for up to 10 years following a first self-poisoning episode or individual motivations of subsequent suicide. Some self-poisoning episodes may have been impulsive and not of fatal intent, particularly in younger people. As noted, the coroner’s determination of the manner of death is likely even higher than our study suggests.

Some limitations of our study merit emphasis. Our data sources do not permit a detailed exposition of the circumstances of each self-poisoning event or individual motivations of subsequent suicide. Some self-poisoning episodes may have been impulsive and not of fatal intent, particularly in younger people. As noted, the coroner’s determination of the manner of death likely underestimates suicide, in part because of the stigma associated with suicide and the financial consequences for the family. Therefore, the true incidence of suicide following self-poisoning is likely even higher than our study suggests.

Conclusions

We found that a first episode of deliberate self-poisoning is an exceedingly strong predictor of subsequent suicide and premature death. Suicide accounts for roughly 1 in 4 fatalities in the decade following self-poisoning. Many additional deaths are assigned an undetermined intent, suggesting that the true rate of subsequent suicide is even higher. Most suicides occur long after the index episode. Our findings regarding long-term suicide risk emphasize the need for sustained and focused prevention efforts, particularly in patients with objective risk factors.
Risk of Suicide Following Deliberate Self-poisoning

Original Investigation Research

**REFERENCES**

1. Bohanna I. Suicide “contagion”: what we know and what we need to find out. CMAJ. 2013;185(10): 861-862.


