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# Near-hanging injuries: A 10-year experience

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**KEYWORDS**
Hanging injury;
Cervical spine fracture;
Cerebral anoxia

**Summary**

*Objective:* To review the injury patterns and analyse outcomes in patients who present after near-hanging.
*Methods:* This is a trauma registry study that included all patients who were admitted to an academic Level I trauma centre with the diagnosis of attempted suicide by hanging between January 1993 and December 2003. All patients who were dead on arrival or in cardiopulmonary arrest were excluded. Data regarding demographics, injuries, and outcomes were examined. Independent risk factors for poor outcome were identified.
*Results:* During the 10-year study period, 63 patients were admitted after near-hanging. A total of 12 patients (19%) had 17 injuries. Cervical spine fractures occurred in nearly 5% of cases. Four factors were found to be significantly associated with poor outcome: systolic blood pressure $<90$, Glasgow coma score $\leq 8$, anoxic brain injury on computed tomography (CT) scan, and injury severity score $>15$. However, logistic regression analysis found only anoxia on CT scan to be independently associated with poor outcome ($p < 0.01$).
*Conclusion:* Injuries commonly occurred after near-hanging. Liberal screening using CT scans is warranted. The prognosis is favorable, even with patients who arrive with a GCS $\leq 8$. Overall survival was 90% and only 3.5% were discharged with severe or permanent disability.
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## Introduction

Hanging has become the second most common cause of suicide in the United States, accounting for 14% of the over 31,000 suicides that occurred in the year 2002.[24] However, there have been relatively few

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studies on the outcomes and injury patterns in patients after unsuccessful hanging (near-hanging) attempts. The purpose of this study was to evaluate the demographics, injury patterns, and outcomes for near-hanging patients admitted to the Los Angeles County + University of Southern California (LAC + USC) Medical Center.

## Methods

The trauma registry at the LAC + USC Medical Center was queried for all patients admitted after attempted suicide by hanging, between 1 January, 1993 and 31 December, 2003. All patients who were dead on arrival or in cardiopulmonary arrest were excluded. The trauma registry is maintained by seven full-time trained nurses, and the quality of data entry is monitored by the Emergency Medical Service of the Department of Health Services of the County of Los Angeles. Patient variables collected included age, gender, ethnicity, injury severity score (ISS), admitting vitals, Glasgow coma score (GCS) on admission, airway management, types of injury, hospital (HOSP-LOS) and intensive care unit length of stay (ICU-LOS), and overall outcome. Discharge capacity was divided into three groups: none, temporary disability, and severe/permanent disability. Temporary disability was defined as disability from hospital discharge up to one year while severe/permanent disability was defined as lasting for more than one year. Patients were divided into groups depending on whether injuries were present (INJ Group) or absent (NONINJ Group) and subsequently compared for differences.

Data was entered into a computerised spreadsheet and analysed using SPSS 12.0 for Windows (SPSS Inc., Chicago, Illinois). Statistical analysis was performed using the unpaired student's *t*-test or Mann–Whitney rank sum test for continuous variables and Chi-square with Yates correction for categorical variables. Variables that were different at $p < 0.2$ were selected for stepwise logistic regression to identify independent risk factors for poor outcome. For the multivariate analysis, continuous variables were converted to dichotomous variables using clinically significant cut-off points (i.e., age $>$ 55 years, SBP $<$ 90, GCS $\leq$ 8, and ISS $>$ 15). Values are reported as means $\pm$ standard deviation or raw percentage. Differences were considered statistically significant for $p < 0.05$.

## Results

During the study period, there were 63 patients admitted after attempted suicide by hanging.

**Table 1** Patient demographics ($n = 63$)

| | |
|---|---|
| Age (years) | 28 ± 14 |
| Age group | |
| 1–14 years, *n* (%) | 8 (12.7) |
| 15–55 years, *n* (%) | 52 (82.5) |
| >55 years, *n* (%) | 3 (4.8) |
| Male sex, *n* (%) | 55 (87.3) |
| Ethnicity | |
| Hispanic, *n* (%) | 30 (47.6) |
| African American, *n* (%) | 13 (22.2) |
| Caucasian, *n* (%) | 11 (17.5) |
| Asian, *n* (%) | 4 (6.3) |
| Unknown, *n* (%) | 4 (6.3) |
| Admitting SBP (mmHg) | 123 ± 41 |
| Admitting hypotension (SBP < 90), *n* (%) | 5 (7.9) |
| GCS | |
| GCS 13–15, *n* (%) | 38 (60.3) |
| GCS 9–12, *n* (%) | 5 (7.9) |
| GCS 3–8, *n* (%) | 17 (27) |
| Missing, *n* (%) | 3 (4.8) |
| ISS | |
| ISS ≤15, *n* (%) | 58 (92) |
| ISS 16–25, *n* (%) | 2 (3.2) |
| ISS >25, *n* (%) | 3 (4.8) |

SBP, systolic blood pressure; GCS, Glasgow coma score; ISS, injury severity score.

Table 1 summarises the admission demographics for the study group. The majority of patients were male, between the age of 15 and 55 years, normotensive, and arrived with a GCS between 13 and 15.

Twelve of the 63 patients (19.0%) required definitive airway management. Two patients were intubated in the pre-hospital setting and 10 in the emergency department. All 12 patients were intubated for either depressed GCS ($n = 8$) or for presumed airway injury ($n = 4$). One of the patients required an emergency cricothyroidotomy.

Table 2 summarises the type and frequency of injuries sustained. A total of 12 patients (19%) had 17 injuries. Three patients sustained multiple injuries. The first patient sustained a pharyngeal laceration, carotid injury and cervical spine fracture. This

**Table 2** Type and frequency of injury

| Injury | Number of cases (%) |
|---|---|
| Cerebral anoxia | 8 (12.7) |
| Laryngeal fracture | 3 (4.8) |
| Cervical spine fracture | 3 (4.8) |
| Tracheal fracture | 1 (1.6) |
| Pharyngeal laceration | 1 (1.6) |
| Carotid artery injury | 1 (1.6) |

**Table 3** Outcomes

| | |
|---|---|
| Died, *n* (%) | 6 (9.5) |
| Survived, *n* (%) | 57 (90.5) |
| ICU-LOS (days) | 1 (0–2) |
| HOSP-LOS (days) | 5 (4–7) |
| Discharge status of survivors | |
| No disability, *n* (%) | 3 (5.3) |
| Temporary disability, *n* (%) | 49 (85.9) |
| Severe/permanent disability, *n* (%) | 2 (3.5) |
| Unknown, *n* (%) | 3 (5.3) |

patient had repair of the pharyngeal injury while the carotid injury was managed conservatively. The second patient had fractures of the cervical spine, larynx and trachea. This patient was managed non-operatively. The third patient had fractures of both the larynx and cervical spine. The remaining nine patients sustained one injury each (eight with cerebral anoxia diagnosed by head computed tomography (CT), and one patient had a laryngeal fracture).

The outcomes of the study group are summarised in Table 3. The mortality rate for the study population was 9.5%. The discharge status for survivors was favourable with 91% having no or temporary disability.

The patients were then divided into two groups, those with injuries (INJ) and those without injuries (NONINJ), which were then compared in terms of admission demographics (Table 4), airway management (Table 5), and outcomes (Table 6). The two

**Table 4** Comparison of demographics between injured and non-injured patients

| Characteristic | INJ (*n* = 12) | NONINJ (*n* = 51) | *p*-Value |
|---|---|---|---|
| Age (years) | 31 ± 21 | 28 ± 12 | 0.60 |
| Age group | | | |
| 1–14 years, *n* (%) | 3 (25) | 5 (9.8) | 0.16 |
| 15–55 years, *n* (%) | 7 (58.3) | 45 (88.2) | 0.01 |
| >55 years, *n* (%) | 2 (16.7) | 1 (2.0) | 0.03 |
| Male sex, *n* (%) | 12 (100.0) | 43 (84.3) | 0.14 |
| Ethnicity | | | |
| Hispanic, *n* (%) | 5 (41.7) | 25 (49.0) | 0.65 |
| African American, *n* (%) | 3 (25.0) | 11 (21.6) | 0.80 |
| Caucasian, *n* (%) | 2 (16.7) | 9 (17.6) | 0.94 |
| Asian, *n* (%) | 1 (8.3) | 3 (5.9) | 0.75 |
| Missing, *n* (%) | 1 (8.3) | 3 (5.9) | |
| Admitting SBP | 99 ± 82 | 129 ± 20 | 0.23 |
| Admitting hypotension (SBP < 90), *n* (%) | 5 (41.7) | 0 (0.0) | <0.01 |
| GCS | | | |
| GCS 13–15, *n* (%) | 1 (8.3) | 37 (72.5) | <0.01 |
| GCS 9–12, *n* (%) | 0 (0.0) | 5 (9.8) | 0.26 |
| GCS 3–8, *n* (%) | 9 (75.0) | 8 (15.7) | <0.01 |
| Missing, *n* (%) | 2 (16.7) | 1 (2.0) | |
| ISS | | | |
| ISS ≤15, *n* (%) | 7 (58.3) | 51 (100.0) | <0.01 |
| ISS 16–25, *n* (%) | 2 (16.7) | 0 (0.0) | <0.01 |
| ISS >25, *n* (%) | 3 (25) | 0 (0.0) | <0.01 |

INJ, injured patients; NONINJ, non-injured patients; SBP, systolic blood pressure; GCS, Glasgow coma score; ISS, injury severity score.

**Table 5** Comparison of airway management for patients with and without injuries

| Type of airway management | INJ (*n* = 12) | NONINJ (*n* = 51) | *p*-Value |
|---|---|---|---|
| Pre-hospital | | | |
| OPA/BVM, *n* (%) | 1 (8.3) | 0 (0.0) | <0.01 |
| ETI, *n* (%) | 2 (16.7) | 0 (0.0) | <0.01 |
| Emergency department | | | |
| ETI, *n* (%) | 1 (8.3) | 8 (15.7) | 0.51 |
| CRIC, *n* (%) | 1 (8.3) | 0 (0.0) | 0.04 |

INJ, injured patients; NONINJ, non-injured patients; OPA/BVM, oropharyngeal airway/bag valve mask; ETI, endotracheal intubation; CRIC, cricothyroidotomy.

**Table 6** Comparison of outcomes between patients with and without injuries

| Outcome | INJ ($n$ = 12) | NONINJ ($n$ = 51) | $p$-Value |
|---|---|---|---|
| Died, $n$ (%) | 6 (50.0) | 0 (0.0) | <0.01 |
| Survived, $n$ (%) | 6 (50.0) | 51 (100.0) | <0.01 |
| ICU-LOS (days) | 6 (0—13) | 0 (0—1) | 0.10 |
| HOSP-LOS (days) | 15 (4—26) | 4 (3—5) | 0.05 |
| Discharge status of survivors | | | |
| No disability, $n$ (%) | 1 (16.7) | 2 (3.9) | 0.19 |
| Temporary disability, $n$ (%) | 1 (16.7) | 48 (94.1) | <0.01 |
| Severe/permanent disability, $n$ (%) | 2 (33.3) | 0 (0.0) | <0.01 |
| Unknown, $n$ (%) | 2 (33.3) | 1 (1.9) | |

ICU-LOS, intensive care unit length of stay; HOSP-LOS, hospital length of stay.

groups were similar except those with injuries were more likely to be hypotensive and have a depressed GCS (Table 4). With respect to airway management, four patients (33.3%) in the INJ group required airway support versus eight (15.7%) in the NONINJ group (Table 5). Also, patients in the INJ group were more likely to require pre-hospital airway support.

Table 6 compares the two groups with respect to outcomes. Finally, we tried to identify factors that were associated with poor outcome, i.e. mortality or severe/permanent disability at discharge. Four factors were found to be significantly associated with poor outcome ($p < 0.2$): SBP $< 90$, GCS $\leq 8$, anoxic brain injury on CT scan, and ISS $> 15$. Logistic regression analysis found only anoxia on CT scan to be independently associated with poor outcome ($p < 0.01$).

## Discussion

Hanging has become the second most common form of successful suicide, after firearms, in the United States.[20] In the jail system, hanging is the most common form of successful suicide.[8] For this reason, awareness of the types of injuries and outcomes in these patients is important. There have been relatively few non-forensic studies on the demographics and outcomes of hanging injuries. Our report is one of the largest series of hanging injuries admitted to a single institution. Patients who survive hospital admission appear to have favourable outcome. The overall mortality in our series was 9.5% and only 3.5% were discharged with severe disability.

Injuries resulting from hanging have been well documented in autopsy studies and include hyoid bone fractures,[15,18,23] larygotracheal fractures,[3,13] carotid injuries,[13,16] and cervical spine fractures.[4,12,21,22] For patients who survive the hanging, injuries are documented mostly in case reports.[3,5,6,10,16,20] There are very few series that attempt to characterise injuries.[2,9,14,17,19,25] We found injuries in 12 of the 63 patients (19.0%) who presented with signs of life. Three of the 12 (25%) presented with multiple injuries. Interestingly, cervical spine fractures occurred in almost 5% of cases. The incidence of cervical spine injuries in near-hanging has been reported to be extremely low or non-existent.[1,2,7,25] Aufderheide et al.[2] found no cervical spine injuries in 67 patients treated at nine different Milwaukee hospitals. Line et al.[14] in a study of 57 hanging patients documented no cervical spine injury. Kaki et al.[13], in a study of 17 patients, found one patient with incomplete subluxation of the first cervical vertebrae. In a review of the literature, they found cervical spine injuries limited to post mortem reports. Matsuyama et al.[17] also found no cervical spine injuries in 47 patients who presented to their emergency room. Based on this available literature, many have questioned the use of routine cervical investigation.[17,25] With cervical spine injuries in 5% in our series we believe routine cervical spine evaluation is warranted.

The mechanism of injury during hanging depends to a large extent on the height from which the body is dropped. Judicial hangings involved a technique of dropping the subject from a distance equal to or greater than the height of the patient.[25] This would often result in either the hangman's fracture (an unstable fracture of the neural arch of C-2), spinal cord injury, or asphyxiation, and subsequently death. In suicidal hangings, there is often no or minimal drop height. Compression of the soft tissues of the neck results in jugular venous obstruction (stagnant hypoxia) and loss of consciousness.[20] The body then becomes limp from loss of muscle tone, which further tightens the ligature around the neck, resulting in carotid arterial obstruction, with or without airway closure, cerebral hypoxia and death.[11] The duration of hanging correlates with outcome, and several small studies have shown hanging times of less than 5 min predicts good outcome.[17,25] Based on this

mechanism of injury, it is not surprising that almost 13% of our patients showed findings of cerebral hypoxia on head CT. Unfortunately, hanging time was not available for analysis in this study.

Identifying predictors of poor outcome is difficult because of the paucity of studies in the literature. We found that anoxic brain injury seen on head CT was the only independent predictor of poor outcome. Of the eight patients with cerebral anoxia on head CT, six (75%) either died or had severe/permanent disability at discharge. It was a little surprising that GCS did not correlate, however this seems to be substantiated by the available literature. Matsuyama et al.[17] found hanging time, admission GCS, and presence of cardiopulmonary arrest to be prognostic factors influencing outcome in their series of 47 patients. However, patients admitted with a GCS $>$ 3 had a 50% survival. Penney et al.[19] in a review of 42 patients found that the admission GCS was a poor prognostic indicator and that only the presence of cardiac arrest influenced outcome. Hanna[9] in a review of 13 cases found that all patients, regardless of admission GCS, went on to a full recovery. Finally, Vander Krol and Wolfe[25] in a review of 39 patients found favourable outcome for patients admitted with a GCS $>$ 3.

In conclusion, our series represents one of the largest in the literature from a single institution. Nineteen percent of our patients sustained an injury, and in 5% the injury was a cervical spine fracture. Therefore, liberal screening using CT scans is warranted. The prognosis is favourable even when patients arrived with a GCS $\leq$ 8. The overall survival was 90% and only 3.5% were discharged with severe or permanent disability. Aggressive resuscitation and management should be performed for all patients who arrive with signs of life. Studies with larger numbers and detailed functional outcomes are needed.

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