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Early Postoperative Pain and its Predictors in the Adult to Adult Living Donor Liver Transplantation Cohort Study (A2ALL)

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Author Contributions

MSM, EAP, MAD, AS, and DBG designed the study. Data was collected by an investigator at each site and included MSM, EAP, ZB, DL, SH, CF, SM, RF, JG, KO, and TH. Statistical analysis was performed by AS and TH. Data analysis was performed by MSM, EAP, MAD, AD, SH, and ZB. The manuscript was developed and written by MSM, MAD, AS, AD, SH, EAP, and MAS.

Disclosures/Conflicts of Interest

The authors of this manuscript declare no conflicts of interest.

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Abstract

Background—Little is known about how well postoperative pain is managed in living liver donors, despite pain severity being the strongest predictor of persistent pain with long-lasting disability.

Methods—We conducted a prospective multicenter study of 172 living liver donors. Self-reported outcomes for pain severity, activity interference, affective (emotional) reactions, adverse effects to treatment, and perceptions of care were collected using the American Pain Society Patient Outcomes Questionnaire-Revised. Mixed effects linear regression was used to identify demographic and psychosocial predictors of subscale scores.

Results—Donors were young (36.8 ± 10.6) and healthy. Of 12 expert society analgesic recommendations for postoperative pain management, 49% received care conforming to 3 guidelines, and only 9% to 4 or 5. More than half reported adverse effects to analgesic treatment for moderate to severe pain that interfered with functional activity; however, emotional distress to pain was unexpectedly minimal. Female donors had higher affective ($\text{Beta}=0.88$, $p=0.005$) and adverse effects scores ($\text{Beta}=1.33$, $p<0.001$). Donors with 2 or more medical concerns prior to surgery averaged 1 unit higher pain severity, functional interference, adverse effects, and affective reaction subscale scores (Beta range 1.06–1.55, all $p<0.05$). Receiving information about pain treatment options increased perception of care subscale scores ($\text{Beta}=1.24$, $p=0.001$), while depressive symptoms before donation were associated with lower scores ($\text{Beta}=-1.58$, $p=0.01$).

Conclusions—Donors have a distinct profile of pain reporting that is highly influenced by psychological characteristics. Interventions to improve pain control should consider modifying donor behavioral characteristics in addition to optimizing pain care protocols.

INTRODUCTION

Postoperative pain control following living liver donation has received little attention, even though poorly managed pain is the strongest predictor of disability due to chronic pain syndromes in most surgical populations.¹ This may explain why a recent study reported that 27% of living liver donors with moderate to severe postoperative pain had persistent pain 12 months following donation surgery.² The findings raise questions about the quality of pain care and suggest a detailed evaluation in a larger cohort of living liver donors would be informative.

Previous clinical practice guidelines and published literature have long supported the need for a multimodal approach to analgesia, although the definition of “multimodal” has not been well-defined.³ Current recommendations include combinations of analgesics that target different pain receptors in the peripheral and central nervous system. Pharmacological recommendations include: preoperative administration of celecoxib and gabapentinoids;

intraoperative administration of intravenous ketamine; local anesthesia infiltration of the surgical site; postoperative use of intravenous patient-controlled analgesia (IVPCA) when the oral route is not possible; avoidance of intramuscular injection; use of cyclooxygenase-2 inhibitors and acetaminophen; use of oral rather than intravenous opioids; use of intravenous lidocaine infusion; peripheral nerve blocks; and neuraxial blocks, with clonidine as an adjunct.³

Evaluation of pain control requires reliable measurements that capture physical, functional, and emotional responses to pain. Newer validated pain assessment tools, such as the American Pain Society Patient Outcome Questionnaire Revised (APS-POQ-R), are specifically designed to quantify multiple domains of pain experience.⁴ These include: time spent in severe pain, the effect of pain on recovery activities, mood, sleep, treatment side effects, and perceptions of care within a single survey tool. The APS-POQ-R is, therefore, a more holistic view of a patient's pain experience than single numerical or visual clinical scores.⁵

Patient characteristics such as depression and anxiety predict worse pain severity in most surgical populations and provide important context to interpret self-reported outcomes.⁶ However, these characteristics may not have similar effects in living liver donors.^{7,8} Health care provider selection criteria and donor self-selection produces a unique population of young healthy surgical candidates with a concentration of characteristics that affect willingness to donate. Factors such as ambivalence, concerns about the procedure, and social pressures that influence donation decisions have well-documented effects on donor well-being years following surgery.^{8,9} We hypothesize the same factors influence how patients perceive and report their postoperative pain.

The first aim of this study was to evaluate postoperative pain control using the APS-POQ-R in a multicenter prospective cohort. The second aim was to identify donor characteristics that influenced pain scores. Based on past research, we examined donor demographic features, analgesic management, operative details, and whether the donor received information about pain treatment options prior to surgery. Psychosocial information about predonation mood, donation-related concerns, and social pressures were also tested for effects on pain scores.

MATERIALS AND METHODS

Study Participants

Data for this study were collected as part of the Adult to Adult Living Donor Liver Transplantation Cohort Study (A2ALL). The A2ALL study consists of 9 North American transplant centers (see Acknowledgments section for participating centers). Donors eligible for the present study were at least 18 years old, English-speaking, and scheduled for living liver donation surgery.

Study Procedures

Institutional Review Board approval was obtained at each participating center and the data coordinating center (DCC), and informed consent for enrollment in A2ALL was provided by

all donors. Living liver donors enrolled in A2ALL participated in the pain study between September 20, 2012 and May 29, 2014. Predonation psychosocial surveys were conducted through January 31, 2014; therefore, these data were not available for donors in the pain study who donated between February 1, 2014 and May 29, 2014. Treating physicians were blinded to the results of surveys.

Prospective data, including donor demographics and incision type, and postoperative clinical information, including pain management techniques and complications prior to completion of the APS-POQ-R, were collected on all donors. Predonation psychosocial surveys were conducted within 1 month prior to donation by computer-assisted telephone interview, using trained interviewers and lasting approximately 45 minutes. Donors were paid \$20 for a completed survey.

The APS-POQ-R was not administered if the patients were drowsy and fell asleep during the conversation (Pasero Opioid-Induced Sedation Score ≥ 3).¹⁰ Patients were excluded from the study for a score >3 on the third attempt ($n=4$, Figure 1). The APS-POQ-R was administered at 48 rather than 24 hours to ensure liver function was stable and did not contribute to sedation.

Demographic information describing US national living liver donors during the same time period was obtained from the Scientific Registry of Transplant Recipients (SRTR). The SRTR includes data on all donors, waitlisted candidates, and transplant recipients in the United States.¹¹

Measures

Choice of analgesic technique was not influenced by the study. Techniques were classified as Epidural, IVPCA, Local Infiltration (Field block and Transversus Abdominis Plane [TAP] block with and without catheters) and Other. The latter category was composed of treatment that did not enlist 1 of the above categories. Examples were oral and/or intermittent intravenous opioid, and combinations of nonopioid medications.

The APS-POQ-R has 22 questions, of which 18 primary continuous items are scored with a Likert-like scale and form 5 subscales that have internal consistency for the same construct. Higher numbers on a 0 to 10 scale indicated worse scores in 4 subscales: The affective subscale (how much pain negatively affected mood; Cronbach's alpha for internal consistency reliability in the present sample=0.71); pain severity and sleep interference subscale (pain intensity, relief and effects on sleep; alpha=0.81); activity interference subscale (how much pain interfered with activity; alpha=0.81); and adverse effects subscale (side effects of pain and/ or treatment; alpha=0.59). Lower internal consistency thresholds for adverse effects subscales were considered acceptable in the APS-POQ-R (alpha 0.63) due to fewer items in the subscale.⁴

The perceptions of care subscale (percent pain relief, satisfaction with pain treatment and participation in decisions; alpha=0.66) were scored as extremely dissatisfied (0) to extremely satisfied (10). The pain severity and activity interference subscale data were classified into additional broader descriptive categories commonly used in clinical decision-making: For

both, 1–3 was considered mild, 4–6 moderate, and 7–10 severe.^{12,13} Four APS-POQ-R questions elicit descriptive information about use of nonpharmacological methods.⁴

Statistical Analyses

Demographic, predonation psychosocial characteristics, and pain scores are displayed as means, standard deviations (SDs), and ranges for continuous variables and percentages and frequencies for categorical variables. T-tests, Chi-square tests, and Fisher's exact tests were used to evaluate differences between participants in the pain study who did or did not complete predonation psychosocial surveys, as well as between the study population and the US national population of living donors. Distribution of the APS-POQ-R subscale scores in the A2ALL sample was examined using box-plots. Differences in subscale scores by center and center-specific surgical characteristics were tested using Kruskal-Wallis tests.

Mixed effects linear regression models for each of the 5 subscales were fit to assess potential associations with demographic and perioperative characteristics and postoperative complications prior to administering the APS-POQ-R. Potential patient-level fixed effect predictors included age, sex, race, ethnicity, body mass index, relationship to recipient, lobe donated, incision type, analgesic route, multiple versus single route, use of nonmedicine methods for pain relief (physical and cognitive), complications prior to pain survey administration, whether or not the donor received information about pain treatment options prior to surgery, and number of expert guidelines followed. Transplant center was included as a random effect, and intraclass correlation coefficients (ICCs) were calculated to determine variability in subscales accounted for by center. Model selection was guided by the method of best subsets.¹⁴ Similar models were fit using the subgroup of donors that also completed the predonation psychosocial survey. These models included any fixed effects identified as significant predictors in the full sample, as well as the potential psychosocial predictors listed in Table 1. All analyses were completed using SAS 9.4 (SAS Institute, Cary, NC).

RESULTS

Of 172 donors who completed APS-POQ-R, 123 had corresponding psychosocial data. Data were unavailable for 49 donors due to donation dates after the HRQOL study ended (n=37), timing of surgery (n=8), and patient refusal (n=4, Figure 1). No significant differences were found in demographic characteristics between pain study participants who did or did not complete pre-donation psychosocial surveys. Donors were primarily young (36.8 ± 10.6), female (59.7%), and Caucasian (86.9%). The majority donated right lobes (85.8%) for a first-degree relative or spouse (60.8%, Table 2). Donors listed in the SRTR differed in race ($p < .001$) and relationship to the recipient ($p < .001$). The A2ALL had more donors from races other than Caucasian, Black, or Asian (7.4% vs. 1.4%, $p < 0.001$, including Native American, Pacific Islander, and multiracial). The number of first-degree relative donors (parent, child, sibling, or spouse) were similar in both data sets (60.8% in A2ALL, 63.3% in SRTR), but A2ALL nonfirst-degree relative donors differed from the SRTR (21.0% other relative, 18.2% unrelated vs. 10.1% other relative, 26.6% unrelated, $p < 0.001$).

Operative characteristics varied by center (Supplementary Table 1). Only 4 of the 9 centers performed left lobe donations, with the majority performed at 2 centers (22/25). Two centers performed exclusively laparoscopic donation surgeries (n=34 donors), and a third center used the technique for 92% of their donors (n=22 donors). Right subcostal incisions were preferred at 2 centers (n=22 donors), while only 1 center used mostly upper midline incisions (n=14 donors). The remaining 3 centers used multiple incisions, consisting of combinations of right subcostal and upper midline approach (n=64 donors).

Postoperative Analgesic Techniques

Most donors (75.0%) received IVPCA (Table 2), and 7 of 9 centers used IVPCA in >60% of their donors (Supplementary Table 1). Single or continuous TAP block and field block was used in 37.5% of donors in the study, concentrated at 3 centers. Epidurals were least common (16.5%), used at 3 centers regularly, while 38.1% used Other treatment with 1 or more medications that did not enlist the above categories. More than 1 technique was used in 110 donors (62.5%), representing at least 50% of donors at 6 of the 9 centers. Only 12 (7.9%) donors received COX-2 inhibitors as scheduled doses⁹ or as a single or intermittent dose.⁵ No patients received additional nonopioid drugs, and 4 donors received intramuscular analgesics. Out of the 12 pharmacological guidelines, pain management for most donors followed only 2 (65 donors, 38%) or 3 (85 donors, 49%) guidelines. The most number of guidelines followed was 5, achieved by only 1 donor. Commonly used analgesic recommendations were not using the intramuscular route for drug administration (n=170), IVPCA route of opioids (n=172), and peripheral nerve block (n=66).

APS-POQ-R Subscales

Pain was reported across the full range of the 0–10 scale (Table 3). The mean value for worst pain scores was high at 7.05 (SD=2.3) in the 24 hours prior to survey, but patients reported 68.60% pain relief during that time. The distribution of subscale scores is shown in Figure 2. Patients reported little negative emotional reaction to pain with median affective subscale scores of 2.00 (interquartile range [IQR]=0.63–3.50), and the majority had a high perception of care; median subscale score 7.83 (IQR=6.67–9.00). However, the median pain severity and sleep interference subscale score was 4.00 (IQR=2.40–5.60), and 25% had scores as high as 5.6–9.4. The median activity interference subscale score was 5.50 (IQR=3.50–7.50), and adverse effect was 4.75 (IQR = 3.25–6.50).

When excluding centers with fewer than 10 donors, affective reaction, perceptions of care, and activity interference subscale scores did not differ significantly by center (p=0.12, 0.13, and 0.68, respectively, Supplementary Figure 1). Pain severity and adverse effects subscale scores differed significantly across centers (p=0.003 and 0.04, respectively), largely driven by low pain severity scores at center C (median=2.7, IQR=1.6–3.2) and high adverse effects scores at center G (median=6.75, IQR=4.5–7.1). The ICC measuring the percent variation in subscale scores accounted for by centers was low for activity interference and affective subscales (<0.1% and 3%, respectively), moderate for the perceptions of care subscale (7%), and relatively high for adverse effects and pain severity (15% and 17%, respectively).

Predonation Psychosocial Characteristics

Among 123 respondents, 78.0% reported ambivalence about donation, 13.8% were encouraged to donate, and 48.0% were discouraged (Table 4). No patient had a provisional diagnosis of major depression based using Primary Care Evaluation of Mental Disorders (PRIME-MD) criteria; however, 6.5% of donors reported mild-moderate symptoms when surveyed using the Patient Health Questionnaire-9 (PHQ-9).

Only 1 patient had a provisional diagnosis of anxiety syndrome. Predonation pain prevalence and symptoms were minimal; 26.0% reported pain before donation, but the Brief Pain Index (BPI) interference score was low at 0.9 (SD=1.3). The average Short Form 36 (SF-36) bodily pain score was >0.5 SD higher than the US norm, indicating less pain intensity and impairment. While 20.3% of donors had no medical concerns about donation before the surgery, 64.3% had 2 or more concerns about the impending procedure, with 53.7% expressing concerns about pain related to donation.

Demographic Predictors of APS-POQ-R Subscales

Females had higher affective and adverse subscale scores: Beta=0.88 (standard error [SE]=0.31, $p=0.005$) and 1.33 (SE=0.29, $p<0.001$) compared with males, respectively (Table 5a). Adverse effects subscale scores decreased by 0.50 (SE=0.13, $p<0.001$) per 10-year increase in age at donation, reflecting more negative symptoms in younger donors. Patients who received preoperative information about pain treatment options had higher perception of care scores than those who did not. Those who received more than 1, rather than a single technique, on average had lower perception of care (0.82; SE=0.31, $p=0.010$). No associations between type of analgesic, number of guidelines followed, or incision and APS-POQ-R subscale scores were identified.

Psychosocial Predictors of APS-POQ-R

On average, perception of care scores were 1.58 units (SE=0.63, $p=0.014$) lower for those with mild or moderate depression symptoms compared with those without. Donors discouraged from donating by close social ties also had 0.75 units (SE=0.32, $p=0.022$) worse affective subscale scores than those not discouraged from donating. These models were adjusted for the demographic predictors significantly associated with subscales in the full population of donors (Table 5a). Estimates for these predictors were similar in magnitude and direction to those presented in Table 5a.

Ambivalence about donating correlated with number of predonation medical concerns; therefore, both variables could not be included in multivariate modeling. We explored bivariate relationships for each potential predictor with APS-POQ-R subscale scores and found number of concerns to be a significant predictor, while ambivalence was not. We, therefore, retained number of concerns for multivariate modeling. Two or more medical concerns predicted worse subscales scores, except perception of care with average scores for 2 or more concerns ranging from 1.16–1.55 units higher on the affective, pain severity and sleep interference, activity interference, and adverse effects subscales (Table 5b).

DISCUSSION

An analysis of pain outcomes using the APS-POQ-R suggests interventions are needed to improve pain severity, activity interference, and adverse effects of treatment. Analgesic choice could be a contributing factor, as most centers used only 2 or 3 techniques recommended by expert pain societies.³ However, donor characteristics also played a significant role, as the number of medical concerns and being discouraged from donating predicted worse pain outcomes. The distinct pattern of pain perception uncovered by the APS-POQ-R, including little negative emotional distress to pain, suggests that interventions used in other surgical populations may not be equally effective in living liver donors.

We were not able to identify a relationship between the compliance with expert guidelines and APS-POQ-R subscale scores due to few (2 to 3) guidelines used. While it would seem that better compliance could improve pain outcomes, the relationship between number of guidelines followed and outcome is complicated by the limited ability to identify optimal combinations for specific procedures. Choice or dosing of medication may, therefore, play an important role in outcomes. Other factors, such as patient characteristics and unmeasured effects of how care is delivered, also modify the response to pain treatment.¹⁵

Randomized controlled trials show neuraxial blockade and scheduled nonopioid analgesics reduced pain severity, the number and severity of side effects, and improved functional activity.^{16,17} Infrequent use of scheduled nonopioid drugs (4.5%) or neuraxial blockade (16%) may explain the moderate to severe pain, activity interference, and adverse effects reported in the A2ALL donors. Marked deviations from care plans recommended by experts in pain have also been noted in other surgical populations, and investigators agree this is a rich area for improvement of care.^{16,18}

Perception of care has been used as a measure of effective analgesic treatment. However, previous studies show it reflects the interrelated effects of pain relief over time, and involvement in care, in addition to satisfaction with results of treatment.^{4,19} Our findings are consistent with these observations, as the highest perception of care was reported by living liver donors who received predonation information about pain options ($p=0.001$). The association between lower perception of care and use of multiple analgesic techniques requires further evaluation but suggests the use of more than 1 technique leads to negative impressions about appropriateness of care when there is inadequate pain control.

Living liver donors differed from other surgical populations in reporting little emotional distress to moderate-severe pain.^{20,21} This may represent a response that is highly influenced by the psychological benefits of donation.^{22,23} The finding illustrates the important interplay between patient characteristics and individual domains of pain perception. This observation argues against opinion that the only way to improve pain management is the strict use of protocols for monitoring and administering analgesics.²⁴

Demographic and psychosocial predictors of pain outcomes in other surgical populations had similar effects in living liver donors. These include the association between female sex and younger age with adverse effects and emotional distress to pain.^{25–27} No donor was diagnosed with major depressive syndrome, but the presence of symptoms predicted

significant worse pain scores. Even though depressive symptoms predict worse pain scores in most surgical populations, the target domains are usually activity interference and pain severity, but not perception of care.^{28,29} The findings point out important differences in pain perception between surgical populations that need consideration when measuring the outcomes of new care plans.

Predonation medical concerns are an important finding associated with significant and multiple effects on donor recovery. The presence of concerns predicted not only worse postoperative pain outcomes in 4 of 5 subscales, but also poor mental health up to 9 years following donation surgery.³⁰ Being discouraged from donating was significantly associated with greater emotional distress in response to pain. In-depth qualitative analysis has shown “discouraging donation” produces interpersonal stress and emotional distress due to conflict with social ties.^{23,31} It is possible that social conflict due to disagreement about donation could lead to emotional distress that is expressed in response to pain.

Our study identifies demographic and psychosocial patient characteristics as sources of suboptimal pain scores. We suggest these findings can be generalized to living donors in North American centers who have similar psychosocial profiles. Further testing is needed to determine if similar observations would be elicited in other geographic locations with different sociocultural practices. However, the methodology used in this study has been tested globally and can be used at other centers to generate comparative data.

Revising analgesic care plans using recent expert recommendations will likely improve outcomes in living liver donors and produce more uniform protocols that are amenable to large database analysis for quality improvement. Modifying behavioral characteristics may be necessary to optimize analgesic outcomes. Behavioral interventions, such as motivational interviewing, have helped potential donors resolve predonation concerns and reduced pain in the months following surgery.³² Other therapies, such as cognitive behavioral modification, have successfully reduced pain severity in patients undergoing cardiac surgery.³³

There were limitations to our study. The study was not a trial of analgesic efficacy or superiority of incision type for pain outcome. This would require a prospective randomized study design with protocolized treatment arms to minimize differences in outcome due to monitoring of pain and treatment response, which is not feasible for ethical reasons. In addition, our study was not designed to measure compliance with expert analgesic guidelines. This information was not systematically collected and may have led to underestimation of the number of guidelines followed for each donor. However, the center practice patterns that emerged, as well as comparisons with existing literature, indicate our findings regarding number of guidelines followed were reasonable.^{16,18}

We could not test or did not include other variables that might be risk factors for postoperative pain in living donors. For example, insufficient donors with predonation anxiety syndrome precluded evaluation of pain outcomes. We did not collect information about pain catastrophizing, a trait significantly associated with worse pain and functional outcomes in other surgical populations.^{34,35} We suspect that the rigorous mental health

screening utilized during the donor selection process would have eliminated most individuals with this characteristic.³⁶

In summary, living liver donors reported suboptimal pain control using analgesic care that did not incorporate most evidence-based recommendations.³ While changes to pain care protocols may improve pain control, we identified donor characteristics that predict pain outcomes and serve as additional important opportunities for quality improvement. Interventions that enable donors to resolve predonation concerns or minimize the adverse effects of being discouraged from donating may be integral parts of donor pain quality improvement.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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ABBREVIATIONS

A2ALL	Adult to Adult Living Donor Liver Transplantation Cohort Study
APS-POQ-R	American Pain Society Patient Outcome Questionnaire-Revised
BPI	Brief Pain Index
COX-2	Cyclooxygenase-2
DCC	Data Coordinating Center
HRQOL	Health-Related Quality of Life
ICC	Intraclass Correlation Coefficient
IQR	Interquartile Range
IVPCA	Intravenous Patient-Controlled Analgesia
PHQ-9	Patient Health Questionnaire-9
PRIME-MD	Primary Care Evaluation of Mental Disorders
SD	Standard Deviation
SE	Standard Error
SF-36	Short Form 36
SRTR	Scientific Registry of Transplant Recipients
TAP	Transversus Abdominis Plane
US	United States

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Figure 1.
Study Flow Chart

Figure 2.
Boxplots of APS-POQ-R Subscales

Table 1

Items from pre-donation psychosocial survey

Measure	Instrument Description	No. of Items	Scoring	Source
Donation-specific items				
Ambivalence	Ambivalence scale, assessing doubts, uncertainty and hesitation about donating.	7	Any ambivalence (endorsed ambivalence on any item) vs. no ambivalence	Simmons et al.
Encouraged by anyone to donate	Single item from Simmons' work.	1	Yes vs. no	Simmons et al.
Discouraged by anyone from donating	Single item from Simmons work.	1	Yes vs. no	Simmons et al.
Decision to donate was entirely voluntary	Single item from Simmons' work.	1	Yes vs. no	Simmons et al.
Feel well-prepared for donation	Single item from Simmons' work.	1	Totally prepared vs. could have been better prepared vs. not prepared	Simmons et al.
Spouse/partner supports decision to donate	Single Simmons' work.	1	Agree vs. disagree	Simmons et al.
Parents support decision to donate	Single Simmons' work.	1	Agree vs. disagree	Simmons et al.
Medical concerns related to donation	Medical concern items from checklist. Anticipated problems related to donation (eg. pain, problems undergoing anesthesia).	5	Number of concerns classified as 0, 1, 2+	Simmons et al. DiMartini et al.
Past family disapproval	Black sheep donor scale, assessing whether donor's family generally approved of donor's life and whether the donor ever did something the family did not approve of.	2	Yes vs. no	Simmons et al.
Generic HRQOL				
Depression severity	PHQ-9, assessing depressive symptoms	9	None (0), minimal (1–4), mild/moderate (5–14, combined due to small numbers)	Kroenke et al.
Major depressive syndrome	Provisional diagnosis of major depressive disorder, PRIME-MD.	9	Yes vs. no	Spitzer et al.
Anxiety syndrome	Provisional diagnosis of anxiety disorder, unspecified, PRIME-MD.	7	Yes vs. no	Spitzer et al.
SF-36 bodily pain subscale	Domain of SF-36, version 2 assessing bodily pain.	2	Score ranges from 0 (maximum impairment) to 100 (no impairment) and is standardized to US population (mean=50, SD=10)	Ware
Pre-donation abdominal or back	Pain severity rating scale from brief pain inventory.	1	Any vs. no pain	Mendoza et al., Cleeland and

Measure	Instrument Description	No. of Items	Scoring	Source
pain (previous 24 hours)				Ryan
Pain interference	Brief pain inventory interference scale, assessing pain interference with domains of function (eg, mood, work, sleep). Completed only if any pain was present.	7	Mean score (range 0=no interference to 10=maximum interference)	Mendoza et al., Cleeland and Ryan

Abbreviations: HRQOL, health-related quality of life; PHQ-9, Patient Health Questionnaire 9; PRIME-MD, primary care evaluation of mental disorders; SF-36, Short Form 36; US, United States.

Table 2

Sample characteristics

Characteristic	Total N	Mean(SD) or %(N)	Range
Demographics			
Age at donation (years)	176	36.8 (10.6)	18.3 – 58.1
Sex	176		
Male		40.3% (71)	
Female		59.7% (105)	
Ethnicity	176		
Non-Hispanic		90.9% (160)	
Hispanic		9.1% (16)	
Race	176		
White		86.9% (153)	
African American		3.4% (6)	
Asian		1.7% (3)	
Other		7.4% (13)	
Unknown		0.6% (1)	
BMI at donation	138	26.7 (3.8)	18.1 – 40.6
Relationship to recipient	176		
First-degree relative or spouse		60.8% (107)	
Other relative		21.0% (37)	
Unrelated		18.2% (32)	
Post-Donation Characteristics			
Days from donation to survey	174	2.2 (0.4)	2.0 – 4.0
Sedation score	176		
0		62.5% (110)	
1		32.4% (57)	
2		2.8% (5)	
3 or higher ^δ		2.3% (4)	
Route of pain management (multiple types possible)	174		
Epidural		16.5% (29)	
IVPCA		75.0% (132)	
TAP/catheter		37.5% (66)	
Other [¥]		38.1% (67)	
Multimodal vs. single pain therapy	174	62.5% (110)	
Used non-medicine methods for pain relief	172	65.3% (115)	
Used physical non-medicine methods for pain relief	172	46.0% (81)	
Used cognitive non-medicine methods for pain relief	172	54.0% (95)	
Complication prior to survey administration	176		
None		96.0% (169)	

Characteristic	Total N	Mean(SD) or %(N)	Range
At least 1		4.0% (7)	
Received information about pain treatment options	171	83.5% (147)	

* Right subcostal (n=24) or upper midline (n=26).

** Right subcostal and upper midline (n=64), left and right subcostal (n=3), or left and right subcostal and upper midline (n=2).

^δ These 4 donors were unable to complete the survey and are excluded from further analysis. Note: n=1 donor had a sedation score of 4 (general anesthesia, patient is unconscious).

[¥] Other pain management includes intrathecal and other oral and IV medication.

Abbreviations: BMI, body mass index; IVPCA, intravenous patient-controlled analgesia; SD, standard deviation; TAP, transversus abdominis plane.

Table 3

Descriptors of acute postoperative pain

	Mean	SD	Min	Max
Least pain in the first 24 hours (0=no pain, 10=worst pain possible)	3.08	2.27	0.00	10.00
Least pain in the last 24 hours (0=no pain, 10=worst pain possible)	3.18	2.18	0.00	10.00
Worst pain in the last 24 hours (0=no pain, 10=worst pain possible)	7.05	2.30	0.00	10.00
% of time in severe pain in the last 24 hours (0%=never in severe pain, 100%=always in severe pain)	26.10	23.28	0.00	90.00
% pain relief in the last 24 hours (0%=no relief, 100%=complete relief)	68.60	21.69	0.00	100.00

Abbreviations: SD, standard deviation.

Table 4

Psychosocial characteristics *

Characteristic	Total N	Mean(SD) or %(N)	Range
Donation-specific items			
Ambivalent about donation	123	78.0% (96)	
Encouraged to donate	123	13.8% (17)	
Discouraged from donating	123	48.0% (59)	
Decision to donate was voluntary	123	100.0% (123)	
Prepared for donation	123		
Yes, totally		82.1% (101)	
Yes, but could be better prepared		17.9% (22)	
No		0.0% (0)	
Spouse/partner supports donation decision	123		
Yes		74.8% (92)	
No		2.4% (3)	
No spouse/partner		22.8% (28)	
Parents support donation decision	122		
Yes		83.7% (103)	
No		4.9% (6)	
No parents/no info on parents		10.6% (13)	
Number of medical concerns about donation	123		
None		20.3% (25)	
1		15.4% (19)	
2+		64.2% (79)	
Black sheep donor	123	27.6% (34)	
Generic HRQOL			
Depressive symptoms	123		
None (0)		51.2% (63)	
Minimal (1–4)		42.3% (52)	
Mild/moderate (5–14)		6.5% (8)	
PRIME-MD major depressive syndrome	123	0.0% (0)	
PRIME-MD anxiety syndrome	123	0.8% (1)	
SF-36 bodily pain subscale (range 0=maximum impairment, 100=no impairment, normative mean [SD]=50 [10])	123	58.6 (5.8)	37.2 – 62.1
Any pre-donation pain	123	26.0% (32)	
BPI interference scale (range 0=no interference, 10=complete interference) **	32	0.9 (1.3)	0.0 – 4.1

* Respondents that completed the pre-donation HRQOL survey (n=123) differed from those that did not (n=49) on race (p=0.02).

** Only completed by respondents reporting any pre-donation pain.

Abbreviations: APS-POQ-R, American Pain Society Patient Outcome Questionnaire-Revised; BPI, brief pain index; HRQOL, health-related quality of life; info, information; PRIME-MD, primary care evaluation of mental disorders; SD, standard deviation; SF-36, short form 36.

Table 5**a: Linear regression models among n=172 APS-POQ-R respondents**

Subscale	Predictor	Estimate (SE)	p-value
Affective	Female vs. male	0.88 (0.31)	0.005
Pain severity	-	-	-
Perceptions of care	Received information about pain treatment options	1.24 (0.36)	0.001
	More than 1 vs. single pain therapy	-0.82 (0.31)	0.010
Activity interference	-	-	-
Adverse effects	Age at donation (per 10 years)	-0.50 (0.13)	<0.001
	Female vs. male	1.33 (0.29)	<0.001

b: Linear regression models among n=123 APS-POQ-R respondents with pre-donation HRQOL survey data

Subscale	Predictor	Estimate (SE)	p-value
Affective	Donor was discouraged to donate	0.75 (0.32)	0.022
	Number of medical concerns about donation (ref=none)		0.002
	1	1.02 (0.55)	0.066
	2+	1.55 (0.42)	<0.001
Pain severity	Number of medical concerns about donation (ref=none)		0.042
	1	0.62 (0.61)	0.317
	2+	1.16 (0.47)	0.014
Perceptions of care	Pre-donation depression (ref=none)		0.019
	Minimal	-0.61 (0.31)	0.052
	Mild/moderate	-1.58 (0.63)	0.014
Activity interference	Number of medical concerns about donation (ref=none)		0.077
	1	0.18 (0.82)	0.825
	2+	1.23 (0.62)	0.049
Adverse effects	Number of medical concerns about donation (ref=none)		0.002
	1	0.21 (0.56)	0.708
	2+	1.35 (0.43)	0.002

Abbreviations: APS-POQ-R, American Pain Society Patient Outcome Questionnaire-Revised; SE, standard error.

Abbreviations: APS-POQ-R, American Pain Society Patient Outcome Questionnaire-Revised; HRQOL, health-related quality of life; ref, reference; SE, standard error.