The Potential Benefits of the Pediatric Nonheartbeating Organ Donor

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ABSTRACT. *Objective.* **To examine the population of the pediatric intensive care unit in a large children's hospital to determine the potential importance of pediatric nonheartbeating organ donors (NHBDs).**

Study Design. **We analyzed retrospectively the 6307 admissions to the pediatric intensive care unit at the Children's Hospital of Philadelphia from January 1992 to July 1996 to identify all deaths. The hospital records of the children who had died were then reviewed to determine the mode of death, organ donation rate of heartbeating donors, and the number of potential NHBDs. Criteria for the NHBD included the decision to forgo life-sustaining therapy, death occurring within 2 hours of withdrawal of life support, and the absence of sepsis, HIV, hepatitis, or extracranial malignancy.**

Results. **Of 319 deaths, 102 (32.0%) died with resuscitation, 84 (26.3%) were brain-dead, 111 (34.8%) had withdrawal of life support, and 22 (6.9%) were on do-not-resuscitate orders. Of the 84 brain-dead children, 74 (88.1%) were medically suitable heartbeating donors, and 43 (58.1%) donated organs. Of the 111 patients who had life support withdrawn, 31 (27.9%) qualified for NHBDs.**

Conclusions. **The routine use of the NHBD has the potential to increase organ donation at our institution by 42%. We discuss the ethical issues relating to NHBDs required to properly include these patients as potential organ donors.** ***Pediatrics*** **1998;101:1049–1052;** ***nonheartbeating organ donor, pediatrics, organ donation, transplantation, withdrawal of life support.***

ABBREVIATIONS. NHBD, nonheartbeating organ donor; PICU, pediatric intensive care unit; HBD, heartbeating donor.

As outcomes of organ transplantation continue to improve, more children are placed on waiting lists, causing waiting times to increase and more children to die before organs become available. Even though patients younger than 18 years account for 20% of all cadaveric organ donors, the number of pediatric organs is insufficient to provide organs for every needy child.[1] Child safety laws such as those requiring car seats and bicycle helmets have reduced further the number of fatal injuries in this age group,[2,3] thus decreasing the potential supply of organs. To cope with the inadequate supply of viable organs for transplantation, the transplantation community is examining alternative methods of organ recovery. One method that has received much scrutiny recently is the nonheartbeating organ donor (NHBD).

State and local governments have not addressed the NHBD; however, hospitals and organ procurement agencies are beginning to define the NHBD. One proposed definition for the NHBD is a patient who forgoes life-sustaining therapy, recognizing this will likely lead to death, and subsequently donates viable organs for transplantation. The decision to withdraw life support is reached by the patient or his/her surrogate in consultation with a physician. The decision is made because 1) the patient has a terminal disease and additional therapy is judged futile and prolongs the dying process, or 2) the patient's future quality of life is unsatisfactory to the patient and, therefore, not in the patient's best interest. After the decision to withdraw life support is reached, the option of organ donation is addressed, usually at the request of the family. The NHBD frequently goes to the operating room before withdrawing life support so that organs can be recovered shortly after death.

Recently, we cared for two children whose parents requested organ donation when the decision to withdraw life support was reached. The first child suffered a severe hypoxic ischemic insult after cardiac arrest from a home ventilator disconnect. The second child had an intracranial hemorrhage after being placed on extracorporeal life support for adult respiratory distress syndrome. These experiences led us to examine the issues surrounding the NHBD. The purpose of this study was to examine our pediatric intensive care unit (PICU) population to determine whether a significant number of patients would meet NHBD criteria and to estimate the potential impact of pediatric NHBD on organ procurement. These data provide the background for an evaluation of the ethical issues surrounding the NHBD.

STUDY DESIGN

We examined our database records of the 6307 patient admissions to the PICU at the Children's Hospital of Philadelphia from January 1992 through June 1996, to identify all the deaths. The hospital records of all deaths were reviewed to determine the mode of death, defined as dying after 1) a failed resuscitation attempt, 2) meeting criteria for brain death, 3) withdrawal of life support, or 4) an arrest with a do-not-resuscitate order. For patients dying after the withdrawal of life support, we identified the proximal cause of death and the time between withdrawal of life support and death to determine suitability for NHBD. Suitability for organ donation was defined as absence of severe sepsis, HIV or hepatitis infection, and extracranial malignancy,[4] and the occurrence of death within 2 hours of life support withdrawal to ensure organ viability.[5] The organ donation rate among children who died after brain death criteria was determined and provided an

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estimate for organ donation rates among those meeting NHBD criteria.

RESULTS

Mortality for the 54-month period was 337 of 6307 patients (5.34%). Medical records were unavailable for 18 of these patients, leaving 319 patients for analysis. More than one third of these patients died after forgoing life support (Table 1). Of the 111 patients who had life support withdrawn, 31 (27.9%) met our NHBD criteria, and two patients donated. Twenty-nine (93.5%) of these potential NHBDs suffered severe primary neurologic dysfunction as the proximal cause of death (Table 2). The two exceptions were a child with spinal muscular atrophy and a child with severe primary pulmonary hypertension. The time to death after forgoing life support was brief in the majority of these children, and <10 minutes in 58% (18/31) (Figure).

Of the 84 children who met criteria for brain death, 74 (89.1%) were suitable for organ donation. Forty-three (58.1%) of these patients, whose families consented to donation, became heartbeating donors (HBD).

DISCUSSION

The first organ donors in the 1960s were NHBDs, and some countries (eg, the Netherlands, Spain, and Japan) continue to frequently use these donors.[6] However, in the United States, NHBDs have not been widely accepted because of the establishment of brain death criteria. Recently, organ procurement agencies and hospitals have begun to reexamine NHBDs, because <50% of individuals on the transplant list receive organs annually.[1] To use these donors to their full potential, one must define the patient population, examine the potential impact on donation, and examine the ethical dilemmas surrounding the NHBD.

We found >25% of the children who died after discontinuing life support met criteria for NHBD. We cannot predict what percentage of eligible NHBDs will consent to donation, but we hope it will approximate that for the HBDs. If potential pediatric NHBDs donated at the same rate as HBDs, ~60% of candidates would have donated during the 54-month period. This would have resulted in a 42% increase in organ donors at our institution. Our data contrast with those of Nathan, from the Delaware Valley Transplant Program, who calculated a 20% to 25% increase if all severely brain-injured, but not brain-dead, patients forgoing life support could be NHBDs.[7] Our estimate may be higher because children >1 year of age are most likely to suffer severe neurologic injury[8] and qualify as NHBDs.

Our observations on modes and causes of death are similar to those for several other large children's hospitals. Investigators from these institutions found that 32% to 34% of children in PICUs die after forgoing life support.[9–11] Similarly, two of these studies reported that 43% to 47% of children forgoing therapy had severe neurologic injury.[8,9] These data indicate a potential for a substantial increase in organ donations if organ procurement agencies were permitted to approach all families of children who were forgoing life support.

One major concern with NHBDs is the warm ischemia time of the organs as death occurs. Our findings indicate that the vast majority of children with severe neurologic injury who have life support withdrawn die quickly and would have a short ischemia time if organ retrieval were desired. Additionally, our findings suggest that few of these children would return from the operating room alive and unable to donate organs.

The ethical issues surrounding NHBD include the declaration of death, circumstances surrounding withdrawal of life support, and the public perception of NHBD. Defining death appears simple on the surface; physicians have been declaring patients dead by cardiovascular criteria since Hippocrates. After the introduction of organ transplantation in the

TABLE 1. Modes of Death in the PICU

Mode of Death	Number of Patients	Percentage
Died despite resuscitation	102	32.0
Do not resuscitate	22	6.9
Withdrawal of life support	111	34.8
Brain death	84	26.3
Total	319	

TABLE 2. NHBD Candidates' Cause of Death

Cause of Death	Number of Patients
Closed head injury	4
Hypoxic ischemic encephalopathy s/p cardiac arrest	4*
Intracranial hemorrhage	3*
Static encephalopathy	3
Near-miss SIDS	3
Strangulation	3
Brain malignancy	2
Near drowning	2
Spinal cord injury	2
Congenital neuromalformation	1
Smoke inhalation	1
Meningitis	1
Pulmonary hypertension	1
Spinal muscular atrophy with pneumonia	1

* One patient in each group donated organs.

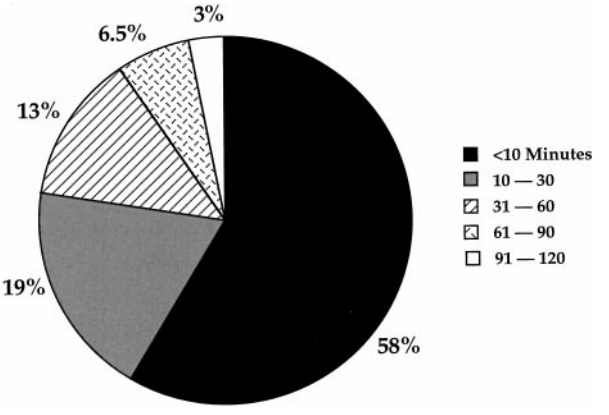

Figure. Time from withdrawal of life support until death in NHBD candidates.

1960s, however, new philosophical questions arose because society embraced the idea that a person could be dead but still have viable organs that could function in another human's body. National criteria for brain death were developed to guide physicians as they diagnosed individuals dead by these criteria. Unfortunately, guidelines for the determination of cardiovascular death were not developed. The discussion of NHBD has necessitated guidelines to ensure that the patient is dead before recovering organs, but also to minimize warm ischemia time. One recent suggestion is to define cardiovascular death as the period of pulselessness, apnea, and unresponsiveness, after which the patient's heart is unable to restart on its own or autoresuscitate.[12] Bircher suggests autoresuscitation will not occur after 1 to 2 minutes of pulselessness,[13] but little data exist to confirm this estimate. Others, however, reject this definition by raising the possibility that death does not occur in this short period because personhood does not end until the brain is completely dysfunctional. Studies indicate 10 minutes of absent blood flow is necessary for the brain to be irreversibly dead.[14] The Uniform Determination of Death Act defines death as either 1) irreversible cessation of circulatory and respiratory functions, or 2) irreversible cessation of all functions of the entire brain, including the brainstem.[15] Using this definition, an inconsistency does not exist because the absence of circulation and respiration is sufficient for death determination. We agree with the proposal by several institutions that a period of 2 to 4 minutes of pulselessness, apnea, and unresponsiveness is sufficient to declare death.[4] This period is consistent with the Uniform Determination of Death Act, because if a person asks to forgo life support and, therefore, cardiopulmonary resuscitation, and cannot autoresuscitate, circulation and respiration will irreversibly stop.

To prevent warm ischemia, the ideal place to withdraw life support is in the operating room, where the recovery of the organs can take place immediately after death. Unfortunately, the family traditionally is restricted from this environment. In addition, if the death does not occur as expected within a reasonable period (1 to 2 hours), the organs will not be recovered for transplantation and, hence, the child must be returned to the PICU or another area to die. These logistical considerations may make the death of the child seem too unnatural for family and medical staff and require considerable advance planning and discussion so that negative perceptions of NHBD do not develop.

At the time life support is withdrawn, some of these patients may perceive pain, which should be relieved with analgesia. These medications may suppress the respiratory drive and raise the possibility of hastening the dying process. Despite this risk, it is well accepted that the primary effect of pain relief supersedes the secondary effect of respiratory depression.[16] Our opinion is that the child should receive adequate analgesia if the physician judges that the patient is able to perceive pain. Most potential NHBDs, especially in pediatrics, will have a significant neurologic injury and the need for analgesia likely will be minimal.

The issues of declaring death and circumstances surrounding the withdrawal of life support are debated because of public perception. The decision for a patient to be a NHBD may be perceived as a quality-of-life judgment and require coercion of the family to withdraw support to recover organs. It may appear that the physician is determining to end one child's life to benefit another person. This issue is not new; in our experience using current organ procurement protocols, some families of brain-dead children express fear that the physician is declaring a child dead just for the organs. To avoid this perception, we believe the decision to withdraw support must precede any discussion of organ donation. In addition, the person discussing organ donation ideally should not be involved with both the child who is dying and the potential recipients of the organs. This task may be more difficult in multidisciplinary PICUs, where trauma patients and transplant patients often are in the same unit.

Although the potential for public misconception exists, adult institutions have used NHBDs without any evidence of a decrease in organ donation rates.[4,17] We believe that families of critically ill children also will view NHBD policies favorably. This patient population has a history of high donation rates under current brain death donation policies,[18] and we expect that they will continue to have a high rate under well-designed NHBD policies.

In conclusion, we found that many children may qualify as NHBDs. We believe that benefits exist for individuals and society if pediatric NHBDs are pursued. To pursue the pediatric NHBD, clear definitions and policies concerning cardiorespiratory death must be developed, and studies examining the attitudes of health care professionals and the general public toward NHBD must be completed.

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