Brief Report
Reducing mortality in near-hanging patients with a novel early management protocol

Muralitharan Tharmarajah, MBBS, PGDEM, MEM, Hamza Ijaz, BS, Mimi Vallabhai, MBBS, PGDEM, MEM, Narendra Nath Jena, MBBS, MEM, FAEM, FIAEM, MPH, Maxine LeSaux, BS, Jeffrey P. Smith, MD, MPH, Chen Chen, MS, Yan Ma, PhD, Katherine A. Douglass, MD, MPH, Andrew C. Meltzer, MD, MS,a,*

a Meenakshi Hospital and Research Centre, Thanjavur, India
b George Washington University School of Medicine & Health Sciences, Washington, D.C., United States of America
c Institute of Emergency Medicine, Meenakshi Mission Hospital and Research Centre, Madurai, India
d Department of Emergency Medicine, George Washington University School of Medicine & Health Sciences, Washington, D.C., United States of America
* Department of Epidemiology and Biostatistics, Milken Institute School of Public Health, George Washington University Milken Institute School of Public Health, Washington, D.C., United States of America

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A B S T R A C T
Background: Hanging is one of the most common causes of suicide world-wide, more prevalent in developing countries. There are no established protocols for early management of near-hanging patients who present to the emergency department (ED). The use of early intubation, strict blood pressure control and targeted temperature management has shown promise in small studies.

Objective: To detect changes in mortality and neurological deficits in near-hanging patients before and after implementation of a novel early management protocol in a tertiary care hospital in India.

Methods: Prospective cohort study conducted at a tertiary-care hospital in Tamil Nadu, India from August 2014–July 2016. For first year of study (pre-implementation), near-hanging patients were treated without a structured protocol. For second year of study (post-implementation), near-hanging patients were treated per a protocol including early intubation, strict blood pressure control and targeted temperature management. Primary outcomes included: (1) in-hospital mortality and (2) hospital discharge without neurological deficit.

Results: 65 patients were included (27 in the pre-implementation phase and 38 in the post-implementation phase.) At presentation, there was no difference between the two groups in mean heart rate, mean arterial pressure, mean oxygen saturation, Glasgow coma score, or mean respiratory rate. Protocol implementation decreased mortality (10/27 (37%) versus 35/38 (92%), P < 0.05) and increased the number of patients discharged without neurological deficit (10/27 (37%) versus 35/38 (92%), P < 0.05).

Conclusions: This novel early management protocol reduced mortality and increased the number discharged without neurological deficit in near-hanging patients in a single tertiary care center in India.

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1. Introduction

1.1. Background

Approximately 800,000 people die due to suicide every year and most suicides occur in low- and middle-income countries [1]. Hanging is a common cause of suicide world-wide, along with poisoning and self-immolation in rural regions of India [2–4]. Suicide is more common in young adults and leads to a significant social, emotional, and economic burden on Indian society [5]. Near-hanging victims can present to the emergency department (ED) with a wide range of symptoms, from patients who are completely stable to acute respiratory failure and shock, to anoxic brain injury [6]. Poor prognosis is associated with a Glasgow Coma Scale (GCS) <8, systolic blood pressure <90 mm Hg, head CT imaging consistent with anoxic brain injury and hanging time longer than 5 min [7–9]. There are currently no established protocols for early management of near-hanging patients who present to the ED [10].

1.2. Importance

Early intervention and resuscitation for patients who present to the ED following near-hanging may reduce mortality and improve neurological recovery [11,12]. The use of early intubation, strict blood
pressure control and targeted temperature management (TTM) has shown promise in small studies and related diseases such as cardiac arrest [11,13,14].

1.3. Objective

The objective of the study was to measure mortality rates in near-hanging patients before and after implementation of a novel protocol for early management in a tertiary care center in Tamil Nadu, India.

2. Materials and methods

2.1. Study design and setting

This prospective cohort study was conducted at the tertiary-care referral center of Meenakshi Hospital in Thanjavur, India with over 200 beds, including 45 ICU beds. The study took place over two years: the pre-implementation phase occurred August 2014–July 2015 and the post-implementation phase occurred August 2015–August 2016. The study design was approved by the ethical committee in Meenakshi Hospital.

2.2. Selection of participants

Patients aged 13 and older who met the inclusion criteria defined as a “near-hanging” diagnosis were approached and consented through a family member. Patients who met the following exclusion criteria: 1) cervical spine injury; 2) carotid or vertebral artery dissection; 3) unstable neurological status. Research staff was unblinded and trained on standardized neurological evaluation.

2.3. Interventions

In the pre-implementation phase, diagnostic and management decisions were made by the treating physician and were not part of a structured protocol. Patients were typically oxygenated using high-flow non-rebreather masks versus standard early endotracheal intubation. Hypotension was managed with crystalloid fluids and vasopressor medications per treating physician but specific blood pressure goals were not established. No targeted temperature management protocol was available.

In the post-implementation stage, care was driven by an established protocol for early management based on three major goals: 1) early ED intubation, 2) strict control of mean arterial pressure (MAP) >65 mm Hg and, 3) targeted temperature management between 32 and 34 °C. The protocol was developed by a multi-disciplinary team of emergency physicians, intensivists, radiologists, pulmonologists, neurologists, critical care nurses and patient representatives. The primary focus of these three goals is to provide neuroprotection and reduce cytotoxic edema. Implementation of the protocol involved several steps. First, patients who had a GCS < 9, MAP < 65 mm Hg or oxygen saturation <94% on 81 oxygen were intubated immediately. Second, patients who had a MAP >65 mm Hg received a central venous line, an arterial line, and a urinary catheter. Third, near-hanging patients who met any one of the above two criteria had TTM initiated in the ICU for 24 h. TTM initiation was dependent on several factors including ED- based interventions, bed availability, equipment availability and reconciliation of logistical factors such as registration and finances. As part of TTM, temperature was maintained between 32 and 34 °C via cooling blankets with a forced air cooling machine, cold normal saline fluids, and ice packs. After 24 h of TTM, the cooling apparatus was weaned to zero over the course of 8 h. (Fig. 1) Providers were educated and protocol compliance was ensured by the presence of a protocol team member upon patient arrival to the ED.

2.4. Measurements and outcomes

Patient characteristics such as age, gender, vital signs, oxygen saturation, blood glucose, GCS, and temperature were recorded by research assistants at time of presentation. Patient clinical outcomes were characterized as: 1) survival to hospital discharge, 2) neurological deficit at hospital discharge, and 3) death. Clinical outcomes were recorded at the time of hospital discharge by research staff. Evaluation for neurological deficits was performed at discharge by research staff by recording a Glasgow Coma Score less than fifteen, the presence of speech abnormalities and presence of extremity weakness. Patients were instructed to return for follow-up five days post discharge and fifteen days post-discharge where they were seen again by research staff to confirm neurological status. Research staff was unblinded and trained on standardized neurological evaluation.

2.5. Primary data analysis

Continuous and discrete data were summarized using mean (±standard deviation) and frequency (percentage), respectively. Wilcoxon rank-sum test was used to compare continuous variables and Chi-square/Fisher's exact test was performed to compare discrete variables. An alpha of 0.05 was used as the cutoff for significance. All analyses were performed using SAS 9.4 (SAS Institute, Cary, NC).

3. Results

27 patients were enrolled in the pre-implementation phase and 38 patients in the post-implementation phase. Eleven patients were excluded from trial in the pre-implementation phase and six were excluded in the post-implementation phase. In the pre-implementation phase, five patients were excluded for being pregnant, three patients...
Table 1
Patient characteristics at presentation of pre/post-implementation phase.

<table>
<thead>
<tr>
<th></th>
<th>Pre-implementation phase (n = 27)</th>
<th>Post-implementation phase (n = 38)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (Mean ± SD*)</td>
<td>26.85 ± 9.41</td>
<td>31.97 ± 11.71</td>
<td>0.094</td>
</tr>
<tr>
<td>Female (n (%))</td>
<td>14 (51.85)</td>
<td>22 (57.89)</td>
<td>0.629</td>
</tr>
<tr>
<td>Time to ED (Mean ± SD)</td>
<td>215.70 ± 93.04</td>
<td>164.16 ± 138.75</td>
<td>0.004</td>
</tr>
<tr>
<td>Heart rate (Mean ± SD)</td>
<td>49.04 ± 14.90</td>
<td>54.16 ± 20.02</td>
<td>0.293</td>
</tr>
<tr>
<td>Mean arterial pressure (Mean ± SD)</td>
<td>63.38 ± 27.41</td>
<td>79.39 ± 32.69</td>
<td>0.078</td>
</tr>
<tr>
<td>Respiratory rate (Mean ± SD)</td>
<td>19.27 ± 8.84</td>
<td>23.57 ± 10.32</td>
<td>0.124</td>
</tr>
<tr>
<td>Oxygen saturation (Mean ± SD)</td>
<td>83.85 ± 15.48</td>
<td>80.68 ± 16.92</td>
<td>0.419</td>
</tr>
<tr>
<td>Blood glucose (mg/dL) (Mean ± SD)</td>
<td>156.44 ± 70.54</td>
<td>158.55 ± 71.44</td>
<td>0.942</td>
</tr>
<tr>
<td>GCS (Mean ± SD)</td>
<td>7.85 ± 3.45</td>
<td>7.53 ± 3.45</td>
<td>0.762</td>
</tr>
<tr>
<td>Temperature (°F) (Mean ± SD)</td>
<td>96.98 ± 1.42</td>
<td>96.87 ± 1.88</td>
<td>0.683</td>
</tr>
</tbody>
</table>

*SD: standard deviation.

were excluded for refusal of recommended medical treatment, two patients were excluded because they were in police custody and one patient was excluded for a C-Spine fracture. In the post-implementation phase, four patients were excluded for pregnancy, one patient was excluded due to a recent stroke and one patient was excluded for a concomitant poisoning. TTM was initiated at 215 min on average from time of ED presentation. The time to TTM initiation was dependent on factors of resource availability. At presentation, there was no difference in the age of patient, the mean heart rate, the mean MAP, mean oxygen saturation, mean GCS and the mean respiratory rate for the pre-implementation phase and the post-implementation phase (Table 1). There was a significant difference in time to ED presentation between the pre-implementation group and the post-implementation group. The duration of ICU stay in the pre-implementation phase was 13.7 days and 10.7 days in the post-implementation phase. (Table 2) In the pre-implementation phase, ten patients (37%) died prior to hospital discharge. Following protocol implementation, only two patients (5%) died. In the pre-implementation phase, ten patients (37%) were discharged without neurological deficits. In the post-implementation phase, 35 patients (92%) were discharged without neurological deficits. (Table 2).

4. Discussion

For near-hanging patients, introduction of an early management protocol that includes early intubation, strict blood pressure control and targeted temperature management was shown to reduce mortality and increase the rate of survival without neurological deficit at hospital discharge. To our knowledge, this is the largest controlled study to examine the benefits of an early management protocol for patients who survive attempted hanging.

Currently, there are no standardized protocols for management of near-hanging patients [10]. Providers focus on following the Advanced Trauma Life Support protocol and maintaining the airway via intubation and positive-pressure ventilation [10]. Resuscitation is managed via intravenous fluids. Cervical spine immobilization is often utilized to prevent spinal injury. Attention is also given to maintaining normoglycemia, and providing ventilator support [15,16]. Radiographic imaging and other management decisions are performed based on the clinical presentation and suspected vascular complications from the hanging attempt. If cerebral edema is suspected, close monitoring of intracranial pressure reduction and seizure prophylaxis may be indicated [17].

There is no validated clinical score to predict prognosis in near-hanging patients. The GCS is commonly used as a prognostic indicator as patients with a GCS > 12 are more likely to be discharged without neurological deficit [18]. However, in the post-implementation phase of this study, patients who presented with a low GCS still recovered with good neurological outcome. The two patients in the post-implementation group who died each had a prolonged time to initial ED presentation. Other patients presenting with a low GCS showed remarkable recovery with limited neurologic deficit. Targeted use of the protocol could improve efficiency of resource allocation in healthcare environments with a scarcity of resources.

In addition to being the largest cohort study on near-hanging patients, there are several other strengths of this study. First, the patient characteristics (age, gender, heart rate, capillary blood glucose, temperature) of the pre/post-protocol implementation groups were similar. Second, this study was conducted in a real-world ED environment and the protocol could likely be replicated at other hospitals. Third, the highly promising results suggest that a controlled study on optimal management of near-hanging patients is warranted.

There are several limitations to this study. First, as with all studies that utilize historical (before-after) controls, the experimental and control group may have been different in unmeasurable ways. There was a measurable difference in time to ED presentation in the post-implementation group which may have played an important role. There are many potential explanations for the quicker presentation, including greater awareness, earlier recognition and possibly increased utilization of resources. Pre-hospital Emergency Medical Services in this province of India are less reliable than in US and European countries, and are infrequently used [19]. The overall development of Emergency Medicine is relatively new, so it is plausible that the existence of an organized ED at this institution could explain the quicker time to presentation, or there are other unknown factors. It is unknown to what extent, if at all, the factor of time to presentation was independently important in the improved outcome of patients in the post-implementation group, considering the patient groups were otherwise similar in clinical factors. Second, we did not measure the duration of hanging time in either group which is a crucial factor in determining prognosis. Third, the early management protocol was carried in ways that may have varied for some patients in the same allocation group. For example, endotracheal intubation and central line placement could have occurred in either the ED or the ICU. Finally, this study was not designed to distinguish which aspect of the early management protocol was most responsible for the improvement in clinical outcomes.

5. Conclusion

Early management protocol for near-hanging patients in India was associated with an increase in both survival to hospital discharge and an increase in survival without neurological deficit. Based on the results of this trial, early endotracheal intubation, avoidance of hypotension...
and targeted temperature management should be considered in near-hanging patients. Future controlled studies are needed to confirm these findings.

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