Hanging in There. Living beyond Hanging: A Retrospective Review of the Prognostic Factors from a Regional Trauma Center

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ABSTRACT

Background: A common cause of suicide in the United States is hanging, which is increasing in incidence. Patients with near-hanging injuries survive long enough to present to the emergency department for resuscitative care. Identifying prognostic factors that can predict survival is needed to improve emergency management in this patient population.

Materials and methods: A retrospective review of all patients diagnosed with an attempted suicide by hanging that presented to a regional level 2 trauma center was studied, inclusive years January 2013 to December 2017. The patients who died upon arrival were excluded. The data collected for comparison included demographic with prognostic characteristics, trauma center admission vitals, type and frequency of injuries, and near-hanging outcomes.

Results: Several statistically significant findings were presented. Associations between systolic blood pressure (BP) upon admission of <90 Hg in patients <65 years of age and survival were statistically significant (Fisher’s exact test, \( p = 0.005 \)). The association between Glasgow coma scale (GCS) category and survival was statistically significant (Fisher’s exact test, \( p = 0.012 \)). Further, there was a weak positive association between the GCS category on admission vitals and survival (\( F = 0.554, p = 0.006 \)). Associations between cervical spine injury with fracture and survival were significant (Fisher’s exact test, \( p = 0.024 \)). A strong negative relationship was found between cerebral anoxia and survival (\( F = -0.772, p = 0.001 \)). The association between cerebral injury and survival was statistically significant (Fisher’s exact test, \( p = 0.002 \)). Finally, a strong negative relationship was found between pulmonary edema and survival (\( F = -0.592, p = 0.004 \)).

Conclusion: Independent risk factors for poor outcomes in near-hanging trauma were identified. These factors include relationships between systolic BP, GCS categories, admission vitals, cervical spine injuries with fracture, cerebral anoxia, cerebral injury, and pulmonary edema with survival.

Keywords: Hanging, Near-hanging, Trauma.

INTRODUCTION

Hanging entails suspension by the neck often resulting in strangulation. It can be divided broadly into complete or incomplete. It is said to be complete when the whole body hangs

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off the ground, and the entire weight of the victim is suspended at
the neck. Incomplete hangings imply that some part of the body
is touching the ground and that the neck does not fully support
the victim’s weight. Judicial hanging is defined when the drop is
at least as long as the victim’s height and the hanging is complete.
The death mechanism in judicial hanging is often attributed to
decapitation, with the head’s distraction from the neck and torso,
ocasionally with fracture of the upper cervical spine (traumatic
spondyloysis of C2 in the classic hangman fracture), and transaction
of the spinal cord.2,3 Death can also occur from a range of head and
颈 injuries, particularly compression or rupture of the vertebral
and carotid arteries leading to cerebral ischemia.2

Near hanging refers to patients who survive a hanging injury
long enough to reach the hospital. This suicidal hanging usually
differs from judicial hanging in many ways. Unlike judicial hanging,
suicidal hanging is rarely associated with cervical fractures, which are
as low as 5% of all cases.3 Furthermore, death is often attributed to
bedral ischemia resulting from disruption of cerebral blood flow
related to the noose around the neck. Cardiac arrest as a result of
autonomic hyperactivity from stimulation of vasoactive centers in the
great vessels; protrusion of the tongue and epiglottis causing airway
compromise; jugular venous occlusion, carotid artery occlusion by
neck closure, and vertebral artery occlusion by spinal injuries all
contribute in a cumulative way to acute cerebral hypoxia.2,4–6

Hanging is the second most common cause of suicide in the
United States after firearms, claiming over 10,000 lives each year,
and its incidence is increasing.7,8 Despite the frequent occurrence of
suicidal attempts and potential near-hanging injuries, few studies
have evaluated the prognostic factors that can predict survival
following a near-hanging experience. This study aims to evaluate
independent risk factors for poor outcomes in hopes of improving
the emergency management of near-hanging victims.

**Materials and Methods**

A retrospective cross-sectional study of all patients diagnosed
with an attempted suicide by hanging and were transported by
emergency medical services to a regional level 2 trauma center
in Pennsylvania, inclusive years January 2013 to December 2017.
The patients who died upon arrival were excluded. This study
received support from Lecom the Lake Erie Osteopathic College
of Medicine in Erie, PA. The Institutional Review Board was granted
by Allegheny Health Network, which facilitated manually extracted
data from medical record review and ambulance reports. The
data were assessed for normality of continuous variables using
the Shapiro–Wilk test. Continuous normally distributed variables
were reported as mean and the standard deviation; non-normally
distributed variables were reported as median with interquartile
range (IQR). Categorical variables were presented as counts and
percentages. The independent sample t-test or Mann–Whitney
U-test was used, which was appropriate to compare continuous
variables. The Chi-squared test or Fisher’s exact test was used to
compare categorical variables. The phi coefficient (F) was given as
a measure of the association between two categorical variables. A
value of p < 0.05, on two-tailed testing, was considered statistically
significant. Statistical analyses were performed using IBM-SPSS
Statistics, version 24.0 (IBM Corp., Armonk, NY). Demographics
with prognostic characteristics included age, gender, race, hanging
method, type of ligature used, and contact with the ground. The
patients were grouped by trauma center admission vitals, type and
frequency of injuries, and outcomes of near hangings (Tables 1 to 4).

**Results**

A total of 25 patients were admitted to an adult level 2 trauma center
with near-hanging injuries, inclusive years January 2013 and
December 2017. The association between systolic blood pressure (BP)
upon admission of <90 Hg in patients <65 years of age and survival was statistically significant (Fisher’s exact test, p = 0.005). The association between GCS category and survival was statistically significant (Fisher’s exact test, p = 0.012). Of the
16 patients in the category of GCS 13–15, 93.8% survived. Within the
GCS category of 3–8, 4 of the 9 patients survived. There was a
weak positive association between the GCS category on admission
vitals and survival (F = 0.554, p = 0.006). A cervical spine injury with
fracture was diagnosed in 2 of the 23 patients (8.7%); both died.
The association between cervical spine injury with fracture and survival was statistically significant (Fisher’s exact test, \( p = 0.024 \)). Cerebral anoxia was diagnosed in 6 of the 23 patients. Of those with diagnosed cerebral anoxia, 4 of the 6 patients (66.7%) diagnosed dead. Extracted data from injuries related to incomplete hanging showed 3 deaths out of 6 total patients. Further, there were 3 out of 6 related deaths to complete hanging. A strong negative relationship was found between cerebral anoxia and survival (\( F = -0.772, p = 0.001 \)). Cerebral injury, including ischemic stroke/cerebral edema, was diagnosed in 3 of the 23 patients, who later died. The association between cerebral injury and survival was statistically significant (Fisher’s exact test, \( p = 0.002 \)). Pulmonary edema was diagnosed in 5 of the 23 patients (21.7%). Pulmonary edema with death impacted three out of five patients (60%). Of the three patients who died of pulmonary edema, none made use of a rope for their attempted suicide; two patients had injuries related to complete hanging, and one patient was reported to have touched the ground. A strong negative relationship was found between pulmonary edema and survival (\( F = -0.592, p = 0.004 \)).

In Figure 1, symmetric restricted diffusion involving the cortex, basal ganglia, and thalami bilaterally can be seen. There is increased T2 flair imaging in this region. Findings are compatible with history.
of anoxic brain injury. In Figure 2, findings are suggestive of hypoxic brain injury as described with cerebral swelling and possible mild hypodensity at the deep gray nuclei. In Figure 3, there is edema in the C5-C6 and C6-C7 interspinous space likely representing acute injury to the interspinous ligaments.

**Discussion**

On an average, 50% of hanging suicides are not fully suspended, and ligature points below head level are commonly used. Although the case fatality following an attempted suicide by hanging is around 70%, most (80–90%) of those who reach the hospital alive survive. The emergency management of near-hanging victims is crucial in that delayed deaths are mostly due to complications of hanging.

Autopsy studies have documented injuries resulting from hanging. Common injuries include thyroid cartilage/hyoid fractures, tracheal laryngeal fractures, vertebral injuries, cervical vascular injuries, and anoxic brain injuries. In near-hanging patients who survived the hanging and were transported to the hospital alive, injuries often include pulmonary edema and bronchopneumonia, laryngeal injuries, hypoxic encephalopathy, pneumonia, cervical vascular injuries, vertebral fractures, adult respiratory distress syndrome, and more.

Many studies have investigated the prognostic factors related to near-hanging injuries, yet a consensus has not been reached. Risk factors for poor outcomes include cardiac arrest at the hanging site, elevated diastolic BP, a low initial GCS, Acute Physiology and Chronic Health Evaluation II, 48-hour Sequential Organ Failure Assessment score, and an elevated blood glucose level. Other predictive measures of death and unsuccessful revival include loss of consciousness at the time of entry into the medical center, as well as complete suspension.

This study has identified factors significantly associated with poor outcomes, including cervical spine injury with fracture; cerebral anoxia; cerebral injury, including ischemic stroke/cerebral edema; pulmonary edema; systemic BP upon admission of <90 Hg in patients <65 years of age; and GCS category. It is critical to recognize the prognostic factors in near-hanging patients to improve their emergency management, therefore improving overall survival.

The neurological deficits of near-hanging injuries are profound and include cervical spine injury and diffuse atonal injury. Diffuse atonal atrophy from the sudden acceleration and deceleration common with hanging attempts can lead to loss of consciousness and death. Near hanging can often result in the rupture of the interspinous ligaments.

Other serious negative health outcomes include carotid artery dissection, stroke, seizures, cortical edema, and intracerebral hemorrhages. The strangulation causes an interruption of cerebral blood flow coupled with hypoxia from respiratory arrest, leading to loss of consciousness. Near hanging results in hypoxic/ischemic injuries to neurons due to oxygen and glucose deprivation.

Neuronal death is followed by deficits in memory formation/cognition and executive function.

Additionally, mechanical trauma to the cervical blood vessels and the airway can cause delayed neurological sequelae. Arterial dissections may occur, resulting in stroke. Trauma to the airway can cause delayed airway obstruction from tissue swelling, compounding the initial hypoxic insult.

**Limitations**

The major limitations of the current study include retrospective methodology and small sample size. Data were obtained from...
medical record review and ambulance reports and, therefore, may be limited by documented data availability. The small sample size may undermine the internal and external validity of the study. Some potential confounding variables may not have been available for analysis. Data on important variables such as blood alcohol level and other drugs at the time of attempted suicide was not available. Finally, this study was carried out in a suburban level 2 adult trauma center, which provides services that may not be available in other hospital settings, thus lessening these study results’ generalizability.

**CONCLUSION**

Independent risk factors for poor outcomes in near-hanging trauma were identified. Further larger studies are required to determine the epidemiology and prognostic implications associated with near-hanging injuries.

**DISCLOSURES**

In compliance with the ICMJE uniform disclosure form, all authors declared that they have received no financial support from any organizations that might have an interest in the submitted work, and there are no other relationships or activities that could appear to have influenced the submitted work.

**DISCLAIMER**

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