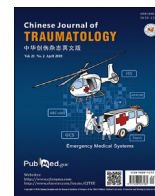




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## Original Article

## Predictors of functional outcome after hanging injury

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## ABSTRACT

**Purpose:** Suicide becomes a serious problem in today's society and hanging is a common method of suicide. We want to find the factors which can predict the final functional outcomes of these cases.**Methods:** All patients who presented to Accident and Emergency Department (ED) of the National Cheng Kung University Hospital from 1st January 2005 to 31st December 2013 with a hanging injury were included in this study. All cases were divided into good outcome group and bad outcome group according to Glasgow Outcome Scale (GOS). Data was analyzed by Mann-Whitney test and chi-square test.**Results:** Glasgow Coma Scale (GCS) < 3, pupil dilation and no pupillary light reflex both at the scene and ED were the factors to indicate poor functional outcome. Out-hospital cardiac arrest (OHCA), acidosis (pH < 7.2) and the need for intubation once arriving at ED were also related to poor functional outcome. OHCA cases all had poor functional outcome.**Conclusion:** GCS, pupil size, pupillary light reflex, OHCA and acidosis are useful as prognostic factors. GCS = 3 lead to a very poor outcome. However, the functional outcome seems good in patients with GCS > 3. These parameters can help to predict the outcome before treatment.© 2018 Production and hosting by Elsevier B.V. on behalf of Daping Hospital and the Research Institute of Surgery of the Third Military Medical University. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## Introduction

Hanging is a relatively common method of attempted suicide and accidental injury worldwide. However, there have been few relatively overall studies or reports on the suicide by hanging. There were many cases of hanging and near-hanging presented to Accident and Emergency Department (ED). We designed this study to evaluate the demographics, methods, and outcomes for hanging and near-hanging patients who were sent to medical center of National Cheng Kung University, and to analyze the factors which can predict the final functional outcomes.

## Methods

All patients who presented to ED of the National Cheng Kung University Hospital from 1st January 2005 to 31st December 2013 with a hanging injury were included in this study. All patients who were sent to ED not via emergency medical system (EMS) were

excluded. All the out-hospital cardiac arrest (OHCA) patients received laryngeal mask airway insertion at scene and standard cardio-pulmonary-cerebral resuscitation according to advanced cardiac life support (ACLS) at that time. Others received oxygen supply in the ambulance. Arterial blood gas (ABG) analysis was performed for all patients when they arrived at ED, and brain computerized tomography (CT) was performed for those whose Glasgow Coma Scale (GCS) was less than 15 or who had neurological deficits. Cervical spine X-ray or neck CT was arranged for checking neck and spinal trauma.

Demographics, site of incident, GCS, pupil size, pupillary light reflex at the scene and ED and the outcomes were collated from the patient's medical records.

The functional outcome was evaluated according to the Glasgow Outcome Scale (GOS). The GOS is a scale for patients with brain injuries, and it can be divided into five groups that allow standardized descriptions of the objective degree of recovery.<sup>1</sup> A five-point scale is described—death, persistent vegetative state, severe disability, moderate disability, and good recovery. These cases were divided into two groups by using final functional outcomes according to the GOS. Poor functional outcome group presents as severe disability (GOS = 3), persisted vegetative state (GOS = 2) and death (GOS = 1), and good outcome means moderate (GOS = 4) and low disability (GOS = 5).

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Data was analyzed using SPSS 16.0 for Windows. Means and standard deviation (mean  $\pm$  SD) are reported for continuous variables and frequencies and percents are reported for categorical variables. The Mann-Whitney test was used to evaluate continuous predictors and Chi-Square test for categorical predictors. The inferences were made at the level of significance with corrections for multiple comparisons.

## Result

### Epidemiology

There were 41 patients admitted to our ED due to attempted suicide by hanging from 1st January 2005 to 31st December 2013. There were totally 23 men (56.1%) and 18 women (43.9%). The age of these patients is range from 26 years old to 78 years old with a mean of (55.54  $\pm$  15.15) years. Twenty cases (48.8%) had a diagnosed psychological disorder; eight (19.5%) had a malignancy disease, and four (9.8%) had both diseases. Eighteen cases (43.9%) had OHCA and 23 (56.1%) presented to ED with vital signs. There are nine OHCA cases who had return of spontaneous circulation (ROSC) for more than 24 h after cardio-pulmonary cerebral resuscitation (CPCR) (Table 1).

### Circumstances

The methods of hanging were as follows: nine cases used electric wire, seven used rope, sixteen were not recorded and others used clothes, a leather belt, a tie or a plastic cord.

The scene circumstances were 33 cases (80.4%) at home, 2 (4.9%) in the farm, 2 (4.9%) in the dormitory of work place and 2 (4.9%) in the nursing home.

### Outcome

In all the 41 cases, 24 (58.5%) survived and 17 (41.5%) died. The GOS was as follow: seventeen were death as scale 1; two were in scale 2 due to vegetative state under ventilation support; three needed for assistance in daily life as scale 3; four were in scale 4 and fifteen was in scale 5 due to they had light damage with minor neurological deficits. The patients were divided into two groups:

**Table 1**  
Patient demographics ( $n = 41$ ).

Items	$n$ (%)
Age (years, mean $\pm$ SD)	55.54 $\pm$ 15.15
Male age ( $n = 23$ )	48.13 $\pm$ 12.30
Female age ( $n = 18$ )	65.00 $\pm$ 13.23
Gender	
Male	23 (56.10)
Female	18 (43.90)
Gender	
Male	23 (56.10)
Female	18 (43.90)
Underlying	
A: Psychologic disease	20 (48.80)
B: Malignancy	8 (19.50)
A + B	4 (9.80)
Non-A, non-B or unknown	17 (41.50)
OHCA	18 (43.90)
Non-OHCA	23 (56.10)
Glasgow outcome scale	
1. Death	17 (41.46)
2. Persistent vegetative state	2 (4.88)
3. Severe disability	3 (7.32)
4. Moderate disability	4 (9.76)
5. Low disability	15 (36.58)

Abbreviation: OHCA: out-of-hospital cardiac arrest.

good functional outcome (GOS in 4–5) and poor functional outcome (GOS in 1–3). The results were summarized in Tables 2 and 3. Nineteen cases (46.34%) had good functional outcomes and twenty-two (53.66%) had poor functional outcomes. These two groups had similar age, sex, emergency medical service (EMS) response and transport time.

Twenty-eight patients needed intubation with ventilation support at ED. Eleven patients survive but only six of them had good functional outcome after removed ventilator. Ischemic brain damage was the major complication of hanging injury in our report (26/41 = 63.41%), and cervical spine fracture or laryngotracheal fracture was not found.

GCS = 3, pupil dilation and no pupillary light reflex at scene or ED were predictors of poor functional outcome. OHCA, acidosis (pH < 7.2) and the need for intubation on arrival at ED were related to poor functional outcome. Poor functional outcome was noted in OHCA cases, although the percentage of ROSC for more than 24 hours rate had up to 50%, but only 2 cases (11.1%) had survival to discharge and these 2 survival cases had poor functional outcome (Tables 4 and 5). The two cases had no pupillary light reflex but their arterial blood gas showed no acidosis.

## Discussion

Hanging injury is classified as judicial or non-judicial. Judicial hanging is definite as a drop equal to or more than the body height.<sup>2</sup> Hyperextension of the neck which is caused by judicial hanging results in Hangman's fracture leading to spinal cord disruption and death.<sup>2,3</sup> The injuries resulting from hanging include hyoid bone fracture, laryngotracheal fracture, carotid injury, cerebral hypoxia and pharyngeal laceration.<sup>4–8</sup> Laryngotracheal injury should be considered when hoarseness, subcutaneous emphysema, dysphagia or hemoptysis appears.<sup>9</sup>

However, most of hanging injury is due to non-judicial hanging because the frequency of judicial hanging decreases and suicide is the major cause of non-judicial hanging.<sup>4,10</sup> The pathophysiological mechanisms of non-judicial hanging are jugular venous compression, brain hypoxia, loss of consciousness within 15 seconds, decreased muscle tone and then death within 5 minutes from cardiac arrest due to carotid sinus stimulation or from complete airway/arterial occlusion due to soft tissue swelling.<sup>3,4,7,11,12</sup>

OHCA cases had a very poor functional outcome in our study. Although the ROSC rate is 50%, the overall survival rate is very low (11.1%) and the functional outcome is poor (Table 5).

**Table 2**  
Comparison of predictors of alive and death patients caused by hanging.

Items	Survival ( $n = 24$ )	Death ( $n = 17$ )	$p$
Age*	52.92 $\pm$ 13.3	59.24 $\pm$ 17.1	0.093
Male	15 (62.50)	8 (47.06)	0.332
Alcohol use	2 (8.33)	0 (0)	0.225
EMS response time (min)*	7.12 $\pm$ 9.10	6.35 $\pm$ 3.01	0.365
EMS transport time (min)*	17.96 $\pm$ 9.8	15.29 $\pm$ 4.3	0.367
OHCA	2 (8.33)	16 (94.11)	<0.001
Pre-hospital CPCR time (min)*	1.25 $\pm$ 2.80	13.60 $\pm$ 5.27	0.001
Hospital CPCR time (min)*	0.42 $\pm$ 1.41	19.52 $\pm$ 14.50	<0.001
GCS at scene*	8.38 $\pm$ 4.80	3 $\pm$ 0	<0.001
Pupil dilated at scene	4 (16.67)	15 (88.23)	<0.001
No pupillary LR at scene	2 (8.33)	17 (100.0)	<0.001
GCS at ER*	8.67 $\pm$ 4.60	3.00 $\pm$ 0.00	<0.001
Pupil dilated at ER	4 (16.67)	15 (88.23)	<0.001
No pupillary LR at ER	3 (12.50)	17 (100.0)	<0.001
Acidosis	0 (0)	17 (100.0)	<0.001

Note: \*means data are expressed as mean  $\pm$  SD, otherwise are expressed as  $n$  (%). Abbreviation: EMS: emergency medical service; OHCA: out-of-hospital cardiac arrest; CPCR: Cardio-pulmonary-cerebral resuscitation; GCS: Glasgow Coma Scale; LR: light reflex of pupil; ER: emergency room.

**Table 3**  
Predictors of functional outcome of hanging injury.

Items	Good functional outcome (n = 19)	Poor functional outcome (n = 22)	p
Age*	53.26 ± 14.9	57.50 ± 15.35	0.737
Male	15 (62.50)	8 (47.06)	0.036
Alcohol use	2 (10.50)	0 (0)	0.001
EMS response time (min)*	4.32 ± 3.3	8.95 ± 8.8	0.147
EMS transport time (min)*	20.11 ± 9.9	14.05 ± 4.7	0.010
OHCA	0 (0)	18 (81.80)	<0.001
Pre-hospital CPR time (min)*	0.53 ± 1.0	11.55 ± 6.6	<0.001
Hospital CPR time (min)*	0.00 ± 0.0	15.50 ± 14.8	<0.001
GCS at scene*	9.63 ± 4.6	3.14 ± 0.64	<0.001
Pupil dilated at scene	4 (16.67)	15 (88.23)	<0.001
No papillary LR at scene	0 (0)	20 (90.90)	<0.001
GCS at ER*	9.84 ± 4.3	3.27 ± 1.2	<0.001
Pupil dilated at ER	2 (10.50)	17 (77.27)	<0.001
No papillary LR at ER	0 (0)	20 (90.90)	<0.001
Acidosis	0 (0)	17 (77.27)	<0.001

Note: \*means data are expressed as mean ± SD, otherwise are expressed as n (%).

Abbreviation: EMS: emergency medical service; OHCA: out-of-hospital cardiac arrest; CPR: Cardio-pulmonary-cerebral resuscitation; GCS: Glasgow Coma Scale; LR: light reflex of pupil; ER: emergency room.

**Table 4**  
Out-hospital cardiac arrest due to hanging (n = 18).

Items	mean ± SD
Age (years)	57.50 ± 16.1
Gender	
Male [n (%)]	10 (55.56)
Female [n (%)]	8 (44.44)
EMS response time	9.67 ± 9.66
EMS transport time	14.44 ± 4.38
Pre-hospital CPR time	13.06 ± 5.07
Hospital CPR time	19.00 ± 14.21
ROSC [n (%)]	9 (50.00)
Survival [n (%)]	2 (11.11)

Abbreviation: OHCA: out-of-hospital cardiac arrest; EMS: emergency medical service; CPR: Cardio-pulmonary-cerebral resuscitation; ROSC: return of spontaneous circulation.

**Table 5**  
Comparison of ROSC and non-ROSC of OHCA due to hanging.

Items	ROSC (n = 9)	Non-ROSC (n = 9)	p
Age (year)*	64.11 ± 13.30	50.89 ± 16.42	0.069
Male	3 (33.30)	5 (55.56)	0.357
EMS response time (min)*	12.78 ± 12.72	6.56 ± 3.84	0.394
EMS transport time (min)*	16.22 ± 4.63	12.67 ± 3.50	0.11
Pre-hospital CPR time (min)*	13.67 ± 6.14	12.44 ± 4.00	0.622
Hospital CPR time (min)*	7.00 ± 3.50	31.00 ± 9.64	<0.001
GCS at scene*	3.00 ± 0.00	3.00 ± 0.00	1.000
Pupil dilated at scene	8 (88.89)	9 (100)	0.317
No papillary LR at scene	8 (88.89)	9 (100)	0.317
GCS at ER*	3.00 ± 0.00	3.00 ± 0.00	1.000
Pupil dilated at ER	8 (88.89)	9 (100)	0.317
No papillary LR at ER	9 (100)	9 (100)	1.000
Acidosis	7 (77.78)	9 (100)	0.145
Severe disability	9 (100)	9 (100)	1.000
Mortality	7 (77.78)	9 (100)	0.145

Note: \*means data are expressed as mean ± SD, otherwise are expressed as n (%). Abbreviation: ROSC: return of spontaneous circulation; OHCA: out-of-hospital cardiac arrest; EMS: emergency medical service; CPR: Cardio-pulmonary-cerebral resuscitation; GCS: Glasgow Coma Scale; LR: light reflex of pupil; ER: emergency room.

Low survival rate and poor outcome are also reported in other studies.<sup>13,14</sup>

Dilated pupil sizes, diminished pupillary light reflex and low GCS (=3) at scene hint a poor outcome when EMS arrives. Although oxygen is used immediately by EMS, poor functional outcome is still found because cerebral cells are very sensitivity

to hypoxia. The same factors (dilated pupils, diminished pupillary light reflex and GCS = 3) in ED are also indicators of poor functional outcome.<sup>2,3,6,7,11,15</sup> According to our study, GCS for all deaths was 3 points (n = 17); and there were 25 cases with GCS = 3 at scene, of which there were 17 deaths and 6 patients with poor prognosis (when they discharge, two patients with GCS = 8, two patients with GCS = 6 and two patients with GCS = 3). These six cases required tracheostomy to help breathe. One retrospective study found all patients with scene GCS>3 have a normal recovery.<sup>2</sup> Our study also found a patient with GCS>3 will have a good functional outcome. None of the patients with GCS>3 has a poor functional outcome. There are six patients had GCS<8 at the scene (GCS = 6, 3 patients; GCS = 7, 1 patient; GCS = 3, 2 patients) who achieved a good functional outcome. For the two cases with GCS = 3, pupil reflex is detected in the field. The study recommend to provide active treatment to the hanging cases whose GCS was more than three points, because six cases of GCS<8 were found to have a very good prognosis. At ED, acidosis arterial blood gas (pH < 7.2) is also a predictor of poor outcome, and all cases of acidosis died.

The real duration of hanging is difficult to know. We cannot get the accurate time of hanging. Hence, we used EMS response and transport time to cover this part. Further studies need to collect more data. This study was a retrospective study, so it is difficult to obtain a more detailed score, such as Karnofsky Performance Scale. However, this is an important point for further study on hanging injury.

Cervical hanging is a problem in today's society. Identification of the injury and the outcome is difficult at initial stage. The cervical spine injury is uncommon, but the immobilization must be maintained till the spine injury is excluded, especially in patients remain unclear. Airway control and adequate oxygenation are also very important. To find the clues of the injuries and to perform adequate examinations should be kept in mind. CT should be performed when brain, vascular, tracheal or spinal injury is suspected.

GCS, pupil size, pupillary light reflex, CPR and acidosis are useful as prognostic factors. GCS of 3 leads to a very poor outcome. However, the functional outcome seems good in the group of GCS>3. For the reason, aggressive treatment is highly suggested for those patients whose GCS is more than 3 at ED.

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