Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
Severe Acute Respiratory Distress Syndrome in Potential Organ Donors—Rescue Prone Positioning: A Case Report

Agnieszka Dyla*, Marta Zając, and Wojciech Mielnicki
Anaesthesiology and Intensive Care Unit, District Hospital in Olawa, Olawa, Poland

ABSTRACT
Organ transplantation is a recognized treatment for many critical organ insufficiencies. One of the main problems in transplantation is the mismatch between organ donation and demand. It is very important to improve donor eligibility after brain stem death and to minimize insult to donatable organs by appropriate donor management. We present prone positioning as an effective supportive method of organ optimization in patients with acute respiratory distress syndrome with severe hypoxemia and hemodynamic instability.

ORGAN transplantation has become a last resort treatment for many organ insufficiencies in modern medicine. One of the main problems in transplantation is the mismatch between organ donation and demand [1,2]. This is the primary limitation for possible transplants, and patients are dying, especially while awaiting heart or lung transplant [2,3]. It is very important to improve donor eligibility after brain stem death and to minimize insult to donatable organs by appropriate donor management [4]. We present successful heart harvest from a donor with severe acute respiratory distress syndrome (ARDS), which was possible with prone position ventilation.

CASE REPORT
A 45-year-old man was admitted to the hospital because of confusion and impaired consciousness. His past medical history included hypertension and probable alcohol abuse. Just after admission to the emergency department, he developed convulsions and experienced cardiac arrest in pulseless electrical activity. Advanced life support was started immediately, and massive stomach content aspiration into the lungs was diagnosed. Return of spontaneous circulation was achieved in 7 minutes, but the patient’s condition was unstable. Two short cardiac arrests occurred in the consecutive hour, and return of spontaneous circulation was achieved with short advanced life support treatment. Head computed tomography was performed, and massive brain edema was revealed. Absence of reflexes and mydriasis were noticed, and brain stem death was suspected. At admission to the intensive care unit, the patient was unresponsive, with no brain stem reflexes. He was mechanically ventilated with fraction of inspired oxygen (FiO₂) 1.0, positive end-expiratory pressure (PEEP) 10 cm H₂O, and tidal volume 6 mL/kg, but severe hypoxemia persisted (partial pressure of oxygen, 27 mm Hg). His blood pressure was maintained with norepinephrine infusion in a dose of 0.3 mcg/kg/min. Echocardiography showed no cardiac abnormalities. Rescue bronchoscopy was performed, with clearance of aspirated stomach contents, but no improvement in partial pressure of oxygen was achieved. Lung ultrasonography revealed many bilateral B-lines. We decided to ventilate the patient in prone position for minimum of 16 hours, and found him to be responsive to proning. Oxygenation parameters improved significantly, and reduction of FiO₂ and PEEP was possible. Hemodynamic parameters also improved, and norepinephrine dose was reduced. When he was turned supine again, he deteriorated quickly and returned to his previous parameters (Fig 1).

In the second day of treatment, fever and increase in inflammatory parameters were detected, and empirical antibiotic for hospital-acquired pneumonia (pipacillin-tazobactam) was started with good response. Angiography computed tomography was performed because of detection of opioids in the patient’s blood at hospital admission. Brain death was confirmed with absence of intracerebral filling at the level of the carotid bifurcation of Circle of Willis, and lack of brain stem reflexes was confirmed. The process of brain death determination was prolonged for 24 hours because of time needed for reverse transcriptase–polymerase chain reaction result of severe acute respiratory syndrome coronavirus 2.

During the stay, the patient was ventilated mainly in prone position, with short periods of supination. Echocardiography was performed each time the patient was in supine position to exclude left and right ventricle impairment due to severe lung damage. Apnea tests were difficult to perform because the patient was significantly hypoxic during supine position. The patient was referred as a potential organ donor and eventually accepted for heart donation. Prone position ventilation was used continuously without supination even during the transfer to the operating room.

*Address correspondence to Agnieszka Dyla, District Hospital in Olawa, Baczynskiego 1, 55-200 Olawa, Poland. Tel: (+48) 713011397; Fax: (+48) 713011301. E-mail: a.dyla@zozolawa.wroc.pl

© 2020 Elsevier Inc. All rights reserved.
230 Park Avenue, New York, NY 10169

0041-1345/20
https://doi.org/10.1016/j.transproceed.2020.10.037

Transplantation Proceedings, 53, 1342–1344 (2020)
theater. Intraoperatively, the heart was evaluated as good for transplant, but the lungs were stiff, wet, consolidated, and severely damaged.

DISCUSSION

Transplantation still remains the only chance for treatment for many patients with end-stage organ failure. Mortality on the waiting list is high [5,6] because of imbalance between the number of available organs and potential recipients. Professional donor management with organ protective intensive care is an important task for the intensive care unit [6,7]. Increasing demand for transplantation has led to increased use of extended criteria organs or marginal donors [8]. In most cases hemodynamic and respiratory management of brain-dead donors (DBDs) is very similar to management of critically ill patients, with the goal of maintaining organ function. Additional problems in DBDs result from many severe physiological changes after brain injury and herniation [6]. In the presented case we used prone position as a rescue maneuver to prevent cardiac arrest and potential cardiac donation rather than as a tool for lung optimization. Prone position was effective and the harvest was possible. Surprisingly, during prone ventilation, the patient was very stable. It was possible to reduce PEEP and FiO₂, and we did not observe any sign of right ventricle overload or liver congestion, despite severe respiratory failure.

Prone position may result in improved ventilation-perfusion matching and regional improvement in lung aeration [9]. This ventilation strategy seems to act beneficially in most pathophysiological pathways in ARDS [9]. Additionally, prone positioning may act against ventilator-induced lung injury [10] and ventilator-associated pneumonia [11]. A protective ventilation strategy bundle (using 6 mL/kg of predicted body weight, PEEP 8-10 cm H₂O, Pplat < 30 cm H₂O, a closed circuit for tracheal suction, alveolar recruitment maneuvers) increased the number of lungs eligible for transplant [12,13]. However, neurogenic pulmonary edema [14] and ventilator-induced lung injury [15] are common in organ donors. We suggest that prone position may be a good solution in some cases and considered a safe and available method of lung function improvement also in marginal lungs donor. Another advantage of prone position ventilation could be reduction of PEEP leading to protection of other organs, especially the liver and kidney. In severe ARDS proning unloads the right ventricle by decreasing right ventricular enlargement and mean septal dyskinesia [16]. Prone position ventilation also increases cardiac preload, reduces right ventricular afterload, and increases left ventricular preload. This resulted in increased cardiac index only in patients with
preload reserve [17]. Prone positioning serves both the lung and the “right ventricle protective approach” of mechanical ventilation [18]. In potential organ donors, a catecholamine storm is typically observed [19, 20], which is a risk factor for deep hypotonia. All these hemodynamic changes are important risk factors of Takotsubo syndrome and left ventricle dysfunction [3]. Many potential heart donors are disqualified because they develop unexpected heart failure or regional wall motion abnormalities, which might be only transient [3]. In the presented case we observed significant hemodynamic improvement during prone position with significantly lower catecholamine requirement. We believe that it lowered the risk of catecholamine storm and serious cardiac complications, which could have affected potential heart transplant success.

CONCLUSIONS
In DBD management prone position might be considered a supportive method of organ optimization, especially in patients with severe hypoxemia not responding to standard ventilation strategies.

REFERENCES
[1] Tore Altun G, Corman Dincer P, Birtan D, Arslantas R, Kasap Yakin D, Ozdemir I, et al. Reasons why organs from deceased donors were not accepted for transplantation. Transplant Proc 2019;51:2202–4.
[2] Mehra MR, Canter CE, Hannan MM, Semigran MJ, Uber PA, Baran DA, et al. The 2016 International Society for Heart Lung Transplantation listing criteria for heart transplantation: a 10-year update. J Heart Lung Transplant 2016;35:1–23.
[3] Oras J, Douch R, Norberg E, Redfors B, Omerovic E, Delglen G. Left ventricular dysfunction in potential heart donors and its influence on recipient outcomes. J Thorac Cardiovasc Surg 2020;159:1333-41.e6.
[4] Souter MJ, Kirschken M. Brain death: optimizing support of the traumatic brain injury patient awaiting organ procurement. Curr Opin Crit Care 2020;26:155–61.
[5] Citerio G, Cypel M, Dobb GJ, Dominguez-Gil B, Frontera JA, Greer DM, et al. Organ donation in adults: a critical care perspective. Intensive Care Med 2016;42:305–15.
[6] Meyfroidt G, Gunst J, Martin-Loeches I, Smith M, Robba C, Taccone FS, et al. Management of the brain-dead donor in the ICU: general and specific therapy to improve transplantable organ quality. Intensive Care Med 2019;45:343–53.
[7] Hahnenkamp K, Böhler K, Wolters H, Wiebe K, Schneider D, Schmidt HH. Organ-protective intensive care in organ donors. Dtsch Arzteblatt Int 2016;113:552–8.
[8] McKeown DW, Bonser RS, Kellum JA. Management of the heartbeating brain-dead organ donor. Br J Anaesth 2012;108(Suppl. 1):i96–107.
[9] Kouklouras V, Papathanakos G, Papathanasiou A, Kakos N. Efficacy of prone position in acute respiratory distress syndrome patients: a pathophysiology-based review. World J Crit Care Med 2016;5:121–36.
[10] Gattinoni L, Protti A, Caironi P, Carlesso E. Ventilator-induced lung injury: the anatomical and physiological framework. Crit Care Med 2010;38(10 Suppl):S539–48.
[11] Li Bassi G, Torres A. Ventilator-associated pneumonia: role of positioning. Curr Opin Crit Care 2011;17:57–63.
[12] Miñambres E, Ballesteros MA, Rodrigo E, García-Migüelés A, Llorca J, Ruiz JC, et al. Aggressive lung donor management increases graft procurement without increasing renal graft loss after transplantation. Clin Transplant 2013;27:52–9.
[13] Mascia L, Boska K, Pasero D, Galli T, Cortese G, Donadio P, et al. Ventilatory and hemodynamic management of potential organ donors: an observational survey. Crit Care Med 2006;34:321–7 [quiz 328].
[14] López-Aguilar J, Villagrá A, Bernabé F, Murias G, Picentini E, Real J, et al. Massive brain injury enhances lung damage in an isolated lung model of ventilator-induced lung injury. Crit Care Med 2005;33:1077–83.
[15] Wheeler AP, Bernard GR. Acute lung injury and the acute respiratory distress syndrome: a clinical review. Lancet 2007;369:153–64.
[16] Vieillard-Baron A, Charron C, Caille V, Belliard G, Page B, Jardin F. Prone positioning unloads the right ventricle in severe ARDS. Chest 2007;132:1440–6.
[17] Jozwiak M, Téboul JL, Anguel N, Persichini R, Silva S, Chemla D, et al. Beneficial hemodynamic effects of prone positioning in patients with acute respiratory distress syndrome. Am J Respir Crit Care Med 2013;188:128–33.
[18] Repessé X, Charron C, Vieillard-Baron A. Acute cor pulmonale in ARDS: rationale for protecting the right ventricle. Chest 2015;147:259–65.
[19] Chiari P, Hadour G, Michel P, Piriou V, Rodriguez C, Budat C, et al. Biphasic response after brain death induction: prominent part of catecholamines release in this phenomenon. J Heart Lung Transplant 2000;19:675–82.
[20] Naredi S, Lambert G, Edén E, Zäll S, Runnerstam M, Rydenhag B, et al. Increased sympathetic nervous activity in patients with nontraumatic subarachnoid hemorrhage. Stroke 2000;31:901–6.