

# Injury Hospitalization and Risks for Subsequent Self-Injury and Suicide: A National Study From New Zealand

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Research has identified several major risk factors for suicide<sup>1</sup> and medically serious self-harm.<sup>2</sup> The health care system is a critical setting for suicide prevention; studies of suicide decedents indicate that between 34% and 76% of these individuals see a primary care physician in the last month of their life.<sup>3</sup> Moreover, research has shown increased numbers of psychiatric and medical hospitalizations among suicide victims in the last year of their life.<sup>4</sup> It is unknown whether there are also increases in other aspects of health care use, such as injury hospitalizations.

Injury hospitalizations confer risk for subsequent injury hospitalizations<sup>5</sup> and may express a chronic risk for exposure to trauma.<sup>6</sup> However, much of the research in this area has focused on assaultive injury,<sup>5,7</sup> particularly among adolescents and young adults.<sup>7</sup> Data on previous injury hospitalizations and suicide are more limited. A US study<sup>8</sup> involving individuals aged 16 to 35 years revealed that suicide decedents, relative to age- and sex-matched controls, exhibited increased odds of previous hospitalizations owing to suicide attempts (odds ratio [OR]=56.0), unintentional injuries (OR=5.0), and assaults (OR=4.5). A controlled study conducted in Sweden<sup>6</sup> that examined treatment patterns during 20 years revealed increased rates of self-inflicted injuries and suicide among individuals who experienced firearm injuries.

In the present study, we investigated a nationwide retrospective cohort of individuals residing in New Zealand to determine whether hospitalizations for assaultive injuries, unintentional injuries, and injuries with undetermined causes conferred risks for subsequent self-injury hospitalizations and suicide. We presumed that elevated risks would be associated with previous self-injury hospitalizations. We also examined age, race/ethnicity, and sex patterns.

**Objectives.** Risks for suicide and nonfatal self-injury hospitalizations associated with previous injury hospitalizations were investigated in a nationwide retrospective cohort study conducted in New Zealand.

**Methods.** Linked data from all New Zealand public hospitals were used to identify individuals with injury hospitalizations. Participants were followed for 12 months.

**Results.** Significantly increased age- and sex-adjusted relative risks for suicide were associated with previous hospitalization for self-injury, injuries of undetermined causes, and assault. Also, elevated risks were associated with these causes of hospitalization in the case of subsequent self-injury hospitalizations.

**Conclusions.** Results indicate that identifiable subgroups of individuals hospitalized for injuries are at marked risk for serious suicidal behavior and suggest the potential of targeted suicide prevention for these individuals. (*Am J Public Health.* 2003;93:1128–1131)

## METHODS

Data on injury hospitalization exposures and subsequent self-injury hospitalizations were obtained from the New Zealand National Minimum Dataset (NMDS), a single integrated collection of secondary and tertiary health data maintained by the New Zealand Health Information Service (NZHIS). The NMDS was developed in consultation with health sector representatives to inform health care policy, monitor and evaluate policy implementation, perform monitoring and evaluation, measure health status, and meet international requirements.

Information about all outpatients and inpatients discharged from public hospitals is supplied directly to the NMDS via hospital-based computer systems. We excluded outpatients from our analyses because the changes in reporting policies regarding these patients that have occurred over time were likely to introduce bias. The data supplied to NMDS include information on diagnoses, diagnostic and therapeutic procedures, and demographic characteristics. In the case of all injury and poisoning diagnoses, circumstances of injury were classified according to *International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM)* external causes of injury

and poisoning codes (E codes) and nature of injury codes.<sup>9</sup>

Because private hospitals do not consistently use E code discharge data, we analyzed public hospital discharges. This introduced minimal bias, because the vast majority of individuals injured and requiring acute inpatient treatment in New Zealand are admitted to public hospitals.<sup>10</sup> In recent years, the private sector has played an increasing role in the delivery of inpatient health services, but the most recent statistics from NZHIS suggest that service delivery in regard to acute management of injuries requiring inpatient treatment has remained unchanged.<sup>11</sup>

New Zealand national mortality data from 1997 and 1998 were used to determine suicide outcomes. These data, also obtained from NZHIS, involved the same personal identification and coding information as the hospitalization data, so we were able to determine whether a patient hospitalized in 1997 subsequently died in 1997 or 1998. E codes allowed us to determine causes of death.

## Definitions of Exposure and Nonexposure

The exposure group was defined as individuals first discharged from a New Zealand hospital during 1997 with a diagnosis of acute injury or poisoning (*ICD-9-CM* codes

E800–E999). We created 4 mutually exclusive categories of exposure: self-injury (E950–E958), assaultive injury (E960–E968), unintentional injury (excluding assaultive injury and self-injury; E800–E869, E880–E928), and injury of undetermined cause (E980–E988). Exclusion criteria were injuries suffered through medical or surgical procedures, “late effect” cases in which effects occurred more than 12 months after the initial injury, and injuries resulting from legal interventions.<sup>5</sup>

New Zealand’s health information records capture nearly all hospitalizations that occur throughout the country.<sup>10</sup> Given the small percentage of the exposure group (1.3%) relative to the overall population of New Zealand, the characteristics of the entire population were considered to be the same as those of the unexposed population. Therefore, the unexposed group was defined through the use of census data.<sup>12</sup>

### Outcomes and Follow-Up

The outcomes analyzed were (1) nonfatal self-injury hospitalizations and (2) suicide. In the case of both hospital and mortality data, E codes were used to determine causes of injury. Personal identifiers determined whether individuals were included in both data sets. A small minority of included individuals had more than 1 relevant outcome (0.53%) during the follow-up period. Such individuals contributed only 1 outcome (the earliest) to the present analysis. Individual exposure group cases (i.e., cases among those hospitalized in 1997 for an injury) were examined over the 12 months following the index injury. In the case of the unexposed group, the 12-month follow-up comprised all of 1998.

### Stratification and Variable Definitions

Sex and age were the key stratification variables. Age categories (0–9, 10–19, 20–29, 30–39, 40–49, and more than 49 years) were consistent with those used in an earlier investigation of injury hospitalizations in New Zealand.<sup>5</sup> The upper category of more than 49 years was justified by the low rates of hospitalizations for assaultive injury and self-injury observed among older adults. Race/ethnicity was categorized as Maori (14.9%), Pacific Islander (5.8%), and “other” (79.2%). The “other” category was composed as fol-

**TABLE 1—Selected Characteristics of 1997 New Zealand Population, by Injury Status**

	No Injury (n = 3 711 327), No. (%)	Hospitalized, Any Injury (n = 49 683), No. (%)	Hospitalized, Assaultive Injury (n = 2517), No. (%)	Hospitalized, Self-Injury (n = 2728), No. (%)	Hospitalized, Unintentional Injury (n = 44 269), No. (%)
<b>Sex</b>					
Male	1 824 073 (49.1)	29 677 (59.7)	2037 (80.9)	1007 (36.9)	26 546 (60.0)
Female	1 887 254 (50.9)	20 006 (40.3)	480 (19.1)	1721 (63.1)	17 723 (40.0)
<b>Age, y</b>					
0–9	585 628 (15.8)	9 162 (18.4)	90 (3.6)	2 (0.1)	9 061 (20.5)
10–19	533 433 (14.4)	8 847 (17.8)	602 (23.9)	644 (23.6)	7 562 (17.1)
20–29	548 446 (14.8)	8 534 (17.2)	939 (37.3)	813 (29.8)	6 728 (15.2)
30–39	594 003 (16.0)	6 337 (12.8)	529 (21.0)	605 (22.2)	5 171 (11.7)
40–49	515 603 (13.9)	4 257 (8.6)	234 (9.3)	378 (13.9)	3 627 (8.2)
> 49	934 214 (25.2)	12 546 (25.3)	123 (4.9)	286 (10.5)	12 120 (27.4)
<b>Race/ethnicity</b>					
Other <sup>a</sup>	2 939 995 (79.2)	39 815 (80.1)	1 652 (65.6)	2 252 (82.6)	35 781 (80.8)
Maori	553 130 (14.9)	7 570 (15.2)	688 (27.3)	398 (14.6)	6 451 (14.6)
Pacific Islander	218 202 (5.9)	2 298 (4.6)	177 (7.0)	78 (2.9)	2 037 (4.6)

Note. The data shown include only the first nonexcluded injury of record in 1997; subsequent 1997 admissions are excluded.  
<sup>a</sup>Primarily White (82%).

lows: White (82.2%), “not stated” (5.2%), other Asian (2.9%), and other non-White (9.7%). Pacific Islanders were primarily Samoan (52.1%), Tongan (18.1%), and Cook Island Maori (14.4%).

### Data Analysis

We calculated incidence rates (per 100 000 population per year) by dividing the number of individuals with self-injury outcomes by the number of person-years of follow-up. Stratified age- and sex-adjusted incidence rates were calculated via the direct method.<sup>13</sup> The New Zealand population was used as the standard.<sup>12</sup> Mantel–Haenszel methods were used to calculate age- and sex-adjusted relative risks (RRs) and 95% confidence intervals (CIs).

## RESULTS

Characteristics of exposed and nonexposed participants stratified by sex, age, and race/ethnicity are presented in Table 1. There were insufficient cell sizes to examine exposures to undetermined-cause injury. Relative risks and 95% confidence intervals for subsequent nonfatal self-injury hospitalizations associated with injury hospitalization exposures

are presented in Table 2. The relative risk of a self-injury hospitalization associated with previous hospitalization for self-injury (175.7) was substantial. Relative risks associated with previous assaultive injuries (9.2), unintentional injuries (5.6), and injuries resulting from undetermined causes (13.7) also were elevated. Results of analyses in which suicide was the outcome are shown in Table 3. Substantial relative risks for suicide were associated with previous self-injury hospitalizations (105.4) and hospitalizations for injuries of undetermined causes (164.1); in addition, elevated risks were associated with previous assault hospitalizations (10.4) but not unintentional injuries.

Relative risks for self-injury hospitalizations and suicide associated with previous hospitalizations stratified by sex (adjusted for age) and race/ethnicity (adjusted for age and sex) were also calculated (data not shown). This analysis produced only 2 statistically significant findings: risks for nonfatal self-injury hospitalizations associated with previous self-injury hospitalizations were higher for women than for men (RR=1.7; 95% CI=1.3, 2.2), and such risks were lower for Pacific Islanders than for members of the “other” race/ethnicity category (RR=0.2; 95% CI=0.1, 0.3).

**TABLE 2—Incidence and Relative Risk of Nonfatal Hospitalization for Self-Injury, by Exposure: New Zealand, 1998**

Group	No.	No. Hospitalized for Self-Injury <sup>a</sup>	Incidence Rate per 100 000 Persons <sup>b</sup>	Relative Risk <sup>c</sup> (95% Confidence Interval)
Total population	3 761 010	3625	82.6	...
Previous hospitalization				
None <sup>d</sup>	3 711 327	2637	71.0	1.0
Any injury	49 683	494	1 434.5	20.5 (18.8, 22.3)
Self-injury	2 728	341	11 096.6	175.7 (155.0, 199.1)
Assault	2 517	20	646.7	9.2 (5.6, 14.9)
Unintentional	44 269	128	399.3	5.6 (4.8, 6.6)
Undetermined	169	5	962.2	13.7 (2.9, 64.1)

<sup>a</sup>Excludes self-injury resulting in death.<sup>b</sup>Age and sex adjusted, incidence per 100 000 person-years.<sup>c</sup>Age and sex adjusted, calculated via Mantel-Haenszel method.<sup>d</sup>Includes those whose 1997 exposure injury was an exclusion and those in 1998 with assaultive injury but no 1997 exposure.**TABLE 3—Incidence and Relative Risk of Suicide, by Exposure: New Zealand, 1998**

Group	No.	No. Fatal Self-Injuries <sup>a</sup>	Incidence Rate per 100 000 Persons <sup>b</sup>	Relative Risk <sup>c</sup> (95% Confidence Interval)
Total population	3 761 010	644	15.4	...
Previous hospitalization				
None <sup>d</sup>	3 711 327	520	14.0	1.0
Any injury	49 683	62	155.3	11.1 (8.7, 14.1)
Self-injury	2 728	39	1457.5	105.4 (76.2, 145.9)
Assault	2 517	5	145.7	10.4 (3.7, 29.1)
Unintentional	44 269	12	25.4	1.8 (1.0, 3.3)
Undetermined	169	6	2251.0	164.1 (59.2, 455.2)

<sup>a</sup>Excludes nonfatal self-injury resulting in hospitalization.<sup>b</sup>Age and sex adjusted, incidence per 100 000 person-years.<sup>c</sup>Age and sex adjusted, calculated via Mantel-Haenszel method.<sup>d</sup>Includes those whose 1997 exposure injury was an exclusion and those in 1998 with assaultive injury but no 1997 exposure.

injury hospitalizations. The relative risks for subsequent suicide (RR=10.4) and self-injury hospitalization (RR=9.2) associated with assaultive injury hospitalizations indicate that previous assaultive injury is a potent risk factor for serious suicidal behavior. This is not surprising given the risk factors common to assaultive injury and suicide, including alcohol use disorders,<sup>1,15</sup> marital and interpersonal conflicts,<sup>2,16</sup> and exposure to abuse during childhood.<sup>17,18</sup> However, it remains unclear whether the deleterious effects of assaultive injury play a direct causal role in suicide and in self-injuries requiring hospitalization, whether they are mediated by other factors (e.g., posttraumatic symptoms), or whether they merely serve as variable markers not related causally to suicide risk. More studies of the mechanisms underlying this association are needed, including investigations of whether it is the physical effects or the psychological effects of assaultive injury that are most salient to subsequent self-harm.

#### Undetermined-Cause Injury Exposure

Previous injury hospitalizations resulting from undetermined causes were associated with a large relative risk for suicide (164.1). Perhaps there was a bias to classify self-injury cases as originating from undetermined causes owing to withholding of information by patients committing acts of self-harm or to reluctance among clinicians to acknowledge self-inflicted injuries. Our data suggest that individuals at risk for completed suicide may be especially prone to obscure the cause of their injuries. Self-injurious behavior has been shown to be prone to misclassification,<sup>19</sup> and this may be particularly true in the case of populations prone to injury.<sup>20</sup> It is also possible in the present study that certain assault victims, particularly abused children and women experiencing domestic violence, withheld the cause of their injuries and were thus overrepresented in the undetermined-cause injury group. Regardless of the explanation, individuals hospitalized as a result of injuries of undetermined causes require targeted suicide prevention efforts.

#### CONCLUSIONS

Relative risks for suicide and self-injury hospitalization associated with unintentional

## DISCUSSION

### Self-Injury Exposure

Previous studies examining increased risks for suicidal behavior associated with previous suicide attempts have defined previous attempts broadly and examined risks for suicidal behavior associated with a lifetime history of attempts.<sup>2</sup> Limiting the exposure period and restricting the definition of suicidal behavior to acts necessitating hospitalization provided unique data about 1-year risks for medically serious suicidal behavior associated with nonsuperficial self-injuries. Research on risk of suicidal behavior associated with previous attempts has also often been limited by a

reliance on proxy reports and self-reports of previous suicidal behavior, which may be prone to retrospective biases.<sup>14</sup> Our use of a national database obviated this problem. Although elevated risks were expected, the huge relative risks for suicide (105.4) and nonfatal self-injury hospitalizations (175.7) associated with previous self-injury hospitalizations are alarming. Individuals hospitalized after acts of self-harm require aggressive follow-up.

### Assaultive Injury Exposure

To our knowledge, this was the first population-based, cross-age study to provide estimates of risk of suicide and self-injury hospitalizations associated with previous assaultive

injury did not approach the magnitude of the other injury exposures. Suicide prevention efforts targeted toward individuals exposed to unintentional injuries may have little impact on prevention of serious suicidal behavior. In contrast, the very high relative risks for suicidal behavior associated with self-inflicted injuries and injuries of undetermined cause demand the development and assessment of suicide prevention strategies aimed at all such patients. Moreover, as demonstrated in this study, morbidity and mortality rates are high among persons exposed to assault, because these individuals are prone to subsequent assaults<sup>5,7</sup> as well as other causes of injury and death, including self-harm. Therefore, rigorous injury prevention efforts targeted toward assaultive injury patients are needed and should include a focus on suicide prevention.

Limitations of this study included the potential for misclassification of injury exposures and misclassification of subsequent suicide and self-injury hospitalization. There may have been significant underreporting of self-harm in the hospital data. In addition, information on other important characteristics of exposed participants (e.g., socioeconomic status, marital status, psychiatric diagnoses) was unavailable. Intent and medical lethality of suicidal behavior are correlated highly but not perfectly; thus, the choice to limit the measure of suicidal behavior to that resulting in hospitalization or death served to exclude some individuals committing acts of self-harm with the intent to die.

In the United States, unlike New Zealand, firearms are the most common cause of fatal assaultive injuries<sup>21</sup> and suicides,<sup>22</sup> and the way in which the greater availability of firearms in the United States may affect the injury exposure–suicide relationship is unclear. There are also important racial and ethnic differences between these 2 countries. Still, the United States and New Zealand both have advanced health care systems, and a majority of their citizens are of European descent. Therefore, our findings are expected to generalize to a large degree to the US population.

This study provides data on risks for subsequent suicide and nonfatal self-injury hospitalizations associated with previous injury hospitalizations. Although there have been exceptions,<sup>2</sup> few previous studies have included information on risk factors for both

suicide and medically serious suicide attempts, and indeed the population of suicide attempters has been sorely underinvestigated. The present results indicate that identifiable subgroups of individuals hospitalized for injuries are at marked risk for serious suicidal behavior and illustrate the critical need for implementation and evaluation of targeted suicide prevention efforts aimed at these individuals. ■

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**Note.** The views and conclusions offered in this article are those of the authors and do not necessarily reflect those of the Health Research Council of New Zealand or the Accident Compensation Corporation.

#### Contributors

K.R. Conner planned the study and took the lead on article preparation. J. Langley provided the data, contributed to the planning of the study, and assisted in article preparation. K.J. Tomaszewski analyzed the data. Y. Conwell assisted in article preparation.

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#### Human Participant Protection

Secondary data sources were used devoid of personal identifiers; thus, informed consent was not necessary. The study was reviewed by the institutional review board at the University of Rochester, which determined that it met federal and university criteria for exemption.

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