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CASE REPORT

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Temperature management using an intervascular cooling device for a COVID-19 patient with refractory hyperthermia

Yuya Yoshino | **Michihito Kyo** | **Shinichiro Ohshimo** | **Nobuaki Shime**

Department of Emergency and Critical Care Medicine, Graduate School of Biomedical and Health Sciences, Hiroshima University, Hiroshima, Japan

Correspondence
Nobuaki Shime, Department of Emergency and Critical Care Medicine, Graduate School of Biomedical and Health Sciences, Hiroshima University, 1-2-3 Kasumi, Minami-ku, Hiroshima 734-8551, Japan.
Email: nshime@hiroshima-u.ac.jp

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Abstract

COVID-19 is a life-threatening disease complicated by hyperinflammation followed by multi-organ failure. Although refractory hyperthermia in COVID-19 contributes to an unfavorable prognosis, little is known about effective interventions. We present a case of successful temperature management using an intravascular cooling device in a patient with COVID-19 who developed refractory hyperthermia.

KEYWORDS

coronavirus, hyperpyrexia, temperature control

1 | INTRODUCTION

COVID-19 is a life-threatening disease complicated by hyperinflammation followed by multi-organ failure. Although fever is a common symptom of COVID-19, there are case reports of refractory hyperthermia of more than 41.1°C.[1] In a case series of six patients with refractory hyperthermia, all patients died, indicating that a markedly high body temperature may correlate with poor outcomes.[2]

Intravascular temperature management is indicated for patients with hyperthermia accompanied by heat stroke or a return of spontaneous circulation. However, little is known about the effectiveness of these interventions for infection-induced hyperthermia. Furthermore, to the best of our knowledge, there are no reports of intravascular temperature management for refractory hyperthermia in COVID-19 patients. We report the successful treatment of a patient with COVID-19 who developed refractory hyperthermia necessitating intravascular temperature management.

2 | CASE PRESENTATION

A 56-year-old man (height, 177 cm; weight, 114 kg) had been suffering a fever and cough for 7 days. The patient was admitted to our intensive care unit due to SARS-COV-2 pneumonia confirmed by polymerase chain reaction. On day 1, laboratory tests revealed elevated levels of C-reactive protein (CRP) (19.21 mg/dL) and ferritin (2531 ng/mL).

The patient was immediately intubated because of severe hypoxemia (PaO_2/F_IO_2: 80). On day 2, venovenous extracorporeal membrane oxygenation (VV ECMO) was initiated due to worsening oxygenation, and we successfully decannulated VV ECMO on day 8. On day

13, a tracheostomy was performed because of the difficulty in weaning him from mechanical ventilation. Dexamethasone was administered 7 days after admission.

On day 15, the patient developed a high fever of unknown origin, with a body temperature of 41.2°C, blood pressure of 120/54 mmHg, heart rate of 128 beats/min, and respiratory rate of 26/min. Despite the administration of acetaminophen, sedatives, and a muscle relaxant, the refractory hyperthermia persisted. Owing to concerns about multi-organ dysfunction and increased oxygen consumption, cooling was implemented with an intravascular temperature management system (IVTM™; ZOLL Medical Corporation) using an intravascular catheter (ICY®; ZOLL Medical Corporation) via the left femoral vein. The body temperature decreased to 38.0°C in 4 h and remained at 38.0°C. On day 16, the body temperature increased again to 40.6°C despite setting the target body temperature to 38.0°C in the steady-state mode. The patient's hemodynamics rapidly deteriorated with progressive hypotension (blood pressure: 84/40 mmHg), tachycardia (130 beats/min), and hyperlactatemia (4.1 mmol/L) under the support of 0.35 μg/kg/min of noradrenaline. The patient's respiratory status also deteriorated with low oxygenation level (PaO_2/F_IO_2: 80) and tachypnea (32/min). Laboratory tests revealed elevated levels of CRP (12.5 mg/dL) and ferritin (1494 ng/mL) and normal levels of white blood cell (4180 /μL), platelet (163,000 /μL) total bilirubin (0.8 mg/dL) and creatinine (0.79 mg/dL). The IVTM™ setting was changed to the fastest mode at the target body temperature of 38.0°C. Furthermore, muscle relaxants were continuously administered to prevent shivering. After achieving the target body temperature of 38.0°C, the hemodynamic and respiratory status improved, with a blood pressure of 120/75 mmHg under the support of 0.2 μg/kg/min of noradrenaline, heart rate of 100 beats/min, and respiratory rate of 22/min, oxygenation level (PaO_2/F_IO_2: 200; Figure 1). The lactate levels gradually decreased. Prophylactic anticoagulation was administered during temperature management. On day 17, IVTM was stopped because the body temperature could be maintained at 38°C in steady-state mode, and the lactate level improved (2.1 mmol/L). Laboratory tests revealed elevated levels of CRP (33.7 mg/dL). On day 18, the muscle relaxants were discontinued.

Despite negative blood and urinary cultures, normal computed tomography report, and discontinuation of propofol to exclude propofol infusion syndrome, the cause of the fever was unknown. On day 34, the patient was removed from mechanical ventilation. On day 35, a cytomegalovirus C7-HRP test was positive, and a colon biopsy showed large cells with intranuclear inclusion bodies. The patient was treated with ganciclovir for cytomegalovirus enteritis, which resolved the fever. Contrast-enhanced computed tomography before hospital discharge revealed no thrombus formation. The patient was transferred to a rehabilitation hospital on day 62.

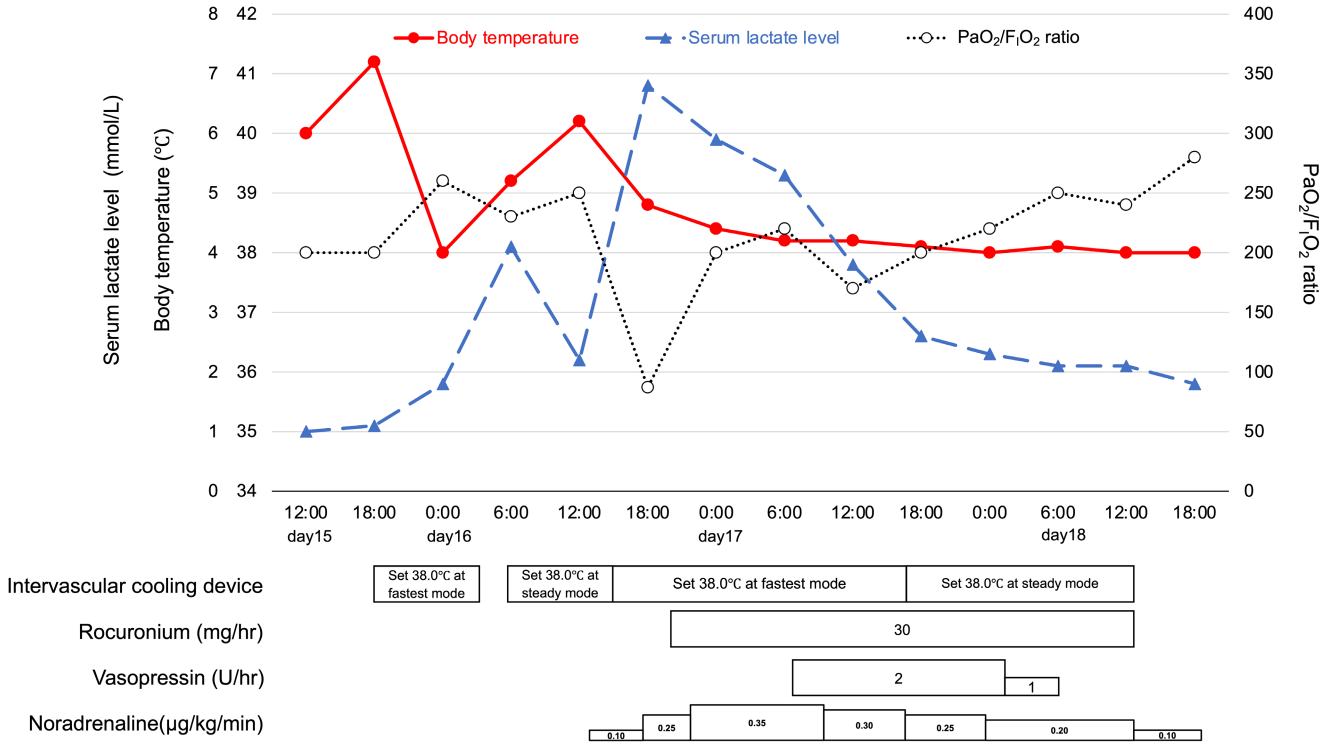

FIGURE 1 Clinical course of the patient. The graph shows the clinical course of a patient with COVID-19 who developed refractory hyperthermia. On day 15, cooling with an intravascular cooling device was initiated for refractory hyperthermia (41.2°C) to achieve the target body temperature of 38.0°C. Closed circle, body temperature; open circle, PaO_2/F_IO_2 ratio; closed triangle, serum lactate level.

3 | DISCUSSION

Herein, we describe a patient with COVID-19 who developed refractory hyperthermia and underwent temperature management without complications using a novel intravascular device.

In critically ill COVID-19 patients, refractory hyperthermia may be a risk factor for mortality. In an observational study of 103 intubated patients with COVID-19, 14 patients with peak body temperatures of >40.5°C died during hospitalization.[3] Indeed, we previously experienced a similar case in which a patient with COVID-19 developed refractory hyperthermia (43.5°C) with multiorgan dysfunctions on day 13. Despite various therapeutic interventions other than intravascular cooling, the patient's elevated temperature remained unresponsive and the patient died within a short period of time. Although there is still no clear evidence of the optimal interventions for infection-associated hyperthermia, a randomized controlled trial involving external cooling of patients with septic shock showed that external cooling was associated with a significant reduction in 14-day mortality.[4] Additionally, there is a report of a hyperthermic patient with COVID-19 who was successfully treated using Blanketrol®III, an automated surface cooling device, to maintain normothermia.[5] Intravascular cooling devices, which are mainly used in patients with postcardiac arrest syndrome, may be superior to other external cooling devices in terms of cooling rate and temperature maintenance.[6] Therefore, we performed temperature management using an intravascular cooling device in this COVID-19 patient with refractory hyperthermia.

When using an intravascular cooling device, clinicians must be aware of complications, including shivering and deep vein thrombosis. Shivering can further increase oxygen consumption and exacerbate the oxygen supply–demand balance. In this case, shivering was prevented by setting the temperature to 38.0°C and using a muscle relaxant as appropriate. Regarding the risk of deep vein thrombosis, the diameter of the intravascular catheter is larger than that of standard central venous catheters, causing congestion of the blood flow. In this case, prophylactic anticoagulation was administered during temperature management.

In conclusion, we described a case of successful temperature management using an intravascular cooling device in a patient with COVID-19 who developed refractory hyperthermia.

AUTHOR CONTRIBUTIONS

Yuya Yoshino: Data curation; writing – original draft. **Michihito Kyo:** Conceptualization; supervision; writing – review and editing. **Shinichiro Ohshimo:** Supervision; writing – review and editing. **Nobuaki Shime:** Funding acquisition; supervision; writing – review and editing.

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CONFLICT OF INTEREST STATEMENT

None.

ETHICS APPROVAL

This study was conducted in accordance with the declaration of Helsinki.

CONSENT FOR PUBLICATION

Written informed consent was obtained from the patient to publish this report in accordance with the journal's patient consent policy.

ORCID

Yuya Yoshino https://orcid.org/0000-0002-6047-6911

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