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Victory out of tragedy: organ donation

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SUMMARY

Major improvements in trauma care during the last decade have improved survival rates in the severely injured. The unintended consequence is the presentation of patients with non-survivable injuries in a time frame in which intervention is considered and often employed due to prognostic uncertainty. In light of this, discerning survivability in these patients remains increasingly problematic. Evidence-based cut-points of futility can guide early decisions for discontinuing aggressive treatment and use of precious resources in severely injured patients arriving in extremis.

ORGAN DONATION

The technological advancements in transplantation today have made organ donation a common and culturally accepted practice. As of January 2024, there were over 103 000 patients on the Organ Procurement and Transplantation Network/United Network for Organ Sharing waiting list.[1] Despite the continued advances in the field of transplantation, ongoing challenges continue to limit the accessibility of this life-saving procedure for a significant number of patients with end organ failure. There is no bigger challenge than the availability of organs for transplantation. In 2023, there were 42 601 organ transplants performed from 21 200 donors and over 6200 patients died while waiting for an available organ.[1] This disparity in organ supply and organ need continues as more and more patients are added to the transplant waiting list. The transplant community continue to work on ways to expand the donor pool and have made significant advances in recent years to improve the quality and quantity of organs available for the transplantation. Efforts include targeting peritransplant donor tissue damage, organ preservation, combating rejection, and even revisiting xenotransplantation, all to meet the demands of the ever-growing population of recipients.[2] Additionally, recent advances in antiviral drugs and the passage of the HIV Organ Policy Equity Act have allowed for expansion of the potential donor pool by including donors with HIV and hepatitis C virus.[3,4]

The majority of transplanted organs come from donors after neurological determination of death (DNDD).[1] These patients have catastrophic brain injury and often have complex physiological responses to the injury. Intensivists therefore play a crucial role in their management and ensuring that these patients preserve the option of organ donation. Understanding the complex physiology and implementing appropriate management strategies are keys to helping address the most significant challenge to organ transplantation. The following is a brief overview of the donor management process to help intensivists maximize donor potential.

Identifying potential donors

There are three major sources of organs used for transplants. These are from cadaveric 'brain-dead' donors (DNDD), cadaveric 'cardiac death' donors (donors after circulatory determination of death, DCDD), and living (related and unrelated) donors. Currently, the majority of transplanted organs come from DNDD. In 2023, there were 36 241 (85%) deceased donor transplants while there were only 6360 (15%) living donor transplants.[1] DCDDs currently comprise 30% of all deceased donors. This number has more than doubled in the past 10 years and accounts for the rise in organ donors during that same time period.[1]

Referral of potential donors

Once the potential donors have been identified, organ procurement organizations (OPOs) must be involved in the management of the donation process. This referral step should be taken as early as possible because early referral is associated with better outcomes including higher consent rates and conversion rates.[5] Early referral gives the OPOs the opportunity to form relationships with the caregivers, educate them on the details of the process, and attend to the unique ethical and social needs of each situation.

Of note, the task of obtaining consent to donate should not be performed by the physician but should be left to the staff of the OPOs since they have the necessary training and experience.

Team management approaches to donation

Like any successful process, the organ donation process requires teamwork. Aside from the primary physician, other members of the healthcare team play critical roles in guiding the families and supporting them in their grief. A senior physician should interact with the families early in the process and be identified as a ready source of support.

The presence of OPO staff housed within the hospital is also crucial for optimal donation outcomes. These in-house coordinators are usually nurses trained in organ procurement and they form strong bonds with donor families; providing support, ensuring the timings of discussions are appropriate, and adapting the approaches to the cultural backgrounds of the families.[6] They also ensure timely donor referral via donor surveillance, organize regular staff education sessions, and daily monitor the donation activities of the hospital.[7] Implementation of in-house coordinators has been shown to increase consent and conversion rates significantly.[6,7]

Pathophysiology of brain death

Neurological death is caused by the herniation of cerebral contents due to supranormal intracranial pressures. Early pontine ischemia results in a catecholamine surge with hypertension, known commonly as the first stage of the Cushing's reflex. As ischemia progresses caudally to the vagal nucleus in the medulla oblongata, the loss of baroreceptor reflexes and unopposed sympathetic activity results in a profound hyperdynamic state.[8] This sympathetic vasoconstriction causes compromise of end organ perfusion. As the brain continues to herniate, a sudden cardiovascular collapse can develop, in part due to direct catecholamine-induced myocardial injury and subsequent cardiac dysfunction, as well as destruction of pontine and medullary vasomotor centers.[9–12] The effects of this hemodynamic instability can cause marked damage to potentially donatable end organs. Understanding these physiological responses is important for the optimal care of the injured patient and maximal utility of donated organs.[13]

Systemic sequelae of brain death

Cardiovascular system

Two distinct profiles of hemodynamic activity are seen during the process of neurological death. The first is due to the catecholamine surge described above which leads to increases in heart rate, blood pressure, cardiac output, and systemic vascular resistance. The second is characterized by hemodynamic collapse which coincides with brain stem herniation and results in the loss of sympathetic activity causing profound vasodilatation, myocardial depression, and low levels of serum catecholamines.[14] The hemodynamic effects can be amplified by hypovolemia due to diabetes insipidus (DI) which is often present concurrently.

Pulmonary system

Increased systemic pressures and left atrial pressures during the catecholamine surge can result in elevated pulmonary artery pressures and subsequent endothelial damage, leading to direct pulmonary damage due to capillary leak. During cardiovascular collapse, intravenous fluid administration needed to maintain systemic blood pressure can cause further pulmonary damage due to volume overload, pulmonary capillary leak, and resultant development of pulmonary edema (neurogenic pulmonary edema, NPE).[14]

Lung protective strategies commonly used in the intensive care unit should continue to be performed in the potential organ donor. Pulmonary toilet maneuvers such as chest percussion, postural drainage, recruitment maneuvers, and serial bronchoscopy can also improve lung function.

Renal system

Sympathetic storm and the subsequent cardiovascular collapse have a deleterious effect on the renal system. Hypoperfusion of the juxtaglomerular cells of the kidney activates the renin-angiotensin-aldosterone axis, causing salt and water retention as well as vasoconstriction, which in turn can lead to compromised renal blood flow, glomerular and tubular injury, and ultimately renal insufficiency.[14] The maintenance of urine output to a minimum of 0.5 mL/kg/h, while avoiding the massive diuresis of DI, is the goal of renoprotective resuscitation.

Coagulation and thermoregulation disorders

Disorders of coagulation are a direct consequence of the release of thromboplastin, cerebrogangliosides, and plasminogen-rich substrate from traumatized brain tissue.[15] Hypothermia and acidosis, along with the dilution of clotting factors, fibrinogen and platelets, can contribute to a state of disseminated intravascular coagulation (DIC) and uncontrollable bleeding.[16] Massive transfusion protocols are often required. Hypothermia should be proactively addressed with patient warming devices, including heated intravenous fluids and ventilated gases.

The role of protocols in organ donation

Because of the complexities involved in the caring for the critically ill patient and the numerous considerations for optimizing donation, it is useful to have written guidelines to direct the steps taken during the organ donation process. Most organ donors donate after neurological determination of death and may have been earlier managed with the goal of optimizing brain tissue outcome. Many intensive care units have catastrophic brain injury guidelines, which are useful in guiding patients with neurological injuries to recovery.

For the potential donor with severe irreversible neurological injuries, however, care shifts from maximizing neurological recovery to the maintenance of the remaining organ systems. Often, there are conflicts about which organ systems to prioritize as attempts to optimize one system may be deleterious to another. Unless the intensivist knows a priori that a particular organ will not be suitable for transplantation, one is faced with a delicate balancing act between the competing needs of several different organ systems. Therefore, the use of a checklist of standardized critical care endpoints, or Donor Management Goals, or donor management protocols, will be beneficial in guiding care providers to optimize the number of organs suitable for transplant from donors.[17–19]

Resuscitation of potential donors

Optimal and aggressive critical care of the potential donor begins long before the declaration of death. To ensure that the donor organs would be of utmost benefit to the recipients, efforts must be made to ensure optimal organ status through the process of referral, consent, and organ recovery. The following components of resuscitation would be useful in addressing some of these responses.

Hemodynamic monitoring

To guide resuscitation and support, a recommended practice is to institute some sort of hemodynamic monitoring. The growing use of and comfort with bedside echocardiography and ultrasound has led them to be used routinely to help guide resuscitation strategies.

Fluid resuscitation

The goal of fluid resuscitation is to maintain optimal fluid status to preserve end organ perfusion. Fluid resuscitation is recommended to maintain a central venous pressure (CVP) of 8–12 mm Hg and a systolic arterial pressure between 90 and 140 mm Hg.[18]

The role of vasopressin

After the achievement of adequate fluid resuscitation, vasopressin should be considered as the first-choice hemodynamic therapy. Administration of vasopressin acts to inhibit the diuresis of DI and the resultant hypotension due to its catecholamine sparing effects and ability to counteract vasodilatation. Vasopressin is also usually seen to be deficient in donors who require catecholamine support.[20]

The role of thyroxine

The hemodynamic instability in DNDDs is partly due to low circulating levels of thyroxine. Therapeutic replacement with T3 has been associated with significant improvements in cardiovascular status, reductions in inotropic support, and decreases in donors lost from cardiac instability.[21 22] A 'T4 protocol' is recommended in situations where there are increased vasopressor requirements. This protocol consists of 1 ampule 50% dextrose, 2 g of solumedrol, 20 units regular insulin, and 20 μg of thyroid hormone (T_4), followed by a continuous infusion of 10 μg/h.[23]

The role of insulin

After the development of neurological death, insulin levels have been measured to decrease to 50% of baseline at 3 hours, and even further to 20% at 13 hours.[24] Keeping glucose levels under 150 mg/dL has been recommended for optimal outcomes.[18]

Managing potential complications

Brain death is associated with numerous complications such as DIC, DI, NPE, hypothermia, and cardiac arrhythmias.[13 23] Understanding and anticipating these complications is important for the managing physician. Early identification of these complications coupled with adequate supplementation is necessary to maintain hormonal balance, hemodynamic stability, and organ perfusion.

CONCLUSION

Organ donation is an important process that ensures the availability of organs for individuals whose only opportunities for survival lie on receiving transplants. Efforts to ensure the success of every step of the process are therefore of utmost importance. Recommendations for all institutions that care for the critically ill patient include incorporating skilled team-driven approaches to the consent process, protocol-guided steps for the management of potential donors, and adequate balance of the physiological status of donors. Optimal hemodynamic management, multidrug hormone replacement therapy, and efficient organ recovery are strategies to improve organ yield and the viability of donor organs.

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