Rural Trauma Recidivism

A Different Disease

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Hypothesis: Unlike the well-characterized urban trauma recidivist (RC), factors associated with the rural RC remain undefined. In an attempt to devise preventative strategies, we theorized that the rural RC profile would be similar to that of urban counterparts.

Design: Retrospective review.

Setting: Rural, university-affiliated, level I trauma center.

Patients: All trauma patients admitted between January 1, 1994, and December 30, 2002.

Interventions: Identification and characterization of rural trauma RCs.

Main Outcome Measures: Trauma recidivism incidence, risk factors, and cost.

Results: Of 15,370 consecutive admissions, 528 (3.4%) were RCs. Demographic comparisons to a non-RC cohort demonstrated rural RCs to be significantly older (mean ± SD age, 55.9 ± 24.8 vs 39.7 ± 24.1 years), disproportionately white (65.2% [344/528] vs 56.5% [8386/14,842]), and more likely female (49.1% [259/528] vs 37.3% [5537/14,842]) (P < .001 for all). Clinical comparisons revealed significant associations between recidivism and substance abuse. The percentage of positive blood ethanol screen results (58.7% [310/528] vs 39.9% [5923/14,842]) and the mean ± SD blood ethanol content (132.1 ± 139.9 mg/dL [28.7 ± 30.4 mmol/L] vs 69.5 ± 114.4 mg/dL [15.1 ± 24.8 mmol/L]) were higher for RCs (P < .001 for both). In addition, cocaine use was significantly higher in the RC cohort (6.4% [34/528] vs 4.1% [607/14,842]; P = .02). The total cost for all RC admissions exceeded $7 million.

Conclusions: The rural RC profile is strikingly different from urban counterparts. The common feature seems to be substance abuse. Correspondingly, prevention strategies for recidivism must be considerably different among rural and urban populations.

Arch Surg. 2007;142:77-81

TRAUMA REMAINS THE LEADING cause of death and disability in the United States during the first 4 decades of life. The staggering societal impact of injury, in cost and human suffering, has incited rapid growth in the field of injury prevention. Historically, trauma centers have focused on secondary prevention, the reduction of death and disability following injury. It has become well recognized that trauma, similar to other disease, affects identifiable high-risk groups. Correspondingly, the primary prevention of injury has become implicit in the development of integrated trauma systems. The identification of individuals at risk for injury has led to the development of preventative measures to reduce predisposing behavior.

Recurrent injury, or trauma recidivism, has been identified as a morbid and costly behavior to trauma centers. Most recidivism research in trauma has focused on the urban population. Studies in urban trauma recidivism have identified an incidence ranging from 6.4% to 52.0%, with a higher cited incidence manifest in populations composed primarily of penetrating and violent injury. Furthermore, consistent risk factors for recidivism within the urban population have been identified, including penetrating trauma, violent trauma, young age, substance abuse, and male sex.

Although recidivism research has included limited segments of rural populations, to our knowledge, no large studies exist that focus specifically on recidivism in a rural demographic. Kaufman and colleagues, in a population-based study of recidivism in Nevada, included rural patients. Although the population density of Nevada is low, the distribution of recidivists (RCs) between rural locales and major cities was not defined. Accordingly, the RC profile demonstrated in this study was similar to that exhibited in urban populations. Sayfan and Berlin assessed pre-
dictors of recurrent injury in rural northern Israel. This small case-controlled study, which was performed in a region with limited population demographics and negligible alcohol and other drug use, demonstrated an association between rural recidivism and youth, male sex, and previous trauma. Similarly, Williams and colleagues, focusing on recidivism in a rural emergency department, noted an association between recidivism and young age and lower socioeconomic status. The study was limited to an emergency department population and was conducted during a single year.

Given the well-demonstrated profile of the urban RC, in combination with a paucity of literature focusing specifically on large rural populations, the purpose of this study was 3-fold. First, we sought to define the incidence of trauma recidivism in a large, single-center, rural population. Second, we sought to characterize the rural RC compared with rural nonrecidivists (NRCs). Third, for the development of environment-specific preventative strategies, we sought to compare the rural RC profile with that of the urban population.

METHODS

All patients admitted to our rural, university, level I trauma center were eligible for study. Approval for the study was obtained from our institutional review board. All patients admitted a second time to the trauma center for distinct injury; patients admitted to the center for a distinct recurrent injury during the study period; patients readmitted for complications of original injury were excluded. Recidivists were subdivided into groups relative to number of admissions for recurrent injury. The RC2s were admitted a second time to the trauma center for distinct injury; RC3s, a third time; RC4s, a fourth time; and RC5s, a fifth time. The succession of admissions for RC2 through RC5 was termed the recidivist distribution. Given the few patients admitted 3 or more times, the RC3, RC4, and RC5 groups were combined into a single group. An NRC was defined as a trauma patient admitted to the trauma center a single time.

Following identification of the RC cohort, the NTRACS database was retrospectively queried for demographic and clinical data. Data included age, ethnicity, sex, and insurance status. Clinical data included mortality, blood ethanol content, toxicology screen results, mechanism of injury, injury e-codes, Glasgow Coma Scale score, Injury Severity Score, intensive care unit length of stay, hospital length of stay, discharge disposition, and patient charge. Blood ethanol content was measured (in milligrams per deciliter) on hospital admission, and a positive blood ethanol level was defined as any positive value. Toxicology screen results were considered positive if amphetamines, opiates, marijuana, or cocaine were present. The mechanism of injury was categorized according to NTRACS definitions as blunt, penetrating, burn, or “other.” Injury e-codes were used to differentiate violent from nonviolent trauma, vehicular trauma, and falls. Violent trauma was defined as intentional and nonintentional injury secondary to a gunshot, a stabbing, or an assault. Vehicular trauma was defined as injury secondary to a car, a truck, a motorcycle, or an all-terrain vehicle crash. Discharge disposition was categorized according to NTRACS definitions to include home, home health care, jail, nursing home, psychiatric or detoxification facility, and rehabilitation. A small percentage of patients were categorized as “other” regarding discharge disposition and were excluded. Patient charge represented the cost of hospitalization in the RC cohort. In addition to demographic and clinical data, the time between injuries for RCs was calculated.

The RC cohort was compared with the NRC cohort across all demographic and clinical variables. Significant differences between groups were identified using independent t tests, χ² analysis, and Mann-Whitney tests where applicable. Differences were considered significant at P<.05. In addition, trends for demographic and clinical variables were assessed throughout the successive admissions for the RC distribution.

A total of 15,370 patients were admitted during the study period. The mean±SD age of the patients was 40.2±24.2 years, and 37.7% were female. Of the patients, 36.0% were black, 3.7% were Mexican American, and 56.8% were white (the remainder is classified as “other” and includes Asian and Native American). The mean±SD Injury Severity Score was 10.6±9.9, and the mean±SD Glasgow Coma Scale score was 13.2±4.0. The mortality was 5.8%. A total of 528 patients were admitted to the trauma center a second time for a novel distinct injury, demonstrating a recidivism incidence of 3.4% for the study period. Of the 528 patients admitted a second time (RC2), 51 (9.7%) were admitted with a third distinct injury (RC3). Of the 51 RC3 cases, 6 (1.1% of the original 528) were admitted a fourth time (RC4), while 1 patient (0.2% of the original 528) was admitted a fifth time (RC5). Combining RC3 through RC5, 58 (11.0%) of the patients were admitted 3 or more times.

Within demographic variables, significant differences were noted between groups relative to age, ethnicity, and sex (Table 1). Recidivists were significantly older than NRCs, and mean age increased with the number of admissions. Regarding ethnicity, RCs were disproportionately white, composing more than 80% of patients admitted more than twice. Within minority groups, recidivism was significantly less common, with more black (36.2% vs 31.8%, P=.03) and Mexican American (3.8% vs 1.1%, P<.001) patients noted within the NRC cohort. In addition, ethnicity remained constant throughout successive admissions for the RC distribution. When assessing the sex distribution between groups, RCs were significantly more likely to be female. Although not significantly different, more NRCs were uninsured. When assessing insurance status within the RC distribution, the percentage of uninsured patients declined in the RC3 through RC5 combined group.

Clinical risk factors exhibiting significant differences between groups are noted in Table 2. In assessing substance abuse patterns, the percentage of positive blood ethanol screen results and the mean blood ethanol content were significantly higher in the RC cohort. Toxicology screen results for the entire study population demonstrated minimal use of drugs other than cocaine. Within both cohorts, less than 1% of patients exhibited positive screen results for amphetamine, opiates, or marijuana. Cocaine use was significantly higher in the RC cohort.

An analysis of the mechanism of injury revealed a slightly higher incidence of blunt trauma in the RC cohort. Nonrecidivists demonstrated a mechanism of injury distribu-
The incidence of blunt trauma in the RC group was 85.8%, with penetrating mechanism representing 8.9%, burn 1.5%, and other 3.8%. The lower incidence of penetrating injury in the RC group was not statistically significant (P = .22).

Further dividing injury mechanism according to e-codes, significant differences were noted between groups (Table 2). Recidivists demonstrated a significantly higher incidence of falls, particularly in the combined RC3 through RC5 group, and a slightly higher incidence of violent trauma. Nonrecidivists were significantly more likely to be injured secondary to vehicular trauma. An injury severity analysis revealed less significant injury in the RC group. The Glasgow Coma Scale score was higher, while the Injury Severity Score was lower, for RCs. The intensive care unit length of stay was slightly shorter for the RC cohort, and the hospital length of stay was slightly longer; neither difference was statistically significant (P = .18 and P = .36, respectively).

Outcome data are presented in Table 3. Mortality was higher for NRCs compared with RCs, but did not achieve significance. Among RCs, mortality remained constant between second-time offenders and those admitted 3 or more times. More NRCs were discharged home, and within this population, RCs had a higher requirement for home health. Discharge to jail was similar between groups, composing less than 1% of the respective populations. Significantly more RCs were discharged to nursing homes. In addition, the percentage of RCs admitted to nursing homes increased throughout the RC distribution: RC2, 16.3%; RC3, 32.7%; and RC4, 33.3%. Although the numbers of patients discharged to inpatient psychiatry or detoxification facilities were low in both cohorts, nearly 3 times the number of RCs entered psychiatry or detoxification facilities vs NRCs. Similarly, more RCs entered inpatient rehabilitation. Finally, patient charges and the mean time between admissions for the RC distribution were analyzed. The mean ± SD patient charges for the RC distribution were

Table 1. Demographic Variables for NRCs vs RCs*

<table>
<thead>
<tr>
<th>Variable</th>
<th>NRCs (n = 14,842)</th>
<th>2 (n = 528)</th>
<th>3-5 (n = 58)</th>
<th>P Value‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean ± SD, y</td>
<td>39.7 ± 24.1</td>
<td>55.9 ± 24.8</td>
<td>62.2 ± 22.9</td>
<td>&lt;.001§</td>
</tr>
<tr>
<td>White ethnicity</td>
<td>56.5</td>
<td>65.2</td>
<td>81.0</td>
<td>&lt;.001‡</td>
</tr>
<tr>
<td>Female sex</td>
<td>37.3</td>
<td>49.1</td>
<td>46.6</td>
<td>&lt;.001‡</td>
</tr>
<tr>
<td>Self-paying</td>
<td>26.6</td>
<td>24.4</td>
<td>15.5</td>
<td>.26</td>
</tr>
</tbody>
</table>

Abbreviations: NRC, nonrecidivist; RC, recidivist.
*Data are given as percentage of each group unless otherwise indicated.
†The RC2 group was composed of persons admitted a second time to the trauma center for distinct injury; RC3, those admitted a third time to the trauma center for distinct injury; RC4, those admitted a fourth time to the trauma center for distinct injury; and RC5, those admitted a fifth time to the trauma center for distinct injury.
‡Statistical comparisons between NRCs and the RC2 group.
§By independent t test.
¶By χ² test.

Table 2. Clinical Risk Factors for NRCs vs RCs*

<table>
<thead>
<tr>
<th>Variable</th>
<th>NRCs (n = 14,842)</th>
<th>2 (n = 528)</th>
<th>3-5 (n = 58)</th>
<th>P Value‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive ethanol screen result</td>
<td>39.9</td>
<td>58.8</td>
<td>70.0</td>
<td>&lt;.001§</td>
</tr>
<tr>
<td>Blood ethanol content, mg/dL</td>
<td></td>
<td>69.5 ± 114.4</td>
<td>132.1 ± 139.9</td>
<td>110.7 ± 93.5</td>
</tr>
<tr>
<td>Positive cocaine screen result</td>
<td>4.1</td>
<td>6.4</td>
<td>5.8</td>
<td>.02§</td>
</tr>
<tr>
<td>Falls</td>
<td>24.4</td>
<td>47.2</td>
<td>63.8</td>
<td>&lt;.001 §</td>
</tr>
<tr>
<td>Vehicular trauma</td>
<td>48.1</td>
<td>28.4</td>
<td>10.3</td>
<td>&lt;.001§</td>
</tr>
<tr>
<td>GCS score†</td>
<td>13.1 ± 4.1</td>
<td>14.1 ± 2.9</td>
<td>14.1 ± 2.9</td>
<td>&lt;.001‡</td>
</tr>
<tr>
<td>ISS†</td>
<td>10.8 ± 9.9</td>
<td>8.3 ± 6.5</td>
<td>7.7 ± 10.6</td>
<td>&lt;.001‡</td>
</tr>
</tbody>
</table>

Abbreviations: GCS, Glasgow Coma Scale; ISS, Injury Severity Score; NRC, nonrecidivist; RC, recidivist.
SI conversion factor: To convert ethanol to millimoles per liter, multiply by 0.217.
*Data are given as percentage of each group unless otherwise indicated.
†These groups are described in the third footnote to Table 1.
‡Statistical comparisons between NRCs and the RC2 group.
§By χ² test.
¶By t test.
||By χ² test.
||By Mann-Whitney test.
Table 3. Outcome Variables for NRCs vs RCs

<table>
<thead>
<tr>
<th>Variable</th>
<th>RC Group†</th>
<th>NRCs (n = 14,842)</th>
<th>P Value‡</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2 (n = 528)</td>
<td>3-5 (n = 58)</td>
<td></td>
</tr>
<tr>
<td>Death rate (%)</td>
<td>3.8</td>
<td>3.4</td>
<td>5.8</td>
</tr>
<tr>
<td>Disposition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home</td>
<td>51.6</td>
<td>44.8</td>
<td>65.3</td>
</tr>
<tr>
<td>Home health</td>
<td>8.1</td>
<td>5.2</td>
<td>6.0</td>
</tr>
<tr>
<td>Jail</td>
<td>0.4</td>
<td>0</td>
<td>0.6</td>
</tr>
<tr>
<td>Nursing home</td>
<td>16.3</td>
<td>32.7</td>
<td>5.0</td>
</tr>
<tr>
<td>Psychiatric or detoxification facility</td>
<td>2.5</td>
<td>1.7</td>
<td>0.9</td>
</tr>
<tr>
<td>Rehabilitation</td>
<td>16.6</td>
<td>13.7</td>
<td>14.1</td>
</tr>
</tbody>
</table>

Abbreviations: See Table 1.
†These groups are described in the third footnote to Table 1.
‡Statistical comparisons between NRCs and the RC2 group.
§By χ² test.

To our knowledge, this study represents the largest and most comprehensive query focusing on trauma recidivism, and the first perspective on a purely rural demographic. Our level I center is the only tertiary care hospital in a rural 29-county catchment area, which is composed of a landmass of more than 33,800 km². Many of the counties in our region are among the poorest in the United States. The population of this region is approximately 1.5 million, producing a population density of fewer than 100 persons per 2.6 km². As the only designated center in a region containing predominantly small understaffed hospitals, we operate in a unique system in which essentially all severely injured patients are triaged to our center and incorporated into the NTRACS database.

The rate of trauma recidivism in our rural population is 3.4%. This incidence is significantly lower than rates cited in earlier works, focusing predominantly on urban populations. The lower incidence cited in this study is likely secondary to the unique demographic analyzed and study methods. With respect to the rural demographic, our recidivism rate is similar to the 2% incidence described by Kaufman and colleagues, focusing on recidivism in Nevada, where population densities are similarly low. However, because 80% of Nevada residents live in urban areas, and the study did not quantify the percentage of patients originating from urban environments, it is difficult to ascertain whether the study represented a focused perspective on rural recidivism. In addition, the risk factors identified in the study are similar to those described for urban populations. Concerning methods, the unique referral patterns to our center alluded to previously have likely allowed us to capture nearly all RCs in the region. In rural settings, where blunt trauma of diverse cause predominates, the breadth of injury type likely exceeds comparable methods in urban centers. However, we did include only patients admitted to the hospital. Williams et al, focusing on emergency department visits in a rural population, noted an injury recidivism rate of 12%. If our registry were expanded to capture all patients who were evaluated for injury but discharged from the emergency department, our recidivism incidence would likely increase.

The low incidence of rural recidivism may be related to the variances in the identified risk factors in our rural demographic. The RC profile demonstrated in this study is strikingly different from that described for urban RCs. In contradistinction to the urban profile, demographic risk factors for recidivism in our population included older age, white ethnicity, and female sex. The mean age for RCs was nearly 54 years, significantly higher than the age of NRCs, and clearly dissimilar to the youth association identified in urban recidivism literature. The age difference may be related to a strong statistical contribution from elderly patients within our RC cohort. In the elderly population, previous injury is the single strongest risk factor for recurrent injury. Gubler et al, in a study focusing on recidivism in elderly persons, identified an increase in the relative risk for recurrent injury as age increases, and noted that women are more likely to require admission for recurrent injury compared with men. The researchers also demonstrated that white ethnicity to be a risk factor for recidivism in elderly persons. The mean age for the entire population in our study was just older than 40 years, ranging by 10 to 20 years older than the age in previous studies. In addition, our trauma registry indicates that approximately 50% of trauma patients evaluated by our cen-
acter are older than 40 years and that 8.9% of trauma admissions exceed the age of 80 years. The commonality between our rural study and nearly all previous recidivism studies relates to substance abuse. We noted a strong association between ethanol use and recidivism. Not only were more RCs admitted with positive ethanol screen results, the mean amount consumed before injury was significantly higher than for NRCs admitted with positive screen results. Ethanol abuse has been identified as the leading risk factor for injury, and as a clear risk factor for trauma recidivism. Similarly, our study demonstrated a higher incidence of cocaine use in the RC cohort.

Associations between recidivism and intentional or violent injury were not evident in this rural demographic. On the contrary, RCs were more frequently injured secondary to blunt trauma. Within the RC group, less penetrating injury was noted, and significantly more falls were noted within RCs injured secondary to blunt mechanisms. The significant differences noted in markers of injury severity, including lower Injury Severity Score and higher Glasgow Coma Scale score in RCs, were likely secondary to the large size of the cohorts and may not be clinically relevant. However, RCs were clearly not more significantly injured than their NRC counterparts, a difference that may relate to the significantly lower incidence of vehicular injury. Moreover, the higher incidence of falls, and the potential effect of this statistic on overall blunt vs penetrating percentages, may again relate to an older mean age within the RC cohort.

The results of this study, in agreement with the results of a previous study, demonstrate the significant cost associated with RC behavior. Patient charges for the entire RC distribution exceeded $7 million for the study period. In addition, multiple RCs, including many uninsured patients, accumulated hospital charges exceeding $100,000.00.

Furthermore, in assessing hospital disposition among RCs, further cost to the region is evident. Significantly fewer RCs were discharged home, requiring more home health care and rehabilitation. Potentially reflecting the higher incidence of substance abuse among RCs, more patients in this group required admission to inpatient psychiatry or detoxification facilities. Finally, significantly more RCs required placement in nursing homes. Again, the advanced age of the RC cohort may be contributory.

There are several limitations of this study. The rate of recidivism in our region would likely be higher if all patients returning to the emergency department for injury were included. A second concern relates to the age of our patient population. If elderly patients were extracted from the data set, it is possible that the demographic and clinical associations of the RC may more closely approximate the characteristics demonstrated in urban recidivism literature. However, we believed that analyzing subsets of our population as a whole would misrepresent the regional experience. Finally, as a retrospective study, the data set is subject to missing or incorrect data.

In summary, the incidence of recidivism in rural trauma centers is lower than in urban centers. The difference in incidence is likely related to differences in RC characteristics; the rural RC seems to be demographically and clinically distinct from urban counterparts. The common thread within recidivism between trauma centers relates to substance abuse. This study emphasizes the need for rural trauma centers to individualize primary preventive measures based on region-specific RC characteristics. The foundation of inpatient intervention in patients who are identified as potential RCs must focus on patterns of substance abuse.

Accepted for Publication: December 19, 2005.
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Author Contributions: Dr Toschlog has had access to all the data and assumes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Toschlog, Sagraves, Bard, and Rotondo.

Acquisition of data: Toschlog. Analysis and interpretation of data: Toschlog, Bard, Schenarts, Goettler, Newell, and Rotondo. Drafting of the manuscript: Toschlog, Sagraves, Bard, and Schenarts. Critical revision of the manuscript for important intellectual content: Toschlog, Sagraves, Schenarts, Goettler, Newell, and Rotondo. Statistical analysis: Toschlog. Obtained funding: Toschlog. Administrative, technical, and material support: Toschlog, Goettler, and Rotondo. Study supervision: Toschlog, Sagraves, and Rotondo.

Financial Disclosure: None reported.

REFERENCES