OPEN

Portopulmonary Hypertension: A Survey of Practice Patterns and Provider Attitudes

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Background. The role of liver transplantation (LT) in the management of portopulmonary hypertension (POPH) is poorly understood. The aim of this study was to better understand provider attitudes and practice patterns regarding the management of patients with POPH and to assess the concordance between clinical practice and current guidelines. **Methods.** We performed a multicenter survey study of hepatologists and pulmonary hypertension (PH) physicians at US LT centers that performed >50 transplants per year. Survey responses are summarized as number (%). Associations were assessed using a Wilcoxon-rank sum, chi-square, or Fisher exact test, as appropriate. **Results.** Seventy-four providers from 35 centers were included. There was marked variability regarding screening practices, management, and attitudes. Forty-two percent responded that POPH nearly always or often improves with LT, and 15.5% reported that POPH rarely or never improves. In contrast to current guidelines, 50.7% agreed that treated POPH should be an indication for LT in patients with compensated cirrhosis. Hepatologists were more likely than PH physicians to agree that POPH should be an indication for LT (P = 0.02). Forty-nine percent of respondents thought that the current POPH Model for End-stage Liver Disease exception criteria should be modified, and management of patients with an elevated mean pulmonary arterial pressure and normal pulmonary vascular resistance differed from current policies. **Conclusions.** There is marked variability in provider attitudes and practice patterns regarding the management of POPH. This study highlights the need for prospective studies to inform practice and for improved implementation of practice guidelines in order to standardize care.

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Portopulmonary hypertension (POPH), pulmonary arterial hypertension (PAH) that develops in the setting of portal hypertension, affects 5%–6% of liver transplantation (LT) candidates.[1,2] POPH is a progressive condition that can lead to right heart failure and death.[3,4] Without PAH therapy or LT, survival in POPH is poor, but there are little prospective data to guide decisions regarding medical treatment and the appropriate timing of LT.[5,6]

In order to expedite LT, patients with treated POPH who meet certain hemodynamic criteria (mean pulmonary arterial pressure [mPAP] <35 mm Hg and pulmonary vascular resistance [PVR] <400 dynes · sec · cm^5 [5 Wood units]) are eligible for a Model for End-stage Liver Disease (MELD) exception or waitlist priority upgrade.[7] These criteria were developed in 2006 on the basis of predominantly single-center retrospective studies and before the approval of many currently available PAH therapies.[3] Despite these criteria, however, misclassification of patients with POPH MELD exceptions is common.[8] Recently, studies have also identified significant predictors of mortality in POPH, but these characteristics are not included in the current MELD exception criteria.[9,10]

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Practice guidelines were published by the International Liver Transplant Society in July 2016 regarding the diagnosis and management of POPH, but acceptance of these guidelines and the concordance between published guidelines and clinical practice are not known.[3] The aims of this study were to better understand the attitudes and practice patterns of hepatologists and PH providers, to assess the concordance between guidelines and clinical practice, and to assess provider attitudes regarding the POPH MELD exception policy to aid in determining whether this policy should be revised. Because POPH is a relatively uncommon disease with little evidence to guide management, we hypothesized that there would be significant variation in physician knowledge and practice regarding the care of patients with POPH.

MATERIALS AND METHODS

We performed a cross-sectional mixed qualitative and quantitative multicenter survey-based study of a convenience sample of physicians at liver transplant centers in the United States. Centers that performed >50 liver transplants in 2016–2017 according to the Scientific Registry of Transplant Recipients were included (n = 58). Hepatologists and pulmonary hypertension (PH) providers (cardiologists or pulmonologists) at each center were surveyed. Transplant surgeons were also included in the initial survey, but their responses are reported in **Supplemental Materials** (**SDC,** http://links.lww.com/TXD/A211) due to a low response rate. Physicians were identified from review of the center's website, and email addresses were obtained when possible from an internet search or the member directories for the American Association for the Study of Liver Diseases or Pulmonary Hypertension Association. The survey was administered in August 2017, 1 year after the International Liver Transplant Society guidelines were published. Responses are reported by specialty (hepatology versus PH) and as a total number of responses when no significant differences were identified between specialties. United Network for Organ Sharing (UNOS) regions were categorized by the median MELD at transplant into low MELD (regions 3, 6, 10, and 11), mid MELD (regions 2, 4, 7, and 8), and high MELD (regions 1, 5, and 9) groups as previously described for comparison, because experiences and attitudes regarding POPH at centers with a higher median MELD at transplant (and consequently a longer waitlist time for patients with MELD exceptions) may be different when compared with centers with a lower median MELD at transplant.[11] Responses from providers at larger transplant centers (100 or more LTs per year according to the Scientific Registry of Transplant Recipients) versus smaller LT centers were also compared.

The survey was designed by a multidisciplinary working group (H.M.D., R.J.S., M.J.K., N.L.S., S.D.B., Z.K., D.C.M., R.N.C., and S.M.K.) with representation from hepatologists, pulmonologists, and transplant surgeons and was administered via an email link by the Mayo Clinic Survey Research Center using Qualtrics software (Qualtrics, Provo, UT). Survey questions included basic demographic information as well as questions concerning physician attitudes and practices regarding the management of POPH. Branching logic was used to display selected questions on the basis of specialty or prior survey responses as detailed in the survey questions in the **Supplemental Materials** (**SDC,** http://links.lww.com/TXD/A211).

Statistical Analysis

Descriptive data are reported as number (%). Associations between survey responses and respondent characteristics were assessed using a Wilcoxon-rank sum, chi-square, or Fisher exact test, as appropriate. A two-sided $P < 0.05$ was considered statistically significant. All data were analyzed in SAS, version 9.4. The study was approved by the Mayo Clinic Institutional Review Board.

RESULTS

Thirty-five of 58 (60.3%) transplant centers from UNOS regions 1–8, 10, and 11 were represented in the survey. There was a range of 1–6 respondents per center. Thirty-nine respondents were from larger LT centers (100 or more LTs per year), while 35 were from smaller LT centers (50–100 LTs per year). The overall response rate for the survey was 20.6% (82 out of 399 providers). Response rate varied by specialty ($P < 0.001$) with a response rate of 41.1% for cardiology/pulmonary providers and 17.5% for hepatologists and 9.4% for transplant surgeons. All hepatologists reported additional training or expertise in transplant hepatology. Due to the low response rate among transplant surgeons with a high likelihood of bias, their responses are not included in the manuscript but are included in the **Supplemental Materials** (**SDC,** http://links.lww.com/TXD/A211). A detailed description of survey respondent characteristics is included in Table 1.

Screening for POPH

There was marked variability in hepatology practice regarding screening for POPH in LT candidates (Table 2). Compared to hepatologists from larger LT centers, hepatologists from

TABLE 1.

Survey respondent characteristics

Characteristic	Total (n = 74)	Hepatologists (n = 44)	PH providers (n = 30)	*P*
Male	51 (69.9)	34 (79.1)	17 (56.7)	0.07
Age				0.55
31–40 y	24 (32.4)	15 (34.1)	9 (30.0)	
41–50 y	30 (40.5)	18 (40.9)	12 (40.0)	
51–60 y	13 (17.6)	8 (18.2)	5 (16.7)	
61+ y	7 (9.5)	3 (6.8)	4 (13.3)	
United Network for Organ Sharing Region				
1	3 (4.2)	0 (0.0)	3 (10.0)	
2	10 (13.9)	5 (11.9)	5 (16.7)	
3	7 (9.7)	3 (7.1)	4 (13.3)	
4	4 (5.6)	2 (4.8)	2 (6.7)	
5	11 (15.3)	9 (21.4)	2 (6.7)	
6	6 (8.3)	5 (11.9)	1 (3.3)	
7	12 (16.7)	7 (16.7)	5 (16.7)	
8	4 (5.6)	3 (7.1)	1 (3.3)	
9	0 (0.0)	0 (0.0)	0 (0.0)	
10	5 (6.9)	3 (7.1)	2 (6.7)	
11	10 (13.9)	5 (11.9)	5 (16.7)	

Frequencies not adding to 44 hepatologists indicate missing data.
PH, pulmonary hypertension.

TABLE 2.

Survey questions and responses

Survey questions	Total	Hepatologists (n = 44)	PH (n = 30)	*P*
Screening for POPH				
Which of the following best describes your center's practice related to screening liver transplant candidates for POPH? Mark all that apply				
Annual transthoracic echocardiograms	N/A	22 (50.0)	N/A	
Transthoracic echocardiogram once for screening and then again on a variable interval	N/A	14 (31.8)	N/A	
Transthoracic echocardiogram once for screening and then again as indicated by new signs or symptoms	N/A	8 (18.2)	N/A	
All patients are seen by pulmonary or cardiology as part of their routine pretransplant evaluation	N/A	7 (15.9)	N/A	
Patients are referred to pulmonary or cardiology only if they have an abnormal echocardiogram or symptoms	N/A	12 (27.3)	N/A	
Other	N/A	2 (4.5)	N/A	
In an asymptomatic individual with normal RV size and function on echocardiogram, when would you refer a liver transplant candidate for further evaluation of POPH?				
Estimated RVSP >30 mm Hg	N/A	3 (8.1)	N/A	
Estimated RVSP >35 mm Hg	N/A	13 (35.1)	N/A	
Estimated RVSP >40 mm Hg	N/A	14 (37.8)	N/A	
Estimated RVSP >50 mm Hg	N/A	7 (18.9)	N/A	
In an asymptomatic individual with RV dilatation or dysfunction on echocardiogram, when would you refer a liver transplant candidate for further evaluation of POPH?				
I would refer regardless of RVSP	N/A	23 (62.2)	N/A	
Estimated RVSP >30 mm Hg	N/A	4 (10.8)	N/A	
Estimated RVSP >35 mm Hg	N/A	5 (13.5)	N/A	
Estimated RVSP >40 mm Hg	N/A	3 (8.1)	N/A	
Estimated RVSP >50 mm Hg	N/A	2 (5.4)	N/A	
Attitudes regarding the current MELD exception for POPH				
The following aspects of the current MELD exception for POPH should be modified. Mark all that apply.				
The hemodynamic criteria for an initial diagnosis of moderate-to-severe POPH	12 (16.2)	3 (6.8)	9 (30.0)	**0.01**
The hemodynamic criteria for adequate response to PAH therapy	21 (28.4)	6 (13.6)	15 (50.0)	**0.001**
Need for right heart catheterization every 3 mo	27 (36.5)	12 (27.3)	15 (50.0)	0.05
Lack of specific criteria regarding liver disease severity	23 (31.1)	14 (31.8)	9 (30.0)	1.00
Lack of specific criteria regarding right ventricular function	38 (51.4)	21 (47.7)	17 (56.7)	0.49
None of the above	9 (12.2)	8 (18.2)	1 (3.3)	0.07
Other	7 (9.5)	2 (4.5)	5 (16.7)	0.11
Which of the following do you consider an absolute contraindication to liver transplantation? Mark all that apply.				
mPAP >50 mm Hg	56 (75.7)	33 (75.0)	23 (76.7)	1.00
mPAP >35 mm Hg regardless of PVR	4 (5.4)	4 (9.1)	0 (0.0)	0.14
mPAP >35 mm Hg with an elevated PVR > 240 dynes-s-cm-5	32 (43.2)	23 (52.3)	9 (30.0)	0.09
mPAP >35 mm Hg with an elevated PVR > 400 dynes-s-cm-5	57 (77.0)	30 (68.2)	27 (90.0)	0.047
PVR >240 dynes-s-cm-5 (3 Wood units) regardless of mPAP	8 (10.8)	5 (11.4)	3 (10.0)	1.00
PVR >400 dynes-s-cm-5 (5 Wood units) regardless of mPAP	37 (50.0)	17 (38.6)	20 (66.7)	0.03
None of the above	0 (0.0	0 (0.0	0 (0.0	1.00
Unsure	4 (5.4)	2 (4.5)	2 (6.7)	1.00
What is your center's approach to a patient with an approved POPH MELD exception on PAH therapy who develops an elevated mPAP >35 mm Hg due to a high cardiac output with a normal PVR on follow-up right heart catheterization?				**0.02**
Inactivate from waitlist until pulmonary arterial pressure improves	30 (44.8)	22 (57.9)	8 (27.6)	
Remove from waitlist	0 (0.0)	0 (0.0)	0 (0.0)	
Submit an appeal	19 (28.4)	8 (21.1)	11 (37.9)	
Unsure	11 (16.4)	3 (7.9)	8 (27.6)	
Other	7 (10.4)	5 (13.2)	2 (6.9)	
Management of POPH				
For treatment of POPH in LT candidates, my center uses which of the following classes of pulmonary arterial hypertension targeted therapy. Mark all that apply.				
Phosphodiesterase 5 inhibitors	N/A	N/A	27 (90.0)	
Endothelin receptor antagonists	N/A	N/A	25 (83.3)	
Inhaled prostacyclin analogues	N/A	N/A	18 (60.0)	
Parenteral prostacyclin analogues	N/A	N/A	29 (96.7)	
Oral prostacyclin analogues or IP receptor agonists	N/A	N/A	14 (46.7)	
Soluble guanylate cyclase stimulators	N/A	N/A	11 (36.7)	
Calcium channel blockers	N/A	N/A	2 (6.7)	

Continued next page

TABLE 2. (Continued)

Survey questions and responses

Survey questions	Total	Hepatologists (n = 44)	PH (n = 30)	*P*
Posttransplant, pulmonary arterial hypertension targeted therapy should be weaned based on which of the following?				
Symptoms alone	N/A	N/A	0 (0.0)	
Symptoms and serial right heart catheterizations	N/A	N/A	1 (3.4)	
Symptoms and serial echocardiograms	N/A	N/A	7 (24.1)	
Symptoms, serial echocardiograms, and serial right heart catheterizations	N/A	N/A	20 (69.0)	
Pulmonary arterial hypertension targeted therapy should not be weaned posttransplant	N/A	N/A	1 (3.4)	
Beta-blocker use should be minimized in patients with POPH				0.50
Strongly agree	11 (16.7)	7 (18.9)	4 (13.8)	
Agree	26 (39.4)	14 (37.8)	12 (41.4)	
Neutral	22 (33.3)	14 (37.8)	8 (27.6)	
Disagree	6 (9.1)	2 (5.4)	4 (13.8)	
Strongly Disagree	1 (1.5)	0 (0.0)	1 (3.4)	
Elective TIPS should be avoided in patients with severe POPH				**0.01**
Strongly agree	40 (60.6)	27 (73.0)	13 (44.8)	
Agree	18 (27.3)	9 (24.3)	9 (31.0)	
Neutral	8 (12.1)	1 (2.7)	7 (24.1)	
Disagree	0 (0.0)	0 (0.0)	0 (0.0)	
Strongly disagree	0 (0.0)	0 (0.0)	0 (0.0)	

P values are reported for comparison (Fisher exact or Wilcoxon-rank sum, as appropriate) of responses from hepatologists versus PH providers. Frequencies not adding to 44 hepatologists or 30 pulmonary hypertension providers indicate missing data. *P* values < 0.05 are noted in bold.

LT, liver transplantation; MELD, Model for End-stage Liver Disease; mPAP, mean pulmonary arterial pressure; N/A, not applicable; PH, pulmonary hypertension; PAH, pulmonary arterial hypertension; POPH, portopulmonary hypertension; PVR, pulmonary vascular resistance; RVSP, right ventricular systolic pressure; TEE, transesophageal echocardiogram; TIPS, transjugular intrahepatic portosystemic shunt.

smaller LT centers were more likely to perform annual echocardiograms for screening (42.9% versus 17.9%, P = 0.02). Among hepatologists, there was variability in terms of an estimated right ventricular systolic pressure (RVSP) that would trigger further evaluation (specialty referral or right heart catheterization) of POPH in an asymptomatic LT candidate with normal right ventricular (RV) size and function (Table 2). In the presence of RV dilation or dysfunction, however, most hepatologists (62%, Table 2) would refer these patients for further testing regardless of RVSP.

Attitudes Regarding LT and POPH

There was variability in attitudes regarding the safety and outcomes of treated POPH with LT (Figure 1). Forty-two percent responded that POPH nearly always or often improves with LT, while 15.5% reported that POPH rarely or never improves with LT (Figure 1). Perceptions regarding POPH as a condition that improves with LT varied by UNOS region category (P = 0.03). Respondents from regions with a higher median MELD at transplant were less likely to respond that POPH nearly always or often improves with LT. There was also variability in opinions regarding POPH as an indication for LT in compensated cirrhosis (Figure 2), and attitudes differed by specialty (P = 0.01). Sixty-four percent of hepatologists and 31.0% of PH providers agreed that treated POPH should be an indication for LT in patients with compensated cirrhosis and a MELD score ≤12. More respondents overall agreed that POPH should be an indication for LT in patients with decompensated cirrhosis (83.1% in decompensated versus 50.7% in compensated cirrhosis, P < 0.001) (Figure 2). There was no difference in attitudes of providers at larger versus smaller LT centers (P > 0.05).

Experience With LT in POPH

Seventy-two percent of respondents described their experience with LT in patients with POPH as overall favorable, and all responded that they had prior experience with LT in patients with POPH. Opinions regarding the safety of LT

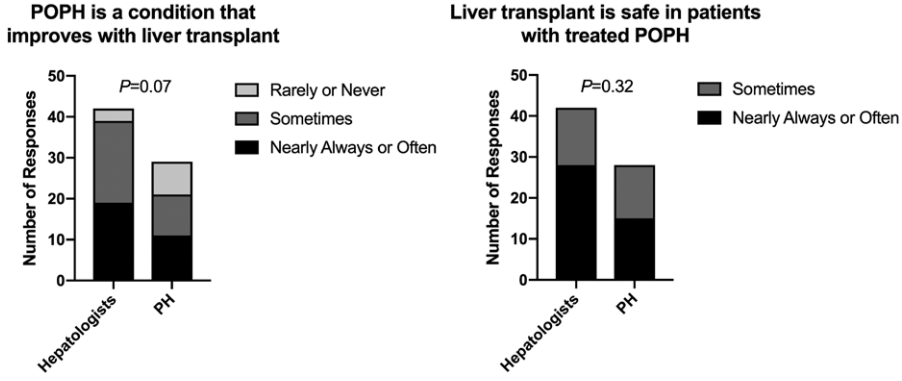

FIGURE 1. Attitudes regarding POPH and liver transplantation. There was variability in attitudes of hepatologists and PH providers regarding the safety and outcomes of liver transplantation in patients with treated POPH. PH, pulmonary hypertension; POPH, portopulmonary hypertension.

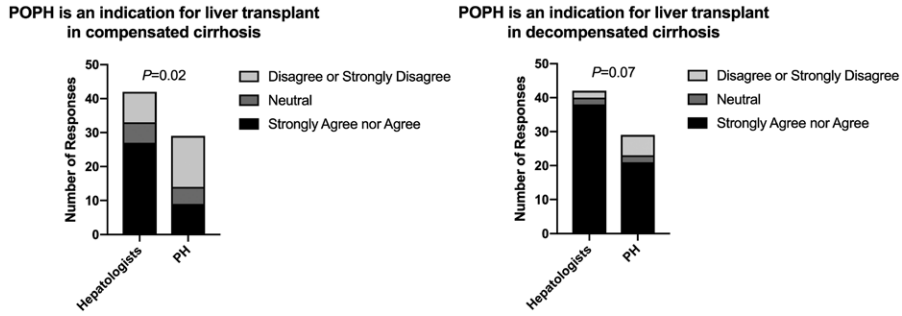

FIGURE 2. POPH as an indication for LT. There was variability in attitudes regarding POPH as an indication for LT. More respondents thought that POPH should be an indication for LT in patients with decompensated vs compensated cirrhosis ($P < 0.001$). Hepatologists were more likely than PH providers to agree that POPH should be an indication for LT in compensated cirrhosis. LT, liver transplantation; PH, pulmonary hypertension; POPH, portopulmonary hypertension.

were significantly impacted by prior experience. Respondents with a favorable experience were more likely to answer that LT was nearly always or often safe (35/49, 71.4%) as compared to respondents with either neutral (8/14, 57.1%) or unfavorable experiences (0/4, 0%) ($P = 0.01$). The majority of respondents (76.8%) reported prior experience with LT being canceled at the time of surgery due to the presence of PH with a range of 1–10 canceled liver transplants per respondent (average 3.3). In most cases, PH was newly detected at the time of planned transplant.

Attitudes Regarding the Current MELD Exception for POPH

Almost half of respondents (49.3%) agreed that the current MELD exception criteria for POPH should be modified while 32.8% were neutral and 17.9% disagreed (Figure 3). Specific aspects of the POPH MELD exception criteria that respondents thought should be modified are detailed in Table 2. Providers from smaller LT centers were more likely than providers from larger LT centers to agree that there should be specific criteria regarding liver disease severity (45.7% versus 17.9%, $P = 0.01$). Other responses regarding the POPH MELD exception did not differ by center size ($P > 0.05$). More PH providers than hepatologists ($P = 0.001$) thought that the hemodynamic criteria for response to PAH therapy should be modified (Table 2). Other suggested modifications included implementation of specific regional criteria to facilitate timely transplant, a need for improved phenotyping of patients with POPH, higher prioritization for patients with POPH on PAH therapy for a longer period of time and modification of the criteria, so mPAP was not the primary determinant of eligibility with the need to properly define an elevated mPAP due to a high flow state.

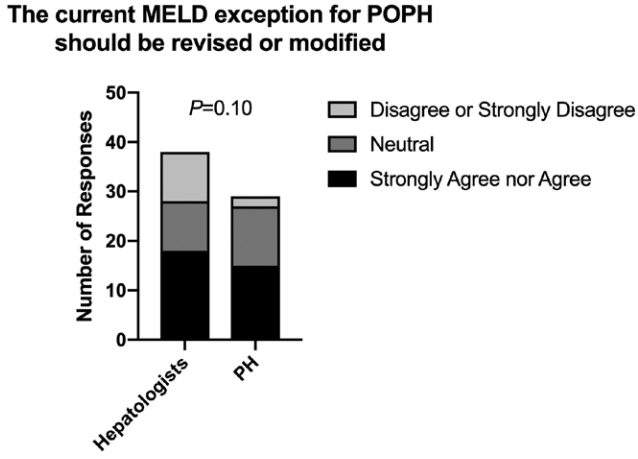

FIGURE 3. Attitudes regarding the current MELD exception for POPH. Almost half of all respondents (49.3%) thought that the current MELD exception criteria for POPH should be modified. MELD, model for end stage liver disease; PH, pulmonary hypertension; POPH, portopulmonary hypertension.

The approach to a patient with treated POPH and an elevated mPAP >35 mm Hg due to a high cardiac output with a normal PVR varied by specialty ($P = 0.02$) (Table 2). Individualized approaches to this scenario included aggressive diuresis or ultrafiltration, repeat right heart catheterization, lowering the dose of PAH therapy, and trying to reduce the cardiac output with midodrine. Only 5.4% of respondents thought that an mPAP >35 mm Hg regardless of PVR should be an absolute contraindication to LT (Table 2) and more PH providers than hepatologists thought that an mPAP >35 mm Hg with an elevated PVR >400 dynes was a contraindication to LT ($P = 0.047$) (Table 2).

Management of POPH

Most respondents agreed that liver transplant candidates with moderate-to-severe POPH should be managed in centers with expertise in POPH (Table 2). Most responses regarding beta-blocker use and transjugular intrahepatic portosystemic shunt in POPH were concordant with current guidelines (Table 2). PH providers were asked additional questions regarding PAH therapy. Treatment with PAH therapy was diverse, spanning the spectrum from oral to inhaled to parenteral therapy. No particular therapeutic class emerged as a favored approach to treatment (Table 2). One respondent reported using calcium channel blockers for treatment of POPH despite current guidelines that recommend avoiding their use in POPH. Providers had varied experience with weaning and discontinuing PAH therapy posttransplant, with some reporting that they nearly always weaned or discontinued PAH therapy and others reporting that they rarely or never weaned or discontinued PAH therapy (Figure 4). The approach to weaning therapy also varied among PH providers (Table 2).

DISCUSSION

We performed the first multidisciplinary survey of transplant hepatologists and PH providers to better understand their attitudes and practice patterns regarding the management of POPH and to compare current practice to clinical

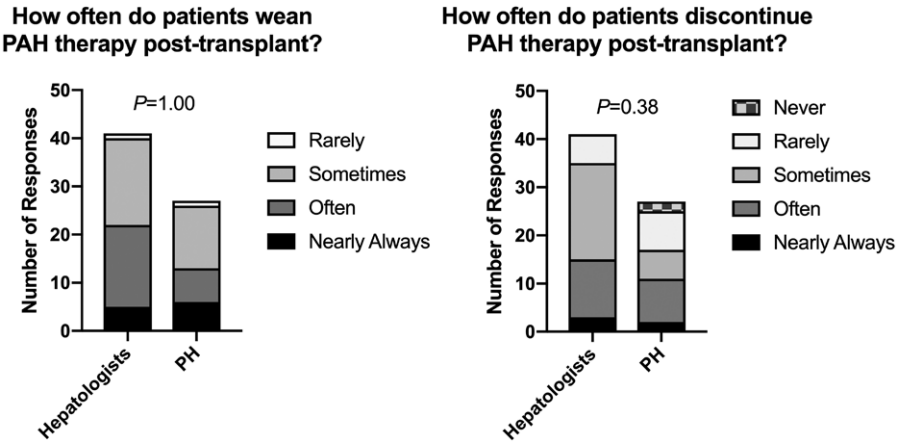

FIGURE 4. PAH therapy. There was variability in hepatologist and PH provider responses regarding weaning and discontinuation of PAH therapy posttransplant. PAH, pulmonary arterial hypertension; PH, pulmonary hypertension.

guidelines. We found that there was marked variability in management, and nearly half thought that the current POPH MELD exception criteria should be modified. Additionally, in contrast to current guidelines, many agreed that POPH should be an indication for LT, even in the setting of compensated cirrhosis. This study highlights the need for prospective studies to address evidence gaps and inform clinical practice and for improved understanding of barriers to adoption of guidelines in order to standardize care for patients with POPH.

Survey Respondents

We chose to study hepatologists and PH providers, as these physicians are involved in the management of POPH regardless of whether they are LT candidates. Other specialists, such as transplant anesthesiologists, play a critical role in the perioperative management of LT candidates with POPH but are not typically involved in the long-term management of POPH, so they were not included. We also surveyed transplant surgeons but did not include their responses in the article due to the low response rate. All of the respondents reported prior experience with LT in POPH. Although this may be due to response bias, this suggests that most providers at large LT centers manage patients with POPH and that the respondents in our survey were equipped to answer questions regarding POPH management.

Although the response rate for the survey was low, there was a wide spectrum of responses, reflecting a diverse range of attitudes and practice of both hepatologists and PH providers from 35 LT centers across the country with representation from 10/11 UNOS regions. Although our results may not be representative of all hepatologists and PH providers, this study is the first to provide insight into the diverse attitudes and practice of providers from across the country.

Screening for POPH

In concordance with current guidelines,[12] most transplant hepatologists perform screening echocardiograms at the time of LT evaluation. In the setting of insufficient data to guide the need for invasive testing, however, there was marked variability among hepatologists in the estimated RVSP that would prompt further workup of POPH, ranging from >30 to >50 mm Hg. This variability in practice may lead to overutilization of invasive testing at some institutions and inadequate recognition or delayed diagnosis of POPH at other centers.

A high percentage of respondents reported prior experience with canceled liver transplants, predominantly due to the presence of newly detected PH. This suggests that improved screening practices are needed in order to identify and treat these patients prior to LT. Due to inadequate evidence, current guidelines are vague regarding optimal time intervals and indications for subsequent echocardiograms in waitlisted LT candidates.[3,12] Multicenter prospective studies to better understand clinical risk factors for POPH and its rate of development and progression could help inform evidence-based screening practice and guidelines.

Attitudes and Experience Regarding LT and POPH

There was variability in attitudes regarding the safety of LT in patients with POPH and the expected posttransplant outcomes. In an effort to better understand reasons for this variability, we found that attitudes regarding safety were impacted by a provider's prior experience with LT in POPH (favorable versus unfavorable). We also observed that respondents from regions with a higher median MELD at transplant were less likely to respond that POPH improves with LT. One possible explanation for this finding is that patients with POPH MELD exceptions have longer waitlist times in regions with a higher median MELD at LT and may have less reversible disease at the time of LT.

The most recent guidelines state that the unpredictability of post-LT outcomes precludes POPH from being considered an indication for LT,[3] but half of respondents thought that POPH should be an indication for LT in patients with compensated cirrhosis, and the majority thought that POPH should be an indication for LT in decompensated cirrhosis. This disparity between current guidelines and provider attitudes highlight the need for better understanding of long-term outcomes in patients with POPH as well as factors that influence provider attitudes. This is especially important given the scarcity of organs and the unknown long-term survival benefit of LT in patients with POPH. Although several recent studies have been published regarding long-term outcomes of POPH with LT, findings and conclusions from these studies are conflicting.[13-16] Savale et al[13] reported 77% survival 3 years post-LT and concluded that stabilization or improvement of POPH was possible with the combination

of PAH therapy and LT, while Verma et al reported 53.8% 5-year post-LT survival with the majority of deaths occurring within the first 6 months and concluded that POPH in isolation should no longer be a valid consideration to LT.[16]

We identified several significant differences between hepatologists and PH providers regarding attitudes and management which highlight the need for improved communication and integration of care among specialists. For example, hepatologists were more likely than PH providers to agree that POPH should be an indication for LT in compensated cirrhosis. The reasons for this are not known but could be due to differences in opinion regarding the reversibility of POPH with LT or differences in awareness of the efficacy of current PAH therapy.

Attitudes Regarding the Current MELD Exception for POPH

Responses regarding the POPH MELD exception policy were insightful, and we hope that this study can provide groundwork for future efforts to examine and revise the current POPH MELD exception policy. Respondents highlighted several key issues with the current MELD exception policy for POPH. (1) More respondents agreed that POPH should be an indication for LT in decompensated cirrhosis rather than compensated cirrhosis. Prior studies have also found that MELD score significantly impacts waitlist mortality risk.[9] Despite this, there is no liver disease severity requirement as part of the current MELD exception criteria. (2) Half of respondents thought there should be specific criteria regarding RV function as part of the MELD exception criteria. Although preserved RV function is essential to the safety of LT, it has not been well studied in POPH, and it is not clear how RV function should be defined or what thresholds should preclude LT. (3) A third and major issue concerned successful response to PAH therapy. It is clear from responses that the clinical scenario of high-flow–mediated elevations in mPAP should be addressed as provider attitudes and practice differed markedly from current policies. Although a posttreatment mPAP <35 mm Hg is required for MELD exception eligibility, only 5.4% of respondents thought that an mPAP >35 mm Hg regardless of PVR should be an absolute contraindication to LT. The approach to a patient with treated POPH and an elevated mPAP due to a high cardiac output also varied with some providers stating they would perform interventions, such as initiation of diuretics, ultrafiltration, or medications, such as midodrine, with no evidence that these interventions reduce perioperative risk.

Management of POPH

The heterogeneity in terms of clinical practice and medications used to treat POPH reflects how little is known about optimal management of this disease. Patients with POPH have been excluded from almost all clinical trials of PAH therapy and providers are left to guess based on their prior experience how to approach treatment of POPH. For uncommon disease such as POPH, more published data are needed from both clinical trials as well as real-world experience in order to improve and standardize care.

Limitations

There are several important limitations to our study. First, our results may not be generalizable to smaller transplant centers that perform <50 LTs per year or centers in countries outside the United States, as they were not included in the survey. Similarly, our results may not reflect the attitudes and practice of other providers involved in the management of patients with POPH, such as transplant surgeons and anesthesiologists. We intended to include transplant surgeons but did not due to the low response rate and likelihood of bias. These specialists likely have a unique perspective, particularly regarding perioperative and intraoperative management. We also did not have data from nonresponders to further explore factors that may have impacted response rates and results. Last, our sample size was small and may not accurately reflect national practice due to the low response rate and limitations that apply to the nature of the study, such as recall bias, response bias, and sampling error.

SUMMARY

In summary, the results of this multidisciplinary survey suggest that there is significant variability in provider attitudes and practice patterns across the country regarding the management of POPH and the role of LT. We also found marked discordance between published guidelines and provider attitudes and clinical practice. This study highlights the need for multicenter prospective studies to address current evidence gaps in POPH and for improved implementation of practice guidelines in order to standardize care for these complex patients.

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