A case report of successful treatment of severe traumatic brain injury by prolonged targeted temperature management

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To the Editor: A 19-year-old Chinese woman presented with a coma after a traffic accident on August 22, 2019. After the injury, she was moved to Guangxi University of Traditional Chinese Medicine First Affiliated Hospital with a diagnosis of severe traumatic brain injury (sTBI) with cerebral herniation [Figure 1A] and underwent craniotomy evacuation of hematoma and decompressive craniectomy twice. The patient was transferred to the intensive care unit (ICU) two days after the surgery. She has been in a coma since sTBI, and her other medical histories were unremarkable. On physical examination at admission, with a Glasgow Coma Scale (GCS) of 3, her vital signs showed a temperature of 35.3°C, blood pressure of 151/128 mmHg, and pulse of 90 beats/min. Her pupils were 3.5 mm in diameter and reactionless. A surgical scar was observed on the right side of the skull, and the missing part of her skull measured 10 cm × 10 cm. Two drainage tubes were implanted in the epidural space. She had undergone a tracheotomy and was given sedation and ventilator breathing, with a peripheral oxygen saturation of 100% on 50% fraction of inspired oxygen. Pathological signs were negative, and corneal reflex could not be elicited. There was skin abrasion on her waist, buttocks, and left hand. Other physical examination findings were unremarkable. Laboratory work was significant, with a procalcitonin (PCT) of 0.688 μg/L, high-sensitivity C-reactive protein (CRP) of 48.04 mg/L, CRP of >10 mg/L, creatine kinase of 1259 U/L, interleukin 6 of 31.62 pg/mL, hemoglobin of 92.3 g/L, white blood cell count of 15.3 × 10^9/L, neutrophil count of 14.24 × 10^9/L, platelet count of 140.6 × 10^9/L, and bilirubin of 4.8 μmol/L. Other laboratory findings were unremarkable. Computed tomography (CT) scan of the head showed epidural and subdural hematomas and severe cerebral edema with loss of sulci/gyri differentiation [Figure 1B]. To reduce oxygen consumption and alleviate brain edema and secondary damage to the nervous system, we immediately placed the patient under targeted temperature management (TTM) in addition to standard treatments, including mechanical ventilation, neuro-nutrition, osmotherapy, and prophylactic antimicrobial therapy of sTBI. The device for TTM we supplied was an ARCTIC SUN® 5000 Temperature Management System (Bard Medical, USA). The initial target temperature was set at 35 to 36°C; we used a cooling blanket to achieve the goal temperature and a nasal probe to continuously monitor the brain temperature. Arteries ice compressions, alcohol bath, and antipyretic were also provided in case of non-ideal effects of the cooling device. At the same time, we provided propofol 50 mg and dezocine 2.5 mg every 1 h for continuous sedation and analgesia and muscle relaxation to reduce man-machine confrontation and muscle fibrillation. During the treatment, the patient’s vital signs were stable, and her body temperature was maintained in the ideal range; she was well adapted to the ventilator, the ventilation parameters were gradually decreased, the bispectral index (BIS) monitoring indicated that her consciousness was gradually regained, and the changes in PCT values showed no increased risk of infection. The trends in body temperature, PCT, and BIS during TTM are shown in Figure 1F. The epidural drainage tubes were removed on day 9 of admission and the incision healed well. The repeated head CT on day 4 [Figure 1C] and day 13 [Figure 1D] showed that the cerebral edema was alleviated gradually, and then the target temperature was set to 36 to 37°C; the patient was then weaned from the ventilator and sedative and analgesic drugs. The patient regained consciousness on day 15, and she received inpatient pulmonary rehabilitation and physical exercises on day 19. TTM was terminated on day 22 after repeat CT showed complete resolution of the brain edema [Figure 1E], and the tracheal tube was removed on day 29. During TTM, no serious muscle fibrillation, coagulation disorder, bleeding events, arrhythmia, hypotension, gastric retention, delayed wound "
healing, or other complications occurred. Continuous monitoring of coagulation indicators and platelet counts showed no abnormalities. The patient was able to pull herself to the standing position and was able to sit down on her own on day 36, after which she was transferred to the general ward. After a half month of rehabilitation, she was able to walk independently and complete activities of daily living and was discharged on October 17, 2019.

Our case was a presentation of a young female who suffered from sTBI and a coma caused by a traffic accident who successfully recovered despite her poor initial prognosis. After sTBI, diffuse axonal injury, damage to the blood–brain barrier, excessive release of inflammatory factors, cerebral edema, and elevated intracranial pressure were closely related to poor prognosis. Previous studies have shown that timely initiation of TTM can decrease exudation and prevent vasogenic edema, reduce free radicals that were generated during cerebral hypoxia-ischemia and reperfusion, and reduce the metabolic rate and energy consumption; it can also be a means of inducing immune tolerance for immunoregulation, though there are no standard guidelines or unified management methods for TTM.

Most of the previous studies believed that the target temperature should be set at 32 to 34°C, and the duration of TTM was usually < 72 h, while the cooling therapy was unable to cope with peak edema, which appeared mostly on days 3 to 5 after trauma so that the improvement in prognosis was not significant. Meanwhile, overaggressive hypothermia therapy may result in a series of complications, such as circulatory imbalance, cardiac dysfunction, blood coagulation disorders, and immunosuppression; therefore, such hypothermia strategies are not usually recommended for sTBI. In contrast, the target temperature range in this study was set at 35 to 36°C, which was a milder setting than the usual definition of mild hypothermia and allowing the patient to avoid the risk of complications such as bleeding, arrhythmia, and infection to a greater extent, while the adjustment of the target temperature was based on the regression of brain edema.
suggested by head CT examination, which was more individualized. In this case, the mild hypothermia therapy lasted for 13 days, followed by normal temperature control until the entire TTM was completely terminated on day 22, the duration of which was much longer than that of other studies; therefore, the risk of free radical release and intracranial pressure re-escalation brought by sudden fluctuations in body temperature were avoided.

In this case, the patient had severe consciousness disorder, which was an indication for TTM. Although the patient was admitted to the hospital in critical condition with a predicted poor prognosis, after treatment with long-term TTM combined with mechanical ventilation, neuro-nutrition, osmotherapy, analgesia and sedation, and other treatments, her consciousness and autonomic respiratory function gradually recovered, the brain edema was alleviated, and neurological function was ultimately completely restored, which was a successful treatment experience. We hold that continuous analgesia and sedation therapy were the key measures to reduce cerebral oxygen consumption and avoid antagonism with ventilators and the occurrence of muscle fibrillation, which were also prerequisites for improving the prognosis. In addition, the patient’s youth, basic lack of underlying diseases, adequate nursing care, close monitoring of blood indicators, and neurological function were also key factors for the successful outcome.

In summary, prolonged TTM was effective in sTBI treatment, which could completely cover the entire period of cerebral edema after injury, reduce systemic oxygen consumption, and alleviate the systemic inflammatory and oxidative stress responses. In addition, appropriate analgesia, sedation, and even muscle relaxation during TTM were closely related to the patient’s recovery. The present results warrant further evaluation of TTM for the treatment of sTBI. A comprehensive, effective, and safe strategy for TTM needs to be confirmed by large-sample studies.

Declaration of patient consent
The authors certify that they have obtained the patient consent form. In the form, the patient has given her consent for her images and other clinical information to be reported in the journal. The patient understands that her name and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest
None.

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