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Emergency medical services knowledge and attitudes about non-heart-beating donors: Effect of an educational intervention

Eileen J. Burker, PhD^{a,b}, David Fingerhut, PhD^c, Daria Ebnetter, PhD^e, Mallory Giza, MS^a, Rachel Espey Weber, MS^a, Peadar G. Noone, MbBch, BAO, MD^d, and Thomas M. Egan, MD, MS^e

^aDepartment of Allied Health Sciences, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina

^bDepartment of Psychiatry, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina

^cDepartment of Psychiatry, Indiana University School of Medicine, Indianapolis, Indiana

^dDepartment of Medicine, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina

^eDepartment of Surgery, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina

Abstract

Background—More than 750,000 people die of sudden death each year, and many are potential non-heart-beating donors (NHBDs) for lung transplant. Although critical, the role of emergency medical services (EMS) personnel in assisting with recovery of NHBD lungs has not been studied. The purpose of this study was to assess knowledge of and attitudes about NHBDs among EMS personnel, evaluate the extent to which knowledge and personal experience with organ donation is associated with attitude, and ascertain the effectiveness of an intervention designed to teach EMS professionals about NHBDs.

Methods—EMS professionals ($n = 361$) completed measures of knowledge of and attitudes about NHBDs and then watched a presentation by a transplant doctor about traditional organ donation, NHBDs, and transplantation. Participants were able to ask questions during and after the presentation. Participants completed the measures again 3 months later.

Results—EMS professionals had a high rate of personal experience with organ donation and positive attitudes toward traditional organ donation. However, they showed lack of knowledge about NHBDs and felt less skilled in being part of the NHBD process, consistent with knowledge scores. The educational intervention was somewhat effective in improving knowledge about NHBDs. Scores improved significantly on 5 of 13 items.

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Reprint requests: Eileen J. Burker, Division of Rehabilitation Counseling and Psychology, Department of Allied Health Sciences, CB #7205, University of North Carolina at Chapel Hill, Chapel Hill, NC 27599-7205. Telephone: +919-966-9125. Fax: 919-477-5865. eburker@med.unc.edu.

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Conclusions—Lung recovery from NHBDs offers the potential of a very large supply for transplantation. This research suggests that with additional training, EMS professionals may be willing to be part of a NHBD recovery team.

Keywords

emergency medical services; paramedics; non-heart-beating donors; educational intervention; lung recovery; lung transplant

Because of a shortage of organ donors for transplantation, more than 117,000 people in the United States await solid organ transplants.¹ The extreme need for donor organs contributes to decreased quality of life and death among wait-listed patients, high costs of medical care, and strict criteria for transplant eligibility. This is particularly true for lung transplant candidates.

Organ donors for lung transplant candidates have been brain-dead patients on mechanical ventilation, known as heart-beating donors (HBDs), and, more recently, donation after cardiac death donors (DCDs).² These represent a tiny fraction of annual deaths. Each year, there are more than 750,000 sudden deaths from all causes.³ In particular, 424,000 people a year experience out-of-hospital cardiac arrest, and resuscitation is initiated in 60% of these by emergency medical services (EMS) personnel.⁴ The median age is 60 years, and survival is less than 10%. These individuals are potential non-heart-beating donors (NHBDs).

At a conference in Maastricht, Netherlands, in 1995, NHBDs were categorized according to where death occurs, which is a surrogate for ischemic time after circulatory arrest.⁵ Category I donors die outside of hospital, or “in the field.” Category II donors die in a hospital (emergency department, intensive care unit, or floor). Category III NHBDs do not meet criteria for brain death but are judged to have an irreversible severe brain injury. If life support is withdrawn, many of these individuals progress to circulatory arrest and death. If consent is obtained, these Category III NHBDs—DCDs—are providing increasing numbers of kidneys, livers, and lungs for transplant, but the number of DCDs is very small. Category I and II NHBDs are a large potential source of tissue and corneal donors.

In the wake of increasing use of Category III NHBDs, this classification was revised so that donation after circulatory determination of death (DCDD) was subdivided into controlled DCDDs—formerly Maastricht Category III—and uncontrolled DCDDs, which unfortunately, combines Maastricht Category I and II NHBDs.⁶ Because design of our questionnaire began before this revision, we used the term NHBD and the Maastricht Categories in this project.

Egan et al^{7,8} were the first to demonstrate the feasibility of transplantation of lungs retrieved hours after death from Category I NHBDs. This was based on the notion that lung tissue lives for hours after death because it does not rely on perfusion for cellular respiration.⁹ Steen et al¹⁰ performed the first human lung transplant from a Category II NHBD after ex vivo lung perfusion (EVLP) and determined the lung functioned well, even though it was retrieved hours after death. Although interest in using EVLP to evaluate lungs from HBDs and DCDs is growing,^{11,12} the potential to substantially increase the lung donor

pool is limited by the number of these donors. EVLP of NHBD lungs has potential to dramatically improve the number of lungs for transplant. Varela et al¹³ began to transplant lungs from Category I NHBDs and recently began to use EVLP to evaluate lungs from NHBDs.¹⁴ Mateos Rodriguez et al¹⁵ reported the transfer of 160 NHBDs to a transplant hospital in Madrid between 2005 and 2010. From these 160 deceased donors, 13 double-lung and 7 single-lung transplants were performed. Survival was 90% at 30 days. They noted the critical importance of involving EMS personnel in the process of obtaining organs from NHBDs for transplant.

In a prior project directed at retrieving lungs from Category I NHBDs to assess transplant suitability,¹⁶ we encountered challenges in engaging EMS personnel in identifying potential donors and interacting with next-of-kin at the scene of a sudden death. We hypothesized this was related to lack of knowledge about the process of organ and tissue donation and the potential benefit of transplant. However, the role of EMS personnel in NHBD organ and tissue donation has not been studied. We sought to (1) assess knowledge of and attitudes about NHBD organ and tissue donation among EMS personnel, (2) evaluate the extent to which knowledge and personal experience with organ donation was associated with attitude, and (3) ascertain the effectiveness of an educational intervention designed to teach EMS professionals about organ donation, transplantation, and NHBDs.

Methods

The University of North Carolina at Chapel Hill (UNC) Institutional Review Board (IRB) (study #09-1292) and the New Hanover Medical Center IRB (study #1011-7), in Wilmington, NC, approved this study protocol. Ethical guidelines for protection of human subjects were followed.

Participants

Directors of 5 North Carolina county EMS programs agreed to participate in this study. A representative sample was recruited by sampling participants at rural (Person, Alamance) and urban (Orange, Wake, New Hanover) county EMS centers, defined by demographic reports from the North Carolina Department of Commerce.¹⁷ A total of 361 North Carolina EMS professionals participated in the study.

Procedure

Participants were informed that their participation in the study was voluntary. They were then given consent forms, educated about the study's purpose and aims, and allowed to ask questions before providing informed consent. We distributed paper-and-pencil questionnaires for consented participants. Twelve participants (3%) took questionnaire packets but did not complete them. Ample time was given to participants to complete the questionnaires. Questionnaires were distributed repeatedly at scheduled meetings of EMS personnel so that all shifts could participate.

After all participants had completed the questionnaires, Dr Egan or Dr Noone gave an hour-long PowerPoint (Microsoft, Redmond, WA) presentation about organ donation, transplant (focused on lungs), and NHBDs. They answered audience questions throughout and after

each presentation. The interactive live lecture format was chosen because it was shown to be as effective or more effective than Web-based instruction.¹⁸ To assess retention of knowledge gained, the questionnaire was distributed again to the EMS participants 3 months after the presentation. The 3-month post-lecture assessment was based on research that showed a decrease in knowledge at 3 months, with no further erosion of knowledge at a 6-month follow-up.¹⁸

Measures

Information about basic demographics of the participants, personal and professional experience with transplant, and years of EMS work experience was collected. The NHBD Knowledge Questionnaire was designed to assess participants' knowledge of NHBDs in transplant. Questionnaire items were developed by Dr Egan, an expert in lung transplantation and NHBDs. After he created the items, Dr Burker compiled the measure and then consulted with Teresa Edwards, an expert in scale measurement at UNC's Odum Institute for Research in Social Science; Ms Edwards' edits were incorporated into the questionnaire. The resulting Knowledge Questionnaire included 13 items (sample item: "Non-heart-beating donor refers to an individual who has sustained a cardiac arrest and has died"). Participants were asked to rate items as true or false.

Dr Burker created items to assess participants' attitudes toward NHBDs, and Ms Edwards reviewed these items. The resulting NHBD Attitudes Survey included 4 items, rated on a 5-point Likert scale (sample item: "How comfortable do you feel with being part of the process of NHBD?"). Scores ranged from 1 to 5, with higher scores reflecting more positive attitudes toward NHBDs.

Attitudes toward traditional organ donation were assessed by using the Organ Donation Attitudes Survey (ODAS).¹⁹ The ODAS consists of 20 items, rated on a 4-point Likert scale from 1 (strongly disagree) to 4 (strongly agree). Total scores can range from 18 to 72, with higher scores indicating a more positive attitude toward organ donation (sample item: "I support organ donation").

Data preparation and analysis

Data were entered in an SPSS 18 (SPSS Inc, Chicago, IL) database²⁰ by 2 UNC Rehabilitation Psychology graduate students. The entire database was rechecked for accuracy; 1 graduate student entered data, and then 2 graduate students sat side-by-side and checked the data entry. We examined all variables for missing data and examined all variables for normality, skewness, and kurtosis.

Data analyses were conducted using SPSS 18 software.²⁰ Descriptive statistics and multiple regression analyses were conducted. To examine group differences, *t*-tests and analysis of variance were used for normally distributed variables; non-parametric Mann-Whitney tests were used on non-normally distributed data. The significance level (α) was set at $p < .05$ for all analyses.

Results

Sample description

The total sample included 361 EMS professionals (70.3% male), with a mean age of 36.9 (standard deviation [SD], 9.47) years (range, 21–66 years). At baseline, 312 (86.4%) were employed in urban settings, and 49 (13.6%) were employed in rural settings. At the follow-up assessment, the urban sample constituted 69.9% ($n = 65$) of the entire sample and the rural sample accounted for 30.1% ($n = 28$). Participants worked in the EMS field a mean of 13.1 (SD, 8.6) years. Participants' EMS jobs were: Emergency Medical Technician (EMT)-Paramedic (71%), Paramedic (22%), EMT-Basic (3%), and District Chief (5%). Participants were permitted to select all responses that applied, so the sum of percentages exceeds 100%. Of those who responded, 30.8% reported knowing a living donor, 31.3% knew a post-mortem donor, and 41.3% reported knowing an organ recipient (more than 1 response was permitted). Table 1 presents age, gender, race/ethnicity, and educational levels of the overall sample. No significant differences in race/ethnicity or level of education were found between women and men, but the women were significantly younger than the men ($p = .009$).

Table 2 reports attitudes toward traditional and NHBD, EMS work experience, and organ donation experience of the complete sample and by gender. Because these data were not normally distributed, differences in gender were examined through Mann-Whitney non-parametric analyses of independent samples. There were no gender differences in attitudes in traditional or NHBD organ donation or of NHBD knowledge. The number of years working in EMS (average, 4 years) differed significantly when men and women ($p = .001$) were compared. Men reported significantly more years serving as an EMT-Paramedic ($p = .003$). There were no significant differences in organ donation experience between female and male participants, except for a higher percentage of men reported knowing a living donor than women.

NHBD knowledge

Descriptive statistics for the NHBD Knowledge Scale are presented in Table 3 and reflect a wide range of correct answers on the 13 items. The mean number of correct responses was 8.32 (SD, 1.60). There were no significant differences on the NHBD Knowledge Scale between female and male participants (Table 2) or between urban (mean, 8.38; SD, 1.60) and rural participants (mean, 7.87, SD, 1.50). Results of the NHBD Knowledge Scale indicated that EMS professionals in this sample showed a significant lack of knowledge about NHBD in transplant. Correct responses ranged from 13% on the item “The lung relies on perfusion for oxygen delivery and cellular respiration” to 94% on the items “People who experience sudden death at the scene, in transit, or in emergency rooms are potential non-heart-beating donors,” and “50,000 corneal transplants are performed in the U.S. each year from non-heart-beating donors.”

When examining individual participant's composite scores on this 13-item scale, 54% of the sample answered at least 8 questions correctly and only 8.3% answered at least 10 answers correctly. Only 1 of the 361 participants was able to provide correct answers to all of the

items. Examining individual scale items revealed that only 4 of the 13 items were correctly answered by more than 90% of the baseline sample. Seven of the 13 items were correctly answered by less than 69% of the participants.

NHBD attitudes

Descriptive statistics for the NHBD Attitudes Survey are presented in Table 2. We used the generally assumed statistic standard for acceptable internal consistency of Cronbach α ²¹ greater than 0.70.²² The NHBD Attitudes Survey Cronbach $\alpha = 0.79$ exceeded the internal consistency norm, demonstrating acceptable internal consistency. Participants' mean ratings on the 4 questions were 11.66 (SD, 3.77) of a possible total score of 20. Participants indicated the least positive attitudes toward item 3: "How skilled do you feel in being part of NHBD process" (mean, 2.34; SD, 1.17); whereas item 1, "How comfortable do you feel with discussing death/dying with family member of NHBD," received the highest mean ratings (mean, 3.26; SD, 1.21). Rural participants' mean scores on the NHBD Attitude Survey (mean, 9.38; SD, 3.07) were significantly different from those of urban participants (mean, 12.02; SD, 3.76; $p < 0.001$).

Organ donation attitudes

The ODAS was the final measure in the survey and had the overall lowest response rate ($n = 242$). Descriptive statistics for the ODAS are in Table 2. Answers to specific questions are in Table 4. Participants' mean score for the total scale was 61.62 (SD, 6.60) of a possible score of 72, indicating that EMS professionals in this sample reported highly positive attitudes toward traditional organ donation. The participants in this sample rated all but 1 item as 3 or above (on a scale from 1 to 4, with 4 indicating strong agreement). Interestingly, the item that received the lowest agreement (mean, 2.23; SD, 0.76) measured knowledge of organ donation rather than attitudes (item 3: "I am knowledgeable about organ procurement and the organ procurement process"). Similarly to the NHBD Attitude Scale, rural (mean, 57.93; SD, 6.73) and urban (mean, 62.351 SD, 6.34) participants also exhibited a significant difference on mean scores on the ODAS ($p = 0.001$).

Regression analyses

No significant predictors of NHBD knowledge emerged in multiple regression analysis. A second multiple regression analysis examining attitudes toward traditional organ donation, as measured by the ODAS scale, revealed several predictive relationships. Demographic variables, years in the EMS field, and experience with organ donation were entered into the regression as independent variables and significantly predicted attitudes toward traditional organ donation ($p < 0.001$). Table 5 reports regression statistics. Identifying as a donor on one's driver's license ($p < 0.001$), knowing someone who has received a transplant ($p = 0.009$), and knowing a person who was a donor after death ($p = 0.035$) emerged as significant predictors of positive attitudes toward traditional organ donation.

Table 6 reports multiple regression analysis statistics of attitudes toward NHBD as predicted by demographics variables, EMS experience, and experience with organ donation. Independent variables significantly predicted attitudes toward NHBDs in transplantation (p

< 0.001). Significant predictors included male gender ($p = 0.044$), identifying as an organ donor on one's driver's license ($p < 0.001$), and knowing a live organ donor ($p = 0.008$).

Post-intervention sample

Across all 5 counties, 93 EMS professionals completed the questionnaires at the 3-month follow-up after the educational intervention. These individuals were 69.6% male, with mean age of 37.9 years (SD, 9.52; range 23-60 years), and 69.9% ($n = 65$) of the sample was urban. These participants worked in the EMS field a mean of 13.5 years (SD, 8.5). Jobs reported were: EMT-Paramedic (78%), Paramedic (23.9%), EMT-Basic (4.3%), and District Chief (4.3%). There were no statistical differences in demographic characteristics between the group who completed the pre-intervention measures and the group who completed the post-intervention measures.

Post-educational intervention effects: NHBD knowledge

Table 3 reports the NHBD Knowledge questionnaire item scores at follow-up. Similar to T1, a comparison of post-intervention NHBD Knowledge scores for urban (mean, 9.66; SD, 1.650) and rural (mean, 8.83; SD, 1.90) did not yield statistically significant differences. However, total scores on the NHBD Knowledge questionnaire did improve after the intervention, reaching statistical significance, with a mean of 8.32 (SD, 1.60) at baseline vs 9.40 (SD, 1.76) at follow-up ($p < 0.001$). Several significant effects were revealed when item scores on our NHBD Knowledge questionnaire at baseline were compared with scores at follow-up. Follow-up participants had significantly higher scores on items 2 (“The lung relies on perfusion for oxygen delivery and cellular respiration”), 3 (“Lung tissues remain viable for substantial periods of time after circulatory arrest”), 5 (“Non-heart beating individuals are generally not considered candidates for organ donation for transplant”), 8 (“Many brain-dead donors have severe lung infection or pulmonary edema, often making lungs unsuitable for transplant”), and 12 (“Lungs retrieved from non-heart beating donors must be transplanted within 60 minutes”).

However, knowledge was still not optimal despite this improvement. For example, although the post-intervention score significantly improved on item 2 (“The lung relies on perfusion for oxygen delivery and cellular respiration”), only 38% answered correctly. Including item 2, the percent correct was at or below 69% for 5 items.

Post-educational intervention effects: Attitude

There were no significant post-intervention effects on ODAS. However, scores on the NHBD Attitude Scale were statistically lower after the educational intervention; participants indicated that they were less comfortable with the NHBD process at follow-up than at baseline. The mean attitude score pre-intervention was 11.66 (SD, 3.77) and 3 months post-intervention was 10.51 (SD, 3.47; $p = 0.012$), where a higher score reflects more comfort with NHBD. Interestingly, although attitude and knowledge scores were not correlated pre-intervention, post-intervention attitude scores and knowledge scores were significantly positively correlated ($r = 0.354$, $p = 0.002$), where higher levels of knowledge were associated with feeling more comfortable with NHBD.

Post-intervention, differences in rural vs urban remained for the NHBD Attitudes Survey (rural mean, 2.72 [SD, 0.52] vs urban mean, 3.57 [SD, 0.46]; $p = 0.005$) and the ODAS (rural mean, 6.32 [SD, 0.95] vs urban mean, 8.28 [SD, 1.73]; $p = 0.003$).

Discussion

We determined that EMS professionals had a relatively high rate of personal experience with organ donation: 30.8% knew a living donor, 31.3% knew a post-mortem donor, and 41.3% knew an organ recipient. Consistent with this experience with organ donation, these EMS professionals as a group expressed highly positive attitudes toward traditional organ donation. Identifying as a donor on one's driver's license, knowing a transplant recipient, and knowing someone who was a donor after death were associated with a positive attitude toward traditional organ donation. There were statistically significant differences at baseline and follow-up between rural and urban participants for attitudes toward organ donation, with urban EMS professionals having significantly more positive attitudes toward traditional organ donation and NHBD.

Although they had fairly extensive personal experience and a positive attitude toward organ donation, EMS professionals showed a lack of knowledge about NHBD in transplantation. Only 4 of 13 items had percentage correct scores above 90%, and only 1 participant of 361 correctly answered all the items. The lack of knowledge is not surprising, because although EMS personnel reported extensive work and personal experience with traditional organ donation, experience with NHBD in America is still a rarity. These results indicate the areas of improvement needed in educational interventions aimed at EMS professionals.

The educational intervention was somewhat effective in improving knowledge about the potential of NHBDs. Overall scores improved, and when individual items were assessed, scores improved significantly on 5 of 13 items. However, several of these items received the lowest correct scores at baseline, so it is not surprising that the follow-up sample exhibited higher scores. In fact, these findings may be attributed to the follow-up sample gravitating to the mean. On the other hand, the baseline sample correctly answered items 3 and 12 at 68% and 61% respectively, leaving marginal room for improvement. Of note, both items of marked improvement pertained to timing of lung transplantation. However, knowledge of NHBD was not mastered; the percentage correct was at or below 69% for 5 of 13 knowledge items at post-test. This may be because the educational presentation covered several areas (lung transplant, organ donation, NHBDs). Perhaps future interventions should focus solely on NHBDs.

On a measure of attitude toward NHBDs, participants indicated that they felt less skilled and least comfortable with their skill level in being part of the NHBD process, which is consistent with their knowledge scores. This suggests they are aware of their limitations in this area. Even the item that had the highest score (degree of comfort in discussing death/dying with family member of NHBDs) was rated at only "somewhat comfortable." At baseline, being male, identifying as an organ donor on one's driver's license, and knowing a live organ donor were associated with a more positive attitude toward NHBDs. These findings suggests that EMS professionals involved in this study did not have a strong

knowledge base about NHBDs and perhaps for that reason were not comfortable with the NHBD process.

Interestingly, attitude or level of comfort with NHBDs significantly decreased 3 months after the educational intervention. This may be because the follow-up sample was smaller, more dedicated, and possibly more insightful of their knowledge deficits. Although knowledge increased, it was not mastered, and perhaps participants did not feel comfortable with being part of the NHBD process. Our data support this interpretation. Knowledge about NHBDs and attitude toward NHBDs were associated 3 months post-intervention, where participants with higher knowledge scores were more comfortable with NHBDs.

Future research needs to evaluate alternative educational presentations to determine the best way to increase knowledge and to ascertain whether increased knowledge leads to a more positive attitude toward NHBDs. Given that EMS professionals from rural settings endorsed less positive attitudes toward NHBD before and after the intervention, future research needs to focus on how to reach these individuals in particular. However, rural areas may not be a large source of NHBDs.

Our study has some limitations. Although an expert in questionnaire design vetted the questions, we did not involve EMS personnel in design of the questions or the educational intervention, nor did we beta-test the questions or the educational intervention. In essence, this study informs us that the educational tool needs to be improved to address the relatively low effect of the educational intervention.

The lower post-intervention response rate may suggest low commitment to the survey, respondent fatigue, or inadequate amount of time to complete the survey. Although we assumed that adequate time was provided to complete the survey—participants were asked if they had completed the survey before they were collected—the fact that the ODAS was the final measure in the survey and had the overall lowest response rate could suggest that some respondents ran out of time to complete the survey but did not want to disclose that they had not finished. Respondent fatigue or low effort is another explanation. If this is the case, then this could suggest that the most committed individuals, and arguably the most sympathetic, knowledgeable, and supportive of the organ donation process, completed the ODAS and thus may have inflated the attitude toward transplant scores of the sample.

We initially intended to match pre-intervention and post-intervention questionnaires, but this might have compromised anonymity, a prerequisite for participation by our IRB. We were disappointed at the low rate of response to the post-intervention questionnaires, but appreciate that EMS professionals are busy and that supervisors did not wish to administer the post-intervention questionnaires at scheduled meetings. It is possible that more motivated/knowledgeable individuals participated in the follow-up questionnaire. Improved participation might occur if incentives were offered. Although we did not use current nomenclature (uncomplicated DCDDs), the term “non-heart-beating donor” was in use when the survey was designed and is easy to understand. These are all lessons that can be applied to future knowledge assessments and educational tools directed at EMS and other stakeholders in the process of lung recovery from NHBDs.

There were unanticipated benefits of the educational presentation and the discussions that followed it. Often in dialogue afterward, EMS personnel mentioned other potential obstacles to organ donation after sudden death. We learned more about the logistics of rapid transportation of recently deceased individuals. We also learned that most EMS staff were not interested in approaching next-of-kin about donation but were very willing to inform organ procurement organizations about potential NHBDs. Trained organ procurement organizations staff should obtain consent for donation,²³ and then they could obtain a detailed medical/social history while the body is in transit. Some EMS staff enthusiastically volunteered to participate in some way. The positive response in Wake County set the stage for a pilot program that allowed for assessment of lungs from 2 Category I NHBDs.

There is a critical shortage of organs for transplant. Category I NHBDs may be a source of a large number of lung donors. An article that describes the creation of a protocol for DCDD in New York city noted that EMS personnel are understandably the first step in the process.²⁴ Ascertaining EMS knowledge of and attitudes about organ and tissue donation will help determine how to address knowledge gaps and misconceptions about donation as well as the benefits to individuals and society as a whole, to maximize EMS collaboration, and ultimately, increase organ and tissue donation. Thus, this project addresses an unrecognized need. Learning the best ways to engage EMS personnel in the NHBD process may ultimately increase the likelihood of lung donation from NHBDs and enhance tissue donation rates.

Lung recovery from Category I NHBDs offers potential of a very large supply for transplantation; EMS professionals need to be part of the team. This research suggests they may be willing to do so with additional training about NHBDs.

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References

1. U.S. Department of Health and Human Services. Health Resources and Services Administration. [Accessed August 1, 2014] Organ Procurement and Transplantation Network. Available at: <http://Optn.transplant.hrsa.gov/>
2. Mason DP, Thuita L, Alster JM, et al. Should lung transplantation be performed using donation after cardiac death? The United States experience. *J Thorac Cardiovasc Surg.* 2008; 136:1061–6. [PubMed: 18954650]
3. Hoyert, DL.; Kung, HC.; Smith, BL. Deaths: preliminary data for 2003. Hyattsville, MD: National Center for Health Statistics; 2005.

4. Go AS, Mozaffarian D, Roger VL, et al. Heart disease and stroke statistics—2014 update: a report from the American Heart Association. *Circulation*. 2014; 129:e28–292. [PubMed: 24352519]
5. Kootstra G, Daemen JH, Oomen AP. Categories of non-heart-beating donors. *Transplant Proc*. 1995; 27:2893–4. [PubMed: 7482956]
6. Bernat JL, Capron AM, Bleck TP, et al. The circulatory-respiratory determination of death in organ donation. *Crit Care Med*. 2010; 38:963–70. [PubMed: 20124892]
7. Egan TM, Lambert CJ Jr, Reddick RL, Ulicny KS Jr, Keagy BA, Wilcox BR. A strategy to increase the donor pool: the use of cadaver lungs for transplantation. *Ann Thorac Surg*. 1991; 52:1113–21. [PubMed: 1953132]
8. Ulicny KS Jr, Egan TM, Lambert CJ Jr, Reddick RL, Wilcox BR. Cadaver lung donors: effect of preharvest ventilation on graft function. *Ann Thorac Surg*. 1993; 55:1185–91. [PubMed: 8494430]
9. D'Armini AM, Roberts CS, Griffith PK, Lemasters JJ, Egan TM. When does the lung die? I. Histochemical evidence of pulmonary viability after “death”. *J Heart Lung Transplant*. 1994; 13:741–7. [PubMed: 7803413]
10. Steen S, Sjoberg T, Pierre L, Liao Q, Eriksson L, Algotsson L. Transplantation of lungs from a non-heart beating donor. *Lancet*. 2001; 357:825–9. [PubMed: 11265950]
11. Ingemansson R, Eyjolfsson A, Mared L, et al. Clinical transplantation of initially rejected donor lungs after reconditioning ex vivo. *Ann Thorac Surg*. 2009; 87:255–60. [PubMed: 19101308]
12. Cypel M, Yeung JC, Liu M, et al. Normothermic ex vivo lung perfusion in clinical lung transplantation. *N Engl J Med*. 2011; 364:1431–40. [PubMed: 21488765]
13. de Antonio DG, Marcos R, Laporta R, et al. Results of clinical lung transplant from uncontrolled non-heart-beating donors. *J Heart Lung Transplant*. 2007; 26:529–34. [PubMed: 17449425]
14. Gomez-de-Antonio D, Campo-Canaveral JL, Crowley S, et al. Clinical lung transplantation from uncontrolled non-heart-beating donors revisited. *J Heart Lung Transplant*. 2012; 31:349–53. [PubMed: 22306439]
15. Mateos Rodriguez AA, Navalpotro Pascual JM, del Rio Gallegos F. Lung transplant of extrahospitalary donor after cardiac death. *Am J Emerg Med*. 2013; 31:710–1. [PubMed: 23465877]
16. HRSA grant R380T03593 to Carolina Donor Services (UNC was subcontractor to CDS). Ex-vivo evaluation of human lungs from non-heart-beating donors for transplant. 8/1/2004-7/31/2007.
17. North Carolina Chamber of Commerce. [Accessed October 29, 2014] Thrive in North Carolina: state, region and county profiles. Available at: <http://accessnc.commerce.state.nc.us/EDIS/demographics.html>
18. West GF, Hurrell G, Rane-Szostak D, et al. An exploratory study of live and web-based education on bioterrorism for healthcare professionals: knowledge acquisition and retention. *CE Meas*. 2009; 3:38–48.
19. Rumsey S, Hurford DP, Cole AK. Influence of knowledge and religiousness on attitudes toward organ donation. *Transplant Proc*. 2003; 35:2845–50. [PubMed: 14697918]
20. SPSS Inc. PASW Statistics for Windows, version 18.0. Chicago: SPS Inc; 2009.
21. Cronbach LJ. Coefficient alpha and the internal structure of tests. *Psychometrika*. 1951; 16:297–334.
22. Streiner, DL.; Norman, GR. Health measurement scales: a practical guide to their development and use. 4th. Oxford, UK: Oxford University Press; 2008.
23. Siminoff LA, Gordon N, Hewlett J, Arnold RM. Factors influencing families' consent for donation of solid organs for transplantation. *JAMA*. 2001; 286:71–7. [PubMed: 11434829]
24. Wall SP, Kaufman BJ, Gilbert AJ, et al. Derivation of the uncontrolled donation after circulatory determination of death protocol for New York city. *Am J Transplant*. 2011; 11:1417–26. [PubMed: 21711448]

Table 1
Sample Demographics

Variables	Entire sample (%)	Men (%)	Women (%)
	N = 361 ^a	n = 253 (70.3)	n = 107 (29.7)
Age, years			
18–24	7.2	6.6	8.7
25–34	38.3	33.2	50.0
35–44	30.7	32.4	26.9
45–54	18.8	21.2	13.5
55	4.9	6.6	1.0
$F_{4,340} = 3.464, P = 0.009^b$			
Race			
Hispanic	1.4	1.2	1.9
African American	2.5	2.8	1.9
Caucasian	93.5	93.6	93.4
Asian	0.6	0.8	...
Other	2.0	1.6	2.8
$F_{4,350} = 0.474, P = 0.755$			
Education			
< College degree	33.8	36.5	27.6
Associate's degree	32.6	31.7	34.7
Bachelor's degree	27.1	25.7	30.6
Post-graduate	6.4	6.1	7.1
$F_{3,324} = 0.850, P = 0.468$			

^aOne participant did not respond to question about gender.

^b $p < 0.01$.

Table 2
Non-Heart-Beating Donor Knowledge, Attitudes Toward Traditional Donors and Non-Heart-Beating Donor, Work Experience, and Organ Donation Experience

Variables	Entire sample	Men ^a	Women ^a
	Median, IQR (No.)	Median, IQR (No.)	Median, IQR (No.)
Organ donation attitudes			
ODAS	63.0, 12.0 (242)	62.0, 13.0 (172)	63.0, 8.5 (70)
NHBD Attitudes Survey	12.0, 5.0 (315)	12.0, 6.0 (224)	12.0, 5.0 (91)
NHBD Knowledge Scale ^b	8.0, 2.0 (265)	8.0, 2.0 (193)	8.0, 2.0 (72)
EMS experience			
Years in EMS field ^c	11.0, 13.0 (358)	14.0, 15.0 (251)	9.0, 10.0 (107)
Years as EMT-Basic	2.0, 3.0 (171)	2.0, 2.63 (118)	2.0, 3.0 (53)
Years as EMT-Intermediate	2.0, 3.0 (115)	2.0, 2.50 (73)	2.0, 3.0 (42)
Years as EMT-Paramedic ^d	8.0, 12.0 (257)	10.0, 13.0 (184)	6.5, 7.0 (73)
Years as Paramedic	9.0, 12.0 (69)	10.0, 13.0 (51)	9.0, 16.0 (18)
	% (No.)	% (No.)	% (No.)
Organ donation experience			
Am an organ donor	80.8 (344)	78.8 (241)	85.4 (103)
Know a recipient	41.3 (349)	40.4 (245)	43.3 (104)
Know a living donor ^d	30.8 (351)	34.1 (246)	22.9 (105)
Know a postmortem donor	31.3 (352)	30.0 (247)	34.3 (105)

EMS, Emergency Medical Services; EMT, Emergency Medical Technician; NHBD, non-heart-beating; ODAS, Organ Donation Attitudes Survey.

^aTo examine difference in groups by gender, Mann-Whitney tests were conducted. All differences were non-significant except where noted.

^bThe complete list of scale items and correct responses is presented in Table 3

^c $p < 0.01$.

^d $p < 0.05$.

Table 3
Non-Heart-Beating Donors Knowledge Scale with Correct Response, Percentage Correct, Number of Respondents and Rate of Response Pre-intervention and at Follow-Up Assessment (in parentheses)

Item	Question	T/F	%	No. ^a (No.) ^b	Response %
1	Donor hearts are scarcer than any other solid organ for transplant	F	37 (41)	323 (84)	89.5 (90.3)
2 ^c	The lung relies on perfusion for oxygen delivery and cellular respiration	F	13 (38)	322 (84)	89.2 (90.3)
3 ^c	Lung tissue remains viable for substantial periods of time after circulatory arrest	T	68 (80)	324 (85)	89.8 (91.4)
4	Non-heart beating donor refers to an individual who has sustained a cardiac arrest and has died	T	83 (87)	323 (85)	89.5 (91.4)
5 ^c	Non-heart beating individuals are generally not considered candidates for organ donation for transplant	T	24 (37)	322 (84)	89.2 (90.3)
6	In conventional organ donation, organs for transplant are retrieved from a brain-dead donor following controlled cardiac arrest in an operating room	T	77 (85)	320 (82)	88.6 (88.2)
7	Lungs have been retrieved from NHBDs and transplanted successfully	T	90 (89)	305 (84)	84.5 (90.3)
8 ^c	Many brain-dead donors have severe lung infection or pulmonary edema, often making lungs unsuitable for transplant	T	45 (60)	313 (82)	86.7 (88.2)
9	There is no method to predict suitability of human lungs ex vivo for transplant	F	62 (69)	292 (81)	80.9 (87.1)
10	People who experience sudden death at the scene, in transit, or in emergency rooms are potential non-heart beating donors	T	94 (93)	311 (83)	86.1 (89.2)
11	Non-heart beating donors are classified based on where death occurs and duration of ischemia to facilitate reporting and interpreting transplant outcomes	T	90 (89)	301 (81)	83.4 (87.1)
12 ^c	Lungs retrieved from non-heart beating donors must be transplanted within 60 minutes	F	61 (78)	290 (82)	80.3 (87.1)
13	50,000 corneal transplants are performed in the U.S. each year from non-heart beating donors	T	94 (89)	305 (81)	84.5 (87.1)

F, false; T, true.

^aNumber of responses of 361 total sample.

^bNumber of responses out of 93 total sample.

^c $p < 0.05$ compared with baseline responses.

Table 4
Organ Donation Attitude Survey (ODAS) Items and Total Score Descriptive Data

Item	Question	Mean	SD	No. ^a	Response, %
1	I believe in the afterlife	3.21	0.86	275	76.2
2	I have religious objections to organ donation	3.49	0.61	288	79.8
3	I am knowledgeable about organ procurement and the organ procurement system	2.23	0.76	287	79.5
4	I support organ donation	3.54	0.56	288	79.8
5	I would agree to an organ transplant if my life were in danger without one	3.52	0.63	286	79.2
6	I am willing to have organs donated after my death	3.48	0.74	283	78.4
7	I have signed an organ donor card or the back of my driver's license	3.33	0.89	285	78.9
8	I know someone who has signed an organ donor card or the back of his/her driver's license	3.47	0.66	285	78.9
9 ^b	It is important to discuss my wishes for after my death with my family	3.66	0.54	286	79.2
10	I have discussed my wishes for after my death with my family	3.29	0.80	281	77.8
11 ^b	If needed, I would receive an organ from a person of a different race than myself	3.49	0.68	277	76.7
12	I would be willing to donate my organs to a person of a different race than myself	3.51	0.74	275	76.2
13	I believe that organ donation is against my religion	3.62	0.52	276	76.5
14	I have been taught that organ donation is against my religion	3.56	0.62	281	77.8
15	I think that organ donation is a safe, effective practice	3.27	0.57	279	77.3
16	I think that organ donation is a mutilation to the body	3.59	0.60	280	77.6
17	I trust that doctors and hospitals use donated organs as they are intended to be used	3.23	0.59	279	77.3
18	I think that doctors would try just as hard to save my life whether or not I plan to be an organ donor	3.32	0.70	278	77.0
19	In general, I think that organ donation is a good thing	3.57	0.52	277	76.7
20	Organ donation is consistent with my moral values and beliefs	3.50	0.62	272	75.3
	ODAS total score	61.62	6.60	242	67.0

SD, standard deviation.

^aNumber of responses out of 361 total sample.

^bItems not included in scoring.

Table 5
Multiple Regression Analyses Showing Amount of Variance of Organ Donation Attitude Survey Accounted for by Demographic Variables, Emergency Medical Service Experience, and Organ Donation Experience

Predictor variables	Unstandardized β	Standardized β	<i>t</i> -value	<i>p</i> -value
Organ donor ^a	-7.794	-0.435	-6.895	<0.001
Know recipient ^a	-2.300	-0.171	-2.620	0.009
Know living donor	1.509	0.105	1.584	0.115
Know post-mortem donor ^b	-1.935	-0.136	-2.117	0.035
Years in EMS field	0.024	0.033	0.351	0.726
Gender	0.038	0.003	0.042	0.967
Ethnic group	-1.652	-0.093	-1.517	0.131
Years of education	-0.042	-0.011	-0.173	0.863
Age	-0.101	-0.146	-1.541	0.125
Marital status	0.033	0.006	0.099	0.921

$R^2 = 0.269, F_{10,211} = 7.391, p < 0.001$

EMS, Emergency Medical Services.

^a $p < 0.01$.

^b $p < 0.05$.

Table 6

Multiple Regression Analyses Showing Amount of Variance of Non-Heart-Beating Donor Attitude Accounted for by Demographic Variables, Emergency Medical Service Experience, and Organ Donation Experience.

Predictor variables	Unstandardized β	Standardized β	<i>t</i> -value	<i>p</i> -value
Organ donor ^a	-2.259	-0.235	-30.826	< 0.001
Know recipient	0.498	0.064	1.001	0.318
Know living donor ^a	-1.411	-0.171	-2.668	0.008
Know post-mortem donor	-0.785	-0.095	-1.520	0.130
Years in EMS field	0.033	0.076	0.889	0.375
Gender ^b	-1.047	-0.122	-2.020	0.044
Ethnic group	-0.658	-0.061	-1.033	0.303
Years of education	0.212	0.097	1.566	0.119
Age	-0.033	-0.083	-0.969	0.333
Marital status	-0.083	-0.027	-0.434	0.665

$R^2 = 0.129, F_{10,269} = 3.830, p < 0.001$

EMS, Emergency Medical Services.

^a $p < 0.01$.

^b $p < 0.05$.