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TOXICOLOGY INVESTIGATION

Using Drug-Intoxicated Deaths as Potential Organ Donors: Impression of Attendees at the American College of Medical Toxicology 2014 Annual Scientific Meeting

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Abstract
Introduction Over the last decade, there has been a reduction of organ donation from intracranial haemorrhage-, stroke- and blunt trauma-related deaths in the USA. There has been a corresponding increase in the use of drug-intoxicated patients as organ donors from 2.1 % in 2003 to 6.8 % in 2013.
Methods Questionnaire survey of attendees at the American College of Medical Toxicology 2014 Annual Scientific Meeting breakout session on transplantation from deaths related to poisoning was performed. Participants were asked whether they would recommend the use of solid organs from cocaine- or carbon monoxide-related death before and after the breakout session.
Results Forty-eight US participants (attending 23, fellow 15, resident 3 and other (including non-medical) 7) completed the survey, and 97.8 and 89.1 % of participants would consider cocaine- and carbon monoxide-related deaths for potential organ donation pre-breakout session, respectively; this increased to 100 % for both post-breakout sessions. There was variability in the consideration of different solid organs (the heart, lungs, liver, pancreas and kidneys)—76.2–95.2 and 76.2–85.7 % for individual solid organs for cocaine- and carbon monoxide-related deaths, respectively. For both scenarios, participants were least likely to consider potential heart donation (76.2 % of participants for both), which increased to 100 % following the breakout session.
Conclusions Medical toxicologists have some reservation in recommending solid organs for transplantation from deaths from cocaine and carbon monoxide. Given the decrease in potential organ donors from typical methods of death, further work is needed to promote organ donation in deaths related to acute poisoning.

Keywords Organ transplant · Death · Carbon monoxide · Cocaine · Drug overdose

Introduction

The Organ Procurement and Transplantation Network (OPTN) was established by the United States Congress under the National Organ Transplant Act (NOTA) of 1984. Whilst its primary objectives are to increase the supply and effectiveness of organ donation, it also collates detailed data on organ donor demographics, including mechanism of death, and outcome of the transplanted organs [1]. In the USA, data from the OPTN shows that over the last decade (2003 to 2013), there has been a change in the mechanism of death in potential organ donors [1]. There has been a reduction in deaths from conditions typically associated with being potential organ donors: (i) intracranial haemorrhage and/or stroke, 45.0 % in 2003 to 34.0 % in 2013, and (ii) blunt trauma, including road traffic accidents, 26.7 % in 2003 to 22.4 % in 2013 [1]. These changes reflect not only improvements in public health measures (for example, air bags and seat belts in cars, reducing population mean blood pressure) but also in standards of medical care, investigation and management.

Over this time frame, there has been an increase in the use of drug-intoxicated patients as organ donors from 2.1 % in

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2003 to 6.8 % in 2013 [1]. This has been across all solid organs from 2003 to 2013: kidney 1.9 to 6.8 %, pancreas 1.6 to 5.1 %, liver 2.0 to 7.1 %, heart 2.6 to 7.1 % and lungs 1.3 to 5.7 % [1]. Although there has been an increase in use of drug-intoxicated deaths for organ donation across all US states, in 2013, there was an over threefold difference in the use of drug intoxication-related deaths in organ donation between the lowest regions (Oklahoma and Texas) at 3.3 % compared to the highest regions (New York and Vermont) at 10.4 % [1]. Drug intoxication-related deaths are commoner in younger individuals without significant underlying long-term solid organ dysfunction, making them more appropriate candidates for organ donation.

There are numerous case reports of successful solid organ (defined as the heart, lungs, kidneys, pancreas and liver) donation from donors who died from an acute poisoning, including cyanide, carbon monoxide, 3,4-methylenedioxymethamphetamine (MDMA), insulin, rodenticides, methanol, barbiturates, benzodiazepines and tricyclic antidepressants [2–6]. Despite this published information, there is limited published information on the opinions of physicians in discussing potential organ donation from a poisoning-related death or transplant surgeons accepting organs from this group of potential donors. There is one published postal survey of 15 intensive care unit directors and 40 transplant physicians/surgeons in the UK that was undertaken in the early 2000s [3]. They were asked whether they would recommend (intensive care unit directors) or accept (transplant physicians/surgeons) organs from individuals who had died from acute cocaine or carbon monoxide poisoning. Eighty per cent of intensivists would recommend organ donation from a cocaine-related death and 95 % from a carbon monoxide-related death. Transplant surgeons were less likely to accept solid organs from a cocaine-related death: heart ~50 %, lungs ~55 %, kidney 50 %, liver ~68 % and pancreas ~40 %. They were more likely to accept solid organs from a carbon monoxide-related death: heart ~95 %, lungs ~95 %, kidney 100 %, liver ~83 % and pancreas 100 %.

In this study, we used a survey to understand the opinion of medical toxicologists in terms of whether they would recommend individuals who died from cocaine and carbon monoxide intoxication as potential organ donors, along with an assessment of the impact of teaching about these issues.

Methods

Attendees at the two 45-min interactive breakout sessions discussing transplantation from deaths related to poisoning at the American College of Medical Toxicology 2014 Annual Scientific Meeting were given a one-page single-sided questionnaire at the start of the breakout session. Completion of the questionnaire was voluntary and anonymous apart from the basic demographic information outlined below.

The questionnaire collected (i) basic demographic data (home city/state and current job role), (ii) previous involvement in utilising one or more poisoned patient(s) as potential organ donors and (iii) whether they would recommend the use of solid organs from an individual who had died from acute cocaine or carbon monoxide toxicity. At the end of the breakout session, after an interactive lecture discussing organ donation from poisoned patients, focusing on the evidence related to donation from carbon monoxide- and cocaine-related deaths, participants were asked to complete the second section of the questionnaire, which asked again whether they would recommend the use of solid organs from an individual who had died from acute cocaine or carbon monoxide toxicity.

Data from the completed questionnaire was extracted, and the proportion of those who would recommend the use of the different solid organs was compared pre- and post-breakout session using a two-by-two test.

Results

Study Participants

A total of 48 US participants across the two breakout sessions completed the survey from 20 states and the District of Columbia (range of one to seven respondents from each state/DC). The grade of participants were as follows: attending 23, fellow 15, resident 3 and other (including non-medical) 7. There were two non-US participants, and given the small number, these were excluded from subsequent data analysis. Twenty-four (50 %) participants reported that they had previously been involved in recommending one or more poisoning-related death as a potential organ donor.

Cocaine

At the start of the breakout session, 97.8 % of participants would consider a cocaine-related death for potential organ donation, which increased to 100 % following the season ($p=0.2$). There was variability in the recommendation of individual solid organs in this scenario prior to the breakout session, which improved following the session; only the increase in the recommendation of the heart was statistically significant ($p<0.0001$) (Table 1).

Carbon Monoxide

At the start of the breakout session, 89.1 % of participants would consider a carbon monoxide-related death for potential organ donation, which increased to 100 % following the season ($p=0.08$). There was a significant increase in the

Table 1 Responses as to whether an individual would recommend the use of different solid organs following cocaine- or carbon monoxide-related death pre- and post-breakout session

Solid organ	Acceptable for transplant following cocaine-related death			Acceptable for transplant following carbon monoxide-related death		
	Pre-breakout (%)	Post-breakout (%)	*p* value	Pre-breakout (%)	Post-breakout (%)	*p* value
Kidney	95.2	100	0.072	85.7	100	0.002
Liver	88.1	97.8	0.074	85.4	100	0.001
Lungs	95.2	100	0.072	83.3	100	0.0006
Heart	76.2	100	<0.0001	76.2	100	<0.0001
Pancreas	95.0	100	0.067	80.0	100	0.002

recommendation of all individual solid organs following the breakout session from the pre-session opinion (Table 1).

Discussion

In this survey, we have shown that overall medical toxicologists would consider individuals dying from drug intoxication for potential organ donation. There was a greater consensus around the use of solid organs from a cocaine-related death compared to those from a carbon monoxide-related death. The use of a simple breakout interactive discussion session significantly improved the understanding of the appropriateness of solid organ donation from deaths related to acute cocaine and carbon monoxide poisoning.

There appeared to be good consensus on the use of the majority of solid organs from cocaine-related deaths, although prior to the breakout session, only 76.2 % of participants would recommend the use of the heart in this situation. This lack of consensus around using the heart in cocaine-related deaths is, despite numerous case reports of their use and several published observational studies, showing long-term positive outcomes following their use [7–9]. In a study of 997 cardiac transplants undertaken in a single transplantation centre, the impact of "high-risk" social behaviours (defined as previous incarcerations, non-professional tattoos/piercing, habitual substance abuse, practice of an alternative lifestyle and HIV/hepatitis infection) found in 143 donors on recipient survival was studied [7]. There was no difference in mean recipient survival between those donors without high-risk social behaviours (10.6 years) compared to those with (10.4 years). Cocaine use, by inhalation, had no impact on recipient survival (hazard ratio 0.92, 95 % confidence interval (CI) 0.35–2.44, $p=0.86$). Although donor history of intravenous drug use did not impact on recipient survival (hazard ratio 0.76, 95 % CI 0.25–2.28, $p=0.62$), hepatitis C infection had a significant negative impact on recipient survival (hazard ratio 3.37, 95 % CI 1.04–10.99, $p=0.04$). The impact of current and previous cocaine use in cardiac donors on the overall recipient survival and development of coronary artery disease in the recipient was studied retrospectively using the United Network for Organ Sharing Thoracic Registry [8]. Of the 9,217 first-time cardiac recipients, history of cocaine use or non-use in the donor was known in 7,937; of these, 7,006 had never used cocaine, 510 had used cocaine but not in the last 6 months, and 421 had used cocaine in the last 6 months, meaning that 11.7 % of individuals received a heart from a donor with a history of cocaine use. The overall recipient mortality at 5 years was 32, 35 and 20 % for non-use, past use and current use, respectively. The development of coronary artery disease at 5 years was 35, 39 and 31 % for non-use, past use and current use, respectively. Whilst cocaine use is well recognised to be associated with cardiac complications, both of these observational studies suggest that previous and/or current use of cocaine in a potential cardiac organ donor does not appear to impact on long-term survival in the transplant recipient, and therefore, the use (current or previous) of cocaine should not routinely preclude these individuals as potential organ donors. There has also been an organ registry study, using the United Network for Organ Sharing (UNOS) Standard Transplant Analysis and Research (STAR) database for thoracic transplant, investigating the impact of cocaine on outcome following lung transplantation [9]. Between 1987 and June 2010, 11,563 donors with a documented history of no cocaine use and 1,364 donors with a history of cocaine use were identified. Using unadjusted survival curves, there was no difference in the recipient irrespective of whether the donor had a history of cocaine use or not ($p=0.58$). There were significant differences between the two groups in terms of other baseline demographics: (i) cocaine users had greater cigarette use (30.7 vs 17.1 %), increased alcohol use (39.5 vs 13.2 %), increase use of other drugs (72.5 vs 21.9 %) and more likely to be male (68.6 vs 58.8 %), and (ii) non-cocaine users had greater co-morbidities: diabetes mellitus (5.1 vs 3.4 %) and hypertension (18.6 vs 16.6 %). To minimise the impact of any of these potential co-founders, using a multivariate analysis of cocaine- and non-cocaine-matched donors, there was no difference in the propensity of recipient survival based on donor cocaine status ($p=0.31$).

The impact of donor death from carbon monoxide toxicity on recipient outcome for a range of solid organs has been studied using a systematic review of the published literature [10]. A total of 42 carbon monoxide-related donor deaths (36 adults with carbon monoxide poisoning and 6 children with carbon monoxide poisoning and burns) from whom solid organs were transplanted were identified, and follow-up was up to 7 years for individual organs. Overall survival of donated organs was 86 %, with 6 % of organs failing and 8 % of recipients dying of other causes. There was no difference in the mean (±SEM) peak carboxyhaemoglobin concentration in donors between organs that survived and those that did not (31±2.7 vs 29±26.8 %, p=0.95). There was some variability of survival for different organs: kidney 100 % (26 transplanted organs), pancreas 100 % (2), liver 100 % (9), heart 68 % (17) and lungs 67 % (2). It should be noted that the reported overall 1-year survival rates for transplanted hearts and lungs, irrespective of the cause of death of the donor, are 73–79 % (2007 data) and 69–75 % (2008 data), respectively, suggesting that although the outcome of heart and lung transplants from carbon monoxide-poisoned donors is lower than that of other organs, it is comparable to that expected from organs donated from donors with other causes of deaths. Overall, this systematic review suggests that organ donation from deaths related to carbon monoxide or carbon monoxide and burns is not associated with a reduction in overall survival of organs following transplantation compared to other organ donor sources, and supports the consideration of organ donation from this group of deaths.

Conclusion

Despite the published evidence on the good outcome from using poisoned patients as potential organ donors, it appears that medical toxicologists have some reservation in recommending some organs for transplantation from these cases. We have shown that these reservations were decreased during a simple breakout session. Given the decrease in potential organ donors from typical sources such as intracranial haemorrhage and road traffic accidents, further work is needed to promote organ donation in deaths related to acute poisoning.

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