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ORIGINAL ARTICLE

Pancreas transplantation perceptions and practice: Results from a national US survey

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Abstract

Background: Due to a substantial decline in pancreas transplantation (PT) across the United States over the past 15 years, we sought to understand the perceptions and practices of US PT programs.

Methods: Surveys were sent to members of the American Society of Transplantation Surgeons and the American Society of Transplantation by email and professional society postings between August 2019 and November 2019.

Results: One hundred twenty three responses were recorded from 56 unique programs. Program characteristics were obtained from the Scientific Registry of Transplant Recipients. Respondents were transplant surgeons (71%), transplant nephrologists (17%), trainees (9%), and allied professionals (3%). Programs were

defined according to annual volume as: low (<5 PT/year), intermediate (6–20), or high (>20). High-volume programs reported that these factors were most important for increased PT: expansion of recipient selection, more aggressive donor utilization, and hiring of PT program-specific personnel. At both the program and national level, the vast majority (82% and 79%, respectively) felt the number of PTs currently performed are not in balance with patients' needs.

Conclusions: Overall, programs reported that the option of PT is not offered adequately to diabetic patients and that strategies to maintain higher PT volume are most evident at intermediate, and especially, high-volume programs.

KEYWORDS

donors and donation: donor evaluation, pancreas after kidney transplantation, pancreas transplant alone, pancreas transplantation, program volume, recipient selection, simultaneous pancreas-kidney transplantation, survey, type 1 diabetes mellitus, type 2 diabetes mellitus

1 | INTRODUCTION

The prevalence of diabetes mellitus (DM) in the United States is increasing rapidly and currently affects an estimated 34 million Americans, or 10.5%, of the US population.[1] Pancreas transplantation (PT) remains the best and only treatment option capable of offering long-term glycemic control as well as the ability to halt or even reverse secondary microvascular diabetic complications, including retinopathy, nephropathy, and neuropathy.[2–4] Additionally, PT offers diabetic patients an improved quality of life by eliminating the need for daily insulin injections, limiting wide fluctuations in blood glucose levels, and minimizing the risk of hypoglycemia.[2–4] Over the past three decades, advancements in surgical technique and immunosuppressive agents along with careful patient selection have resulted in improved outcomes following PT. One- and five-year patient survival are now >95% and >88%, while 1- and 5-year graft survival are ~85% and >60%.[2,5] In addition, the number of pancreas recipients with prolonged graft survival is rising.[6] This progress has established PT as a safe and effective treatment in both appropriately selected type 1 and type 2 diabetic patients.[7–14]

Despite the benefits and improved outcomes associated with PT, rates of PT have paradoxically declined in the United States over the past 15 years, following a peak in 2004.[15] An analysis of simultaneous pancreas and kidney transplant (SPK), pancreas after kidney transplant (PAK), and pancreas transplant alone (PTA) rates from 2004 to 2011 revealed a 55% overall reduction in PAK, followed by 34% in PTA and 10% in SPK.[15] Subsequently, between 2004 and 2016, the average annual decline in PT was 2.9%.[16] This steady decline in rates of PT has been accompanied by a decrease in new additions to the waitlist, decreased pancreas organ recovery, and an increase in waitlist mortality.[5,17] A previous report by Stratta et al. hypothesized the trend in declining pancreas transplant rates was likely multifactorial, owing to improvements in diabetic management, improved and increased use of insulin pumps and glucose sensors, changes to donor and recipient selection criteria, and an overall lack of referrals for PT.[15]

A comprehensive analysis of program attitudes and practice patterns regarding PT was sought to improve understanding of the declining PT rates and to identify areas of growth potential and sharing of best practices. The Pancreas Workgroup of the American Society of Transplantation (AST) Kidney Pancreas Community of Practice (KPCOP) conducted a survey to characterize the perceptions and practices among PT programs with a national survey. This manuscript is a work product of the AST KPCOP.

2 | METHODS

2.1 | Survey population and administration

The Scientific Registry of Transplant Recipients (SRTR) was used to identify all US transplant programs July 1, 2018 to June 30, 2019. A survey regarding program perceptions and practices related to PT was sent to all members of the American Society of Transplant Surgery (ASTS) and the AST via email and professional society listservs between August 28, 2019 and November 27, 2019. Surveys were conducted using Qualtrics Survey Software among surgical and medical program directors, attending transplant surgeons, nephrologists, endocrinologists, fellows, and residents.

2.2 | Study design

The survey was developed in conjunction with members of the pancreas workgroup of the AST KPCOP following a thorough review of the literature on all aspects of PT. Key constructs of interest were identified on conference calls, and survey items were developed and refined by direct discussion and email. The final version of the survey contained 36 separate questions, which were either multiple choice or open response. The AST Education Committee and the ASTS Council approved the final version of the survey. The survey was reviewed and

deemed exempt by the Emory University Institutional Review Board (2019); this research is in adherence to the Declaration of Helsinki and the Declaration of Istanbul.

2.3 | Analysis

First, programs were stratified into either "low" (<5 PT/year), "intermediate" (6–20 PT/year), or "high"-volume (>20 PT/year) programs based on their survey response. The SRTR database was used to confirm pancreas transplant program status (by volume and PT type) based on the dates July 1, 2018 to June 30, 2019. Response frequency was calculated for each survey question. Survey question responses were quantified and presented based on low, intermediate, or high-volume PT status. For programs with multiple respondents, we selected one representative response per program based on the following prioritization: program director-surgeon, transplant surgeon, program director-medical, transplant nephrologist, allied health professional, and trainee. Completed questions were used for analysis at the item level (i.e., skipped responses were not included in the item-by-item analysis). The stratified results were presented to examine trends. All data were analyzed using Microsoft Excel (Microsoft Corporation, Redmond, WA, USA).

3 | RESULTS

3.1 | Survey participants

The survey was queried 122 times, with 93 completed responses. Nine responses were excluded from the analysis due to an inability to provide program assignments. There were 84 completed responses available for analysis. Single responses from each program were identified after 25 duplicate program responses were eliminated according to the a priori selection hierarchy.

Duplicate program responses from the low-, intermediate-, and high-volume cohorts were 0, 23, and 2, respectively. Seventeen programs provided two or more responses, including six programs that provided three or more responses, and one program that provided five responses. The 17 programs that offered duplicate responses underwent an analysis of correlation for their responses to sampled questions. For instance, for the question "over the past three years, has the trend in the number of pancreas transplants performed at your program increased significantly (>25%), increased slightly (0-25%), remained the same, decreased slightly (0-25%) or decreased significantly (>25%)," 59% of responses were identical to the response that was used to represent the program. All of the responses that were not identical were within one increment of representative response (e.g., no program had two answers were increased significantly and remained the same). For the question "do you feel the number of pancreas transplants performed at your program is representative of your diabetic population in need, yes or no?," 65% of the duplicate responses gave an answer identical to their program's representative response. For the question "do you feel the number of pancreas transplants performed nationally is in balance with the number of patients who need a pancreas transplant, yes, no, or not sure?," 65% of the duplicate responses gave an answer identical to their program's representative response, and 94% of the duplicate responses were either no or not sure and only one program had a discordant set of responses (yes vs. no).

Three of low volume program responses were excluded from program level analysis as they stated that their program did not perform a single pancreas transplant and answered no other questions. Four complete responses were from four different low volume programs that performed no PT (effectively kidney only programs). The final analyzed total number of program responses was 56, including 16 (28%), 34 (61%), and 6 (11%) from low-, intermediate-, and high-volume programs, respectively. For the final sample analyzed, 41% were surgical program directors, 38% were transplant surgeons, 11% were medical program directors, 2% were transplant nephrologists, 2% were allied health professionals (coordinators, nurse practitioners, physician assistants, or pharmacists), and 7% were trainees (fellows, residents, or students). The response rate from high-volume programs was 75% (6/8), while the overall response rate of all programs was 42% (56/134), and the percent of pancreas transplant volume represented by the responding programs was 59% (594/1002).

3.2 | Program characteristics

Characteristics of the responding program, stratified by annual PT volume, are summarized in Table 1. In general, resource expenditure and commitment to PT rose with higher volume of PT. Intermediate- and high-volume programs reported that over the past 3 years, the trend in the number of PT has increased at 47% and 50% of their programs, respectively. Conversely, at low volume programs, an increasing trend was noted only at 19% of programs, and half felt the trend remained the same (Table 2). The total pancreas numbers of the six high-volume programs reported here demonstrated similar findings when looking at the actual SRTR reports for PT (Figure S1).

Programs with increased PT volume reported varying levels of influence for the following: increased referrals, expansion of recipient selection, increased donor availability, more aggressive donor utilization, and dedicated hiring of PT program-specific personnel (Figure 1). Likewise, programs with decreased volumes reported varying levels of importance for the following reasons: decreased referrals, no investment in outreach services, decreased availability of suitable organs, conservative donor and recipient selection due to increased regulatory oversight, competition from another local PT program, decreased interest in PT at their program, and decreased experience of transplant providers at their program (Figure 1). Following reported volume changes, programs were then asked to evaluate the significance of multiple factors (Figure 1). The most important reasons programs reported (1 = very important, 5 = not important) for increased PT were increased referrals (2.4/5), expansion of recipient selection (2.1/5), more aggressive donor utilization (2/5), and dedicated hiring of

TABLE 1 PT program practice patterns and personnel characteristics

Question		Low	Intermediate	High	Overall
Does your program have a dedicated PT-specific surgical director who is separate from the kidney transplant surgical director? %YES		38%	29%	100%	39%
Does your program have a dedicated PT-specific medical director who is separate from the kidney transplant medical director? %YES		13%	24%	50%	23%
Who performs pancreas transplants at your program? Liver/kidney/pancreas surgeons Kidney/pancreas surgeons Unknown	LKP KP Unk	38% 50% 12%	59% 41%	50% 50%	53% 46% 1%
Are the following performed at your program?					
PTA		67%	94%	100%	87%
PAK		87%	97%	100%	95%
Allo-islet cell		7%	18%	33%	16%
SPK for T1D		93%	100%	100%	98%
SPK for T2D		60%	88%	83%	80%
PT after DCD		20%	27%	83%	31%
PT after PHSIR		67%	88%	100%	84%

DCD, donation after cardiac death; KP kidney pancreas surgeons; LKP, liver kidney pancreas surgeons; PHSIR, Public Health Service increased risk; T1D, type 1 diabetes; T2D, type 2 diabetes.

personnel specific to the pancreas program (2.8/5). The most important reasons programs gave for decreased PT were decreased referrals (2.8/5), decreased availability of suitable organs (2.6/5), and conservative donor and recipient selection due to increasing regulatory oversight (2.6/5).

3.3 | PTA versus medical management

The most common reasons programs provided for the national decline in referrals for PTA were a decrease in need due to development of insulin pumps and glucose sensors (39%), uncertain benefits of PTA among primary care physicians (PCPs) and endocrinologists (25%), and lack of awareness regarding the indications among PCPs and endocrinologists (20%). The primary reasons programs identified for national decline in referrals for PTA are summarized in Table 2. High-volume programs were more concerned about the awareness of referring providers, rather than the development of insulin pumps and sensors. In terms of the benefit of PT in the current era of insulin pumps augmented with sensors and closed-loop systems, a majority (52%) of programs felt that PT is superior to closed-loop systems for patients with brittle diabetes and/or who have hypoglycemic unawareness. Endorsement of the benefit of PT rose with PT volume, from 56% of low volume, 47% of intermediate volume, and 67% of high-volume programs. However, programs reported concern about the risk: benefit ratio in many cases when comparing the benefit of PT to current medical management (Table 2).

3.4 | Lack of PT volume for perceived need

The majority (82%) of programs reported that the number of PT performed at their program's diabetic population is not representative of their need. This finding was consistent across low-, intermediate-, and high-volume programs. Likewise, a large majority (79%) of responding programs felt the number of PT performed nationally is not in balance with the number of patients who need a PT—findings that were consistent across the three program categories (Figure 2).

3.5 | Pancreas donor selection

The majority of programs (63.6%) reported having a protocol-based approach to pancreas donor-selection criteria. This finding was more common among intermediate- (74%) and high- (67%) volume programs compared to low- (47%) volume programs. The importance of different donor selection criteria is summarized in Table 3; the most important criteria that programs reported were donor age, body mass index (BMI), and opinion of the procurement surgeon. Low-, intermediate-, and high-volume programs responded consistently across most donor selection criteria (Table 3). It was uncommon that a surgeon who was not a member of their program recovered the pancreas, as 55% of the programs stated this happened only for 0–20% of pancreas procurements (Figure 3). This finding was consistent at low and intermediate volume-programs; however, at 50% of high-volume programs, 41–60% of procurements were by outside surgeons. The vast majority of

TABLE 2 Perceptions from total PT programs and based on program volume

Topic	Responses	Total	Low	Intermediate	High
Responses regarding the recent perception in the number of PT performed at their program over the last 3 years	Increased significantly (>25%)	18%	6%	23%	17%
	Increased slightly (0–25%)	21%	12%	24%	33%
	Remained the same	39%	50%	35%	33%
	Decreased slightly (0–25%)	18%	19%	18%	17%
	Decreased significantly (>25%)	4%	13%	0%	0%
Reasons for the national decline in referrals for PTA	Lack of awareness regarding the indications among PCPs and endocrinologists	20%	13%	15%	66%
	Uncertain benefits of pancreas transplant alone among PCPs and endocrinologists	25%	37%	20%	17%
	A decrease in the need with development of the insulin pump and sensors	39%	44%	44%	0%
	Fear of poor outcomes and resulting scrutiny by regulatory bodies	9%	6%	12%	0%
	Other	7%	0%	9%	17%
Opinions about the benefit of PT versus current medical management (multiple answers possible)	Risks of PT outweighs benefit; prefer insulin pump therapy augmented by continuous glucose monitoring	7%	25%	0%	0%
	PT benefits patients needing SPK, but risks exceed benefit for PTA	30%	31%	32%	17%
	PTA is superior to insulin pump therapy augmented by continuous glucose monitoring for patients with type 1 diabetes	18%	6%	27%	0%
	Unsure of the benefit of PT due to lack of research directly comparing PT with closed loop systems	18%	13%	21%	17%
	PT is superior to closed loop systems for patients with brittle diabetes and/or who have hypoglycemic unawareness	52%	56%	47%	67%
	Other	2%	0%	3%	0%

programs (87%), regardless of program volume, stated that they routinely communicate with the procuring pancreas surgeon regarding the visual description of the donor pancreas before making the final selection decision. Transplant surgeons make the final decision regarding donor pancreas offers at 94% of programs, with the remaining made jointly by transplant surgeons and nephrologists. Transplant surgeons or surgical program directors agreed to perform a pancreas procurement for another program if requested 98% of the time.

Common reasons programs gave for declining a donor pancreas were as follows: parts of the pancreas have edema within its lobules (57%), fat is present in the tail of the pancreas (47%), the donor may have a replaced right hepatic artery originating from the superior mesenteric artery (33%), other responses (29%) (including: firm, fatty infiltration, fibrotic pancreas, hematoma, poor flush). The majority (64%) of programs, regardless of volume, have either never or less than 10% seen in their practice a pancreas initially accepted but then declined upon inspection after transportation to their program (Figure 3). Furthermore, 45% of programs accept a pancreas procured by an outside surgeon at least 20% of the time. Of those programs, 84% reported 25% or less cases where a pancreas was declined after transportation to their program.

The maximal distance programs were willing to import a donor pancreas was dictated by the expected cold ischemia time in 48% of programs. However, 20% had a limit of 500 miles, 9% had no limit, 9% had a limit of 100 miles; the remainder were not sure or specified another distance, 200 or 1000 miles. All high-volume programs based the decision on expected cold ischemia time, while at low-volume programs only 21% based the decision on cold ischemia time, and 36% had a limit of 500 miles. The majority (57%) of programs, regardless of volume, will charter a private jet for transportation of a donor pancreas or kidney and pancreas, while 32% would not, and 11% were not sure. Maximum cold ischemia time programs would typically accept were 12 h (46%), 24 h (27%), 8 h (9%), other (responses ranged from 10 to 20 h) (16%), and not sure (2%). Low-volume programs (57%) use 12 h as their

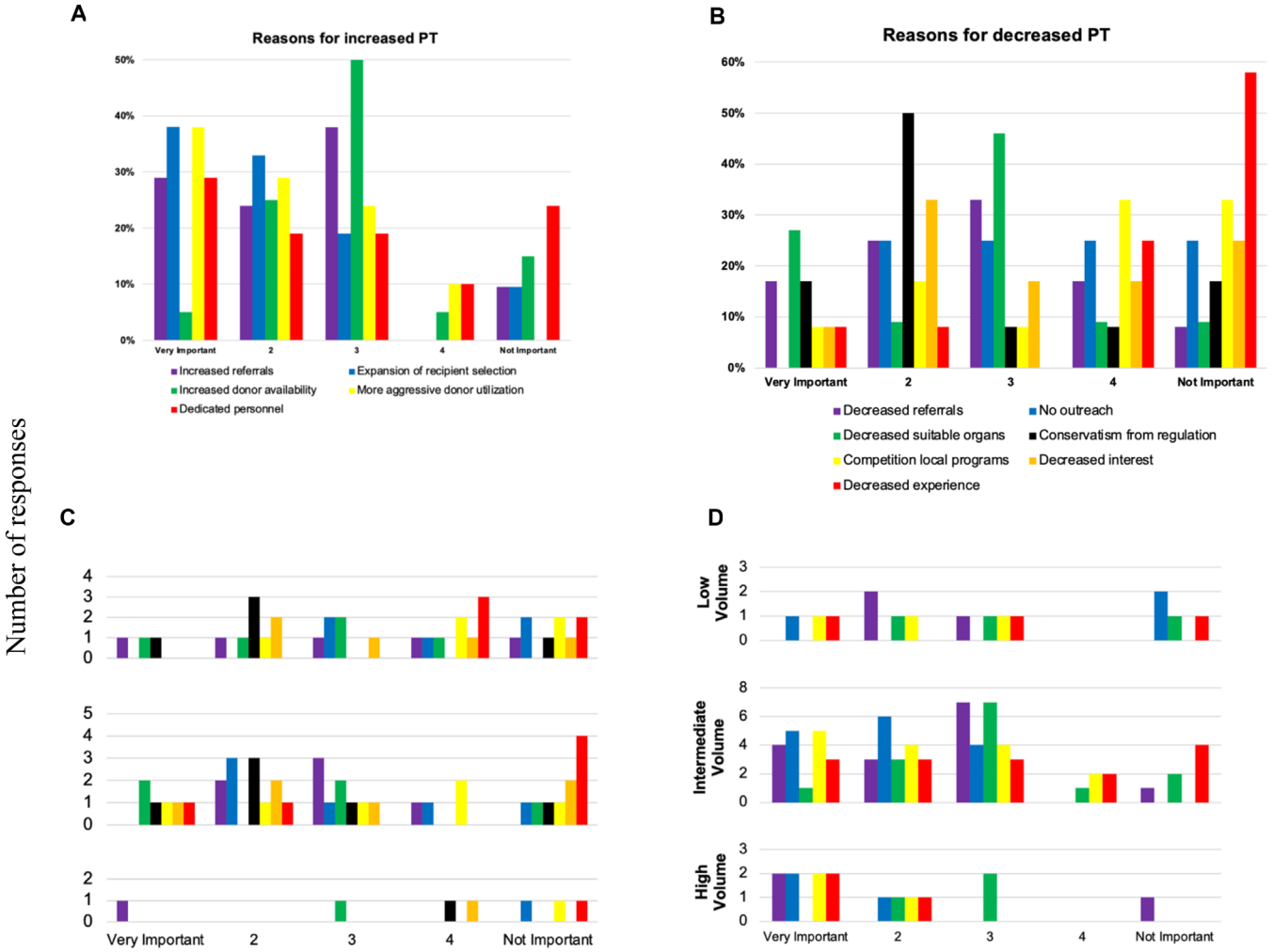

FIGURE 1 Reasons for perceived increased (A,C) or decreased PT (B,D) for all programs (A,B) and according to the number of responses and PT volume (low, intermediate, and high, C,D) based on levels of importance (1 = very important, 5 = not important)

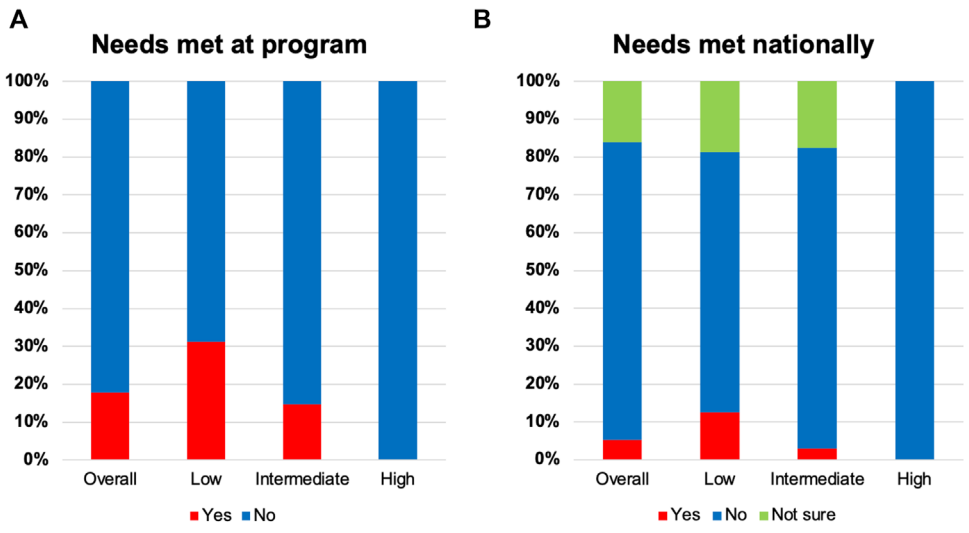

FIGURE 2 Perceptions about the need for PT locally and nationally: (A) Do you feel the number of pancreas transplants performed at your program is representative of your diabetic population in need? (B) Do you feel the number of pancreas transplants performed nationally is in balance with the number of patients who need a pancreas transplant?

TABLE 3 Average reported importance (1 = very important, 5 = not important) of specific pancreas donor and recipient selection criteria

	Selection criteria	All programs	Low	Intermediate	High
Donor	Age	1.4	1.4	1.4	1.3
	Opinion of procurement surgeon	1.4	1.5	1.3	2
	BMI	1.6	1.8	1.5	1.3
	HbA1c	1.9	2	2	1.5
	Distance/shipping time between procurement hospital and your transplant program	1.9	1.7	2	1.7
	Lipase	2.3	2.3	2.3	1.7
	Creatinine	2.3	2.5	2.3	1.7
	Photograph of the pancreas	2.7	2.4	2.9	2.3
	Insulin requirements	2.7	2.3	2.9	2.8
	Vasopressor requirements	2.8	2.7	2.8	3
	Glucose levels	3.1	2.9	3.25	3.5
Recipient	Significant coronary artery disease	1.3	1.4	1.3	1.3
	Moderate (or severe) iliac arterial calcifications	1.6	1.9	1.5	1.5
	Symptomatic peripheral vascular disease	1.8	1.7	2	2
	BMI exceeding cutoff	1.8	1.9	1.6	2.4
	Refusal to accept blood transfusion	1.8	1.8	1.9	2.3
	Current tobacco abuse	1.9	1.6	2.1	2.5
	Oral vasopressor use (e.g., midodrine)	2.3	2.4	2.1	2.3
	Anti-factor Xa medication use (e.g., apixaban, rivaroxaban)	2.5	2.3	2.3	3
	Anticoagulant use (e.g., warfarin)	2.9	2.6	2.8	3.2
	Antiplatelet agent (e.g., clopidogrel)	3	2.5	3.1	3.5
	Type 2 diabetes	3.3	2.6	3.5	4
	Current recreational smoked cannabis use	3.4	2.6	3.5	4.2

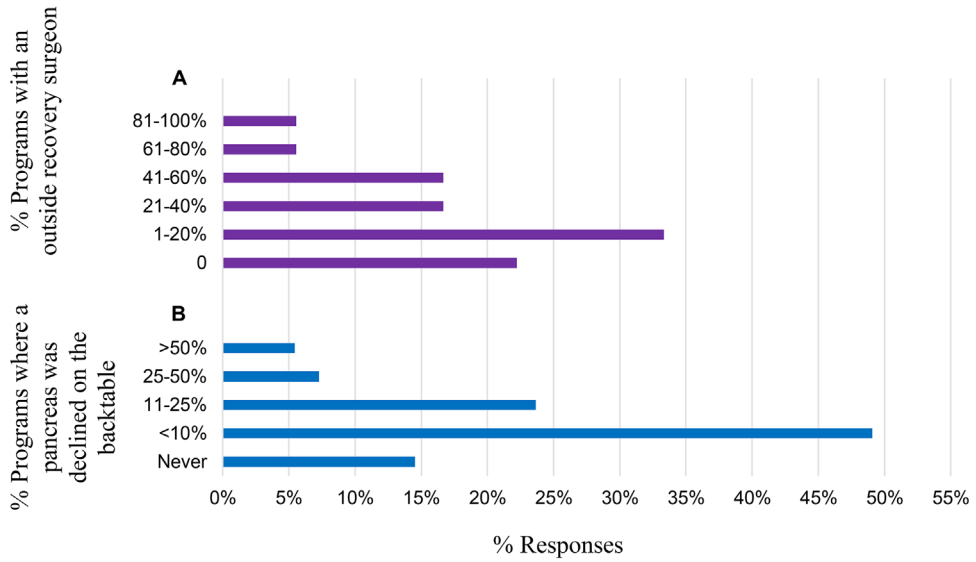

FIGURE 3 Donor pancreas selection practice: (A) Percentage of programs where the pancreas was recovered by a surgeon who was not a member of their program and (B) percentage of programs who have a pancreas initially accepted by your program but then declined upon inspection on the back table after transportation to your program

TABLE 4 Overall, low-, intermediate-, and high-volume programs report their PT selection criteria for candidates with type 2 diabetes and for PTA

	Selection criteria	Total	Low	Intermediate	High
For candidates with type 2 diabetes	Requiring insulin	81%	67%	89%	60%
	Insulin requirement less than 1 unit per kg ideal body weight/day	45%	44%	39%	80%
	BMI less than 30 kg/m^2	62%	78%	68%	0%
	BMI less than 35 kg/m^2	36%	33%	25%	100%
	BMI less than 40 kg/m^2	0%	0%	0%	0%
	History of medical and/or dietary compliance	67%	67%	64%	80%
	Age less than 55 years	45%	67%	43%	20%
	Other	5%	0%	7%	0%
For PTA candidates	Hypoglycemic unawareness	89%	79%	90%	100%
	Brittle diabetes	68%	43%	76%	83%
	Recurrent admissions for diabetic ketoacidosis	57%	36%	67%	50%
	Significant end-organ damage associated with long-standing diabetes	43%	29%	49%	50%
	Other	11%	21%	6%	17%
	Not sure	4%	7%	3%	0%

maximum cold ischemia time, while at high-volume programs, 40% use 12 h and 40% use 24 h.

3.6 | Pancreas transplant candidate selection

The vast majority of programs (82%) use a protocol-based approach to SPK recipient candidate selection, and this practice is more likely reported as program volume increased: low- (67%), intermediate- (85%), and high- (100%). Programs (61%) reported, regardless of volume, that they frequently perform a periodic assessment of the kidney alone waitlist candidates for SPK listing. The maximum age in years for SPK candidates was age 60 (29%), age 55 (25%), none (18%), age 65 (13%), age 50 (11%), not sure (2%), and age 70 (2%). For PAK and PTA candidates, the vast majority of programs (86%) had either the same age maximum as SPK (73%) or had no maximum for either (13%). Factors important (1 = very important, 5 = not important) to programs for recipient candidate exclusion are summarized in Table 3. Overall, the most important recipient selection criteria were significant coronary artery disease, moderate (or severe) iliac arterial calcifications, significant peripheral vascular disease, BMI exceeding cutoff, and refusal to accept a blood transfusion. Of note, high-volume programs felt that type 2 diabetes and current recreational smoked cannabis use were not as important for recipient candidate exclusion. As program volume increased, from low to intermediate to high, the importance of type 2 diabetes as an exclusionary criterion decreased on average from 2.6 to 3.5 to 4.0, respectively.

High-volume programs demonstrated greater tolerance of current tobacco abuse, BMI, anticoagulants, antiplatelet agents, anti-factor Xa agents, and refusing to accept a blood transfusion. The maximum BMI for candidates with type 1 diabetes at programs was 30–35 kg/m^2 (62%), less than 30 kg/m^2 (26%), greater than 35 kg/m^2 (9%), and not sure (3%). At high-volume programs, 83% had a maximum BMI 30–35 kg/m^2 and 16% greater than 35 kg/m^2, while at low-volume programs, 31% used the cutoff less than 30 kg/m^2, 44% 30–35 kg/m^2, and 13 % greater than 35 kg/m^2. Criteria used for selection at programs that perform SPK for type 2 DM are requiring insulin (81%), insulin requirement less than 1 unit per kg ideal body weight/day (45%), BMI less than 30 kg/m^2 (62%), BMI less than 35 kg/m^2 (36%), BMI less than 40 kg/m^2 (0%), history of medical and/or dietary compliance (67%), and age less than 55 years (45%), other (5%), with programs excluded from these analyses who stated they do not perform PT for type 2 DM (10%) or reported not sure (8%). Criteria at low-, intermediate-, and high-volume for selection of type 2 DM candidates are summarized in Table 4. All high-volume programs had a BMI cutoff of 35 kg/m^2 for type 2 DM candidates, while 78% of low volume and 68% of intermediate volume programs had BMI less than 30 kg/m^2 as a selection criterion. Lower volume programs reported greater need (67%) for age less than 55 compared to high-volume programs (20%).

3.7 | PTA candidate selection and other criteria

Programs use the following criteria to select candidates for PTA: hypoglycemic unawareness (89%), brittle diabetes (68%), recurrent admissions for diabetic ketoacidosis (57%), significant end-organ damage associated with long-standing diabetes (43%), other (11%), and not sure (4%). Table 4 summarizes criteria low, intermediate, and high-volume programs use for PTA candidate selection and criteria that high-volume programs had the greatest support were hypoglycemic

unawareness (100%) and brittle diabetes (83%). Programs reported that they would consider a PAK after 6 months (43%), after 3 months (32%), after 1 year (17%), not sure 6%, and other (2%), with these findings consistent across programs volume. In terms of what criteria may be used to distinguish between types 1 and 2 DM, programs reported that they use random C-peptide 43%, fasting C-peptide 44%, and with other approaches at less than 4%, including the age of onset of DM, insulin dose requirement, other, and not sure. Low and intermediate-volume programs reported using fasting C-peptide (47% and 49%, respectively), while high-volume programs reported using random C-peptide (67%) and fasting C-peptide (33%). Regarding the use of glutamic acid decarboxylase and anti-insulin antibodies, programs were consistent across different types of program volume with the majority (59%) stating that they do not measure it and 11% who were not sure. Other programs reported that glutamic acid decarboxylase and anti-insulin antibodies were measured at the time of transplant to determine eligibility or the need for treatment before transplant (9%), measured at the time of transplant for baseline (9%), monitor following pancreas transplant (7%), measure to assess pancreas transplant dysfunction (7%), measure sporadically (4%), and other (6%) (totals over 100% due to multiple reasons given).

4 | DISCUSSION

This national survey of US PT programs provides insight into provider perceptions of issues impacting pancreas transplant access. In most cases, program responses trended according to the volume of PT performed at each program. Not surprisingly, many intermediate and high-volume programs reported a perception toward increased PT, with expansion of donor and recipient selection criteria identified as the most important reasons for this trend. Programs who felt the number of PT were decreasing reported less certainty about the reasons for the perceived decrease. SRTR data among the six responding high-volume programs were consistent with survey responses that half of high-volume programs had growing PT volume in the past 3 years (Table 2 and Figure S1).

High volume programs saw a need to have education and robust communication with referring providers in weighing the benefits of PTA versus medical management. High-volume programs that were especially concerned that referring providers valued the development of insulin pumps and sensors over of PTA. Despite declining numbers, PTA has shown improved overall outcomes, limiting the sequela of diabetes, and providing the best option for glycemic control.[18–22] Nonetheless, only 52% of all programs reported that PT is superior to closed-loop systems for patients with brittle diabetes and/or who have hypoglycemic unawareness, citing concerns about risk over benefit compared to medical management. These findings suggest that programs value continuous glucose monitoring by the closed-loop systems, which showed metabolic control and decreased blood glucose variability similar to PT[23] and remain judicious in their support of PTA due to its inherent risks.

One of the most notable findings from this survey was that the large majority of programs felt that the needs of diabetic patients are not met either nationally or at the program level (Figure 2). These needs have been stressed to an even greater extent during the coronavirus disease 2019 (COVID-19) pandemic as there has been approximately a 10% decline in pancreas transplant volume in 2020 compared to 2019.[24] The unmet needs and the decline in pancreas transplants since 2004 warrant a comprehensive approach from transplant society leadership, transplant programs and their medical/surgical directors, organ procurement organizations, patient advocacy groups, and, in particular, transplant surgeons.

Good communication between the procurement surgeon and the pancreas transplant team, regarding pancreas physical appearance (fatty and/or edematous) and degrees of fibrosis (firmness) was critical to final organ acceptance. The expertise and willingness of high-volume programs to tolerate longer cold ischemia times and procurement by surgeons outside of their program were apparent, likely a key factor that contributes to their ability to perform more PT. Changes in allocation to other organs, logistics of allocation, and transportation may impact these factors (e.g., local procurement of pancreata, concurrent multivisceral transplants, flight availability, etc). The UNOS allocation changes in March 2021 will likely impact PT programs' selection practice and they will need to work closely with donor hospitals and organ procurement organizations with whom they may have not worked with in the past.

PT candidate selection practices were largely consistent across programs; however, high-volume programs demonstrated greater willingness to transplant candidates with higher BMI, type 2 DM, smoked cannabis abuse, tobacco abuse, refusal to accept a blood transfusion, and use of anticoagulants, antiplatelet agents, and anti-factor Xa agents. Selection criteria for PTA and PAK candidates was largely consistent across programs, but for PTA candidate selection, high-volume programs reported more hypoglycemic unawareness and brittle diabetes.

Interestingly, SPK has been shown to mitigate unequal opportunity in receiving transplantation for candidates for kidney transplantation in regions with a long kidney transplant waiting time.[5] The current international guideline suggesting that only candidates with type 1 DM and end-stage kidney disease are candidates for SPK should be revisited.[25] Given the potential patient benefit, formally extending the recommendation to include candidates with type 2 DM could help increase the number of SPK referrals.[13,14,26]

Oversight of the pancreas transplant community has been challenged by competing forces: patient's need for geographic access to PT and programs unable to perform a minimum number of pancreas transplants to meet competence. Following extensive public commentary, the OPTN and the Membership and Professional Standards Committee have established that pancreas programs will be reviewed for functional inactivity if they fail to perform two transplants in 12 consecutive months and have no candidates on their waitlist or have a median waittime in the longest third of the country. Among other notifications, programs are now required to notify patients of other nearby programs' waiting times compared to national standards. Furthermore, the recent

allocation change to allocation circles of 250 nautical miles has shifted the landscape of pancreas allocation and the full downstream impact remains to be determined. Nonetheless, given the limited number of high-volume programs and the large number of functionally inactive PT programs, the potential for the creation of regional center centers of expertise in pancreas transplant appears more likely. The realization of a model of successful regionalized pancreas transplant programs will likely be dictated by the candidate's enthusiasm for travel, the program's ability to collaborate and educate referring providers, and the program's willingness to accept pancreata procured by outside surgeons. One consideration is to require kidney only programs to refer patients who lack a living donor and meet specified criteria to a PT program for consideration of SPK. Such a referral would likely require regulatory oversight to achieve the objective of improving access to PT.

Our study has the limitations inherent to the survey study design, particularly recall bias. The findings represent practices as they are reported; we cannot verify how accurately the reports represent actual practice at the center. Respondents were identified by online outreach to US transplant professionals, and not all centers are represented. However, the response rate of 42% (56/134) is similar or higher than many contemporary studies of transplant program practices.[27–30] A majority (59%) of all pancreas transplant volume is represented by the responding programs in this survey. Most responders were transplant surgeons; however, arguably, the most pressing challenges in the field surround acute donor and recipient selection decisions that come from transplant surgeons. This survey's strength is that it asked a broad range of questions and obtained responses from a large, diverse group of PT programs across the United States.

In conclusion, the vast majority of PT programs believe that, both at their programs and a national level, the needs of patients with diabetes are not meet with current PT volumes. The findings highlight strategies that can potentially grow PT volume at the program level, which would increase national PT need fulfillment if instituted widely. High-volume programs demonstrate a greater willingness to embrace the expansion of donor and recipient selection criteria to increase case volume. Broader education and understanding of the benefits of PT among referring providers and endocrinologists will be critical for establishing necessary referral relationships with transplant programs. Stakeholders and transplant surgeons should consider further revision of the current guidelines and identify pathways for improved access to PT across the United States.

CONFLICT OF INTEREST

None.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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