Published in final edited form as:

Clin Transplant. 2018 June ; 32(6): e13250. doi:10.1111/ctr.13250.

Recent alcohol use prolongs hospital length of stay following lung transplant

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Abstract

Little is known about the alcohol habits of people with advanced lung disease. Following lung transplantation patients are asked to abstain from or minimize alcohol use. The aim of this investigation is to assess alcohol use in a cohort of patients with advanced lung disease undergoing evaluation for lung transplant. This is a prospective observational investigation comparing patient self-report of alcohol use with their responses on the Alcohol Use Disorders Identification Test, and alcohol biomarkers collected at the time of transplant. There were 86 included in the cohort, 34% currently using alcohol, 13% had AUDIT scores >3, and 10% had positive results for alcohol biomarkers at the time of transplantation. Patients with evidence of recent alcohol use prior to lung transplant surgery had a 1.5 fold increase in hospital length of stay following lung transplant ($p=0.028$), spent 3 times as long on mechanical ventilation after transplant, and required intensive care unit monitoring nearly 3 times longer than those without recent alcohol use ($p=0.008$). There were no differences in primary graft dysfunction, although several patients with recent alcohol use had post-transplant atrial arrhythmias, acute kidney injury, and acute cellular rejection. Abstaining from alcohol use may optimize outcomes following lung transplant.

Keywords

Alcohol; Lung Transplant; Advanced lung disease

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Disclosures: The authors of this manuscript have no conflicts of interest to disclose. No conflicts of interest.

Introduction

Alcohol use is common in the United States with 86% of adults over the age of 18 admitting to drinking alcohol at some point in their lives.¹ Following lung transplantation, a complicated procedure that is life-extending for patients with advanced lung disease, patients are asked to abstain from and/or limit alcohol use as alcohol may interact with the prescribed complicated medication regimen which prevents rejection and infections of the lung allograft. Untreated alcohol abuse is a contraindication for lung transplantation.² Little is known about the alcohol habits of people with advanced lung disease or those who are awaiting or have undergone lung transplant. Alcohol misuse is a common problem in the United States, affecting over 15 million adults ages 18 and older.¹ According to the 2015 National Survey on Drug Use and Health (NSDUH), 27% of people ages 18 and older reported binge drinking in the past month, with 7% reporting heavy alcohol use.¹ Alcohol misuse, including both binge drinking and chronic heavy alcohol use, is known to detrimentally affect the lung in several ways, including an increased risk of pneumonia, acute lung injury and an overall decrease in lung function.³ Lung function among people who misuse alcohol, including healthy volunteers and those with obstructive lung disease, is lower.³⁻⁸ Lifetime alcohol consumption predicted lower lung function in a cohort of heavy drinkers compared to controls.⁵ In addition, analysis of the Third National Health and Nutrition Examination Survey (NHANES III) demonstrated an increased odds for airflow obstruction in former heavy drinkers.⁸

Alcohol use in people with advanced lung disease is not well described. Only one investigation was found which looked at alcohol use in people with advanced lung disease undergoing evaluation for lung transplant. Thirty three percent of patients with cystic fibrosis (CF) and 25% of non-CF patients awaiting lung transplant admitted to drinking alcohol.⁹ The gold standard for investigating alcohol use is by self-report.¹⁰ There are several clinically utilized screening tests for alcohol use available, and one such test is the Alcohol Use Disorders Identification Test (AUDIT) which assess alcohol misuse in three domains: frequency of use, dependence and alcohol related problems.^{10,11} Self-report of alcohol use can be fraught with recall bias, and therefore objective, measurable alcohol biomarkers which can be assessed in blood, urine, and even hair and nail samples exist to provide additional information about alcohol use. Traditional alcohol biomarkers, such as aspartate aminotransferase (AST), alanine aminotransferase (ALT), γ -glutamyltranspeptidase (GGT) and mean corpuscular volume (MCV), lack the sensitivity and specificity to identify and quantify alcohol use unless that use is extreme. Direct alcohol biomarkers, including that of phosphatidylethanol (PEth) and ethylglucuronide (EtG) are much more accurate in identifying alcohol use, and are utilized by alcohol abstinence programs to monitor compliance.¹²⁻¹⁸

The use of alcohol biomarkers to study alcohol use in patients with lung disease, and potential impact on the disease course, has been scant. Investigations utilizing either alcohol screens, such as the AUDIT, to assess alcohol misuse or measuring alcohol biomarkers in people with advanced lung disease have not been previously pursued. The aim of this investigation is to assess alcohol use in a cohort of patients with advanced lung disease undergoing evaluation for lung transplant. By comparing patient self-report, AUDIT and

alcohol biomarkers collected at the time of transplant, we aim to understand the frequency of alcohol use in people with advanced lung disease, assess for any alcohol misuse, and to observe any possible negative effects alcohol use may have on the outcome of lung transplant surgery.

Methods

This is a prospective observational investigation which included transplant recipients agreeable to participation in this investigation who underwent lung transplant surgery between February 2014 and February 2017. Information about the patient's self-report of alcohol use was obtained from the transplant social worker's interview with the patient, which was a part of the lung transplant evaluation process. Just prior to lung transplant surgery, the patient was administered the Alcohol Use Disorders Identification Test (AUDIT) questionnaire, assessing for alcohol misuse. Whole blood, serum, and urine samples were collected from lung transplant recipients at the time of transplantation to assess for alcohol use utilizing objective alcohol biomarkers. Demographic, medical history, and post-lung transplant outcomes were collected from the recipient's medical records. The Institutional Review Board of Loyola University Chicago approved this study (LU204490).

Alcohol Biomarkers

Values for clinically utilized alcohol biomarkers such as AST, ALT, and MCV were obtained from recipient charts or blood was sent to Quest laboratories (Quest Diagnostics, Chantilly, VA) for measurement, if these values were not clinically available. Whole blood, serum, and urine were collected on recipients at the time of their lung transplant surgery for measurement of direct and indirect alcohol biomarkers including whole blood for PEth, serum for percent carbohydrate deficient transferrin (%CDT), an indirect alcohol biomarker, and urine for EtG. Dried blood spots were created with 40µL of vortexed whole blood which were then sent to the United States Drug Testing Laboratories (USDTL, Des Plaines, IL) for analysis of PEth by liquid chromatography–mass spectrometry (LC-MS). LC-MS was conducted using a previously published method.¹⁹ Frozen aliquoted serum was sent to Quest laboratories (Quest Diagnostics, Chantilly, VA) to determine serum levels of %CDT. Serum analysis was conducted in a manner similar to that proposed by Schellenberg et al. using rate-nephelometric determination after anion-exchange separation.²⁰ Finally, urine was collected for analysis of EtG, also sent to Quest laboratories for analysis via immunoassay.

Alcohol Use Quantification

Alcohol use in patients with advanced lung disease was quantified using self-report during a pre-transplant interview with the lung transplant social worker. The AUDIT was utilized in addition to self-report in order to identify any alcohol misuse. To improve the accuracy of the questionnaire, it was administered after the patient was called into transplant, therefore there was no possibility that their answers to the AUDIT could influence whether or not they received a lung transplant. Alcohol misuse was defined according to the Centers for Disease Control (CDC) definition for excessive alcohol use: >1 drink per day on average or 4 drinks consumed on one occasion in one month for women; >2 drinks per day on average or 5 drinks consumed on one occasion in one month for men.²¹ An AUDIT score >5 in

females and > 8 in males indicates alcohol misuse.^{14,22} Recent alcohol use included a positive direct alcohol biomarker, either and/or both a positive PEth and/or urine EtG as evidence of recent alcohol use prior to transplant surgery. PEth has a reported sensitivity for recent alcohol use of 99% with diagnostic specificity of nearly 100%, whereas urine EtG has a sensitivity of nearly 100% with specificity of 94%.^{12,13,15} EtG can detect recent alcohol use in the urine for approximately 2-4 days after imbibing alcohol.²³ PEth is detectable in the blood 3-12 days after a single ingestion of an alcoholic drink, with a reported detection window of 2-3 weeks with larger quantities of alcohol.¹⁷

Statistical Analysis

Patient demographic and clinical characteristics were presented as means and standard deviations, medians and interquartile ranges, or counts and percentages as appropriate. Serum cytokines were compared for patients with and without positive biomarkers for alcohol use, and differences were assessed with Wilcoxon rank sum tests. Similarly, Wilcoxon rank sum tests were used to compare outcomes including days at the hospital, in the ICU, and extubated for those with and without evidence of recent alcohol use as well as with AUDIT ≥ 3 versus < 3 . The proportions experiencing graft dysfunction or death by alcohol use were compared using Fisher's exact test.

Results

During the study period, 139 lung transplants occurred. 19 declined participation and 34 were never approached for consent. Therefore, 86 patients with advanced lung disease agreed to participate and were included in this investigation. Their demographics, clinical diagnosis and information, and AUDIT scores are contained in Table 1. The majority of the participants were middle-aged (mean age 55, SD=13), male (59%) and Caucasian. Common pulmonary diagnoses included COPD (34%), idiopathic pulmonary fibrosis (20%), idiopathic interstitial pneumonia (16%), and cystic fibrosis (12%). The alcohol self-report to the transplant social worker showed that 54% had a history of alcohol use and 34% were currently using alcohol. The interview with the social worker took place mean 6.5 (IQR 2.9-12.8) months prior to transplant. Direct alcohol biomarkers examined at transplant included urine EtG, which was positive in 4/73 (6%) samples, and PEth, which was positive in 5/50 (10%) samples, indicating recent alcohol use. Those recipients with either a positive urine EtG or PEth comprised the “recent alcohol use” group.

Information about the AUDIT scores in patients with advanced lung disease are contained in Figure 1. Nearly two thirds of the patients had an AUDIT score of 0 at the time of their lung transplant, 25% had scores 1-2, and 13% had a score ≥ 3 . Only 1 individual had an AUDIT score indicating alcohol misuse (>8), with a score of 12. The AUDIT questions which were most often answered positively in those patients who had an AUDIT score of 1 or greater was in the domain assessing frequency of alcohol consumption, such as “how often do you have a drink containing alcohol” and “how many drinks containing alcohol do you have on a typical day when you are drinking”. Only the patient who screened positive for alcohol misuse answered questions in the domain of alcohol dependence or alcohol related problems positively.

During the interview with the lung transplant social worker, anyone who admits to current use is counseled to abstain from alcohol before and after the transplant surgery. The patient's alcohol use self-response to the social worker regarding current and previous alcohol use compared to their answers at transplant on the AUDIT and the results of the alcohol biomarkers are contained in Figure 2. No current alcohol use was reported by 65% of patients at the time of the interview. Out of the patients who stated they are currently abstaining from alcohol, 4/52 (8%) answered the AUDIT with a score of 3 or greater, and 2/45 (4%) had evidence of recent alcohol use with positive alcohol biomarkers. In those who admitted current alcohol use to the lung transplant social worker, 25% had an AUDIT score 3 and 22% had evidence of recent alcohol use with positive alcohol biomarkers. Of 38 patients with no current or previous use reported to the social worker, n=2 (5%) and n=1 (3%) had AUDIT 3 or positive alcohol biomarkers, respectively. Five patients reported previous excessive and current social use to the social worker, and 23 patients had previous and current social use. None of those who only had previous social alcohol use had AUDIT 3 or positive biomarkers; those with both previous and current social use had highest rates of AUDIT 3 (30%) and positive biomarkers (25%) (Figure 2).

Those with "recent alcohol use" as evidenced by positive direct alcohol biomarkers, EtG and/or PEth, were grouped together and compared to the group with no recent alcohol use (negative EtG and/or PEth). There were 8 recipients in the "recent alcohol group", as 3 recipients were positive by urine EtG only as no PEth was collected, 2 recipients who were positive by PEth only, as no urine was collected, and 1 was positive by both PEth and urine EtG. 2 recipients were positive by PEth only with a negative urine EtG. The window of detectability for PEth is 2-3 weeks, whereas, urine EtG is only 2-3 days, therefore it is likely that those 2 recipients had a drink greater than 4 days prior to transplant, but within 2-3 weeks of transplant.^{13,15} There were 9 patients where neither EtG or PEth was collected due to emergent transplantation or logistical issues, and therefore these patients were excluded from this part of the analysis. Demographics, clinical information and alcohol biomarkers for each of the cohorts are contained in Table 2. There were no significant differences in demographics, comorbidities or severity of lung disease as indicated by the lung allocation score (LAS) or wait time between the two groups. Traditionally utilized clinical markers of alcohol use, such as MCV, ALT, AST, and the indirect alcohol biomarker, %CDT were not different between those with recent alcohol use and those without recent alcohol use indicating that long-standing alcohol misuse is unlikely.

Patients with evidence of recent alcohol use prior to lung transplant surgery had a 1.5 fold increase in hospital length of stay (LOS) following lung transplant (p=0.028). These patients spent 3 times as long on mechanical ventilation after transplant, 3 days (IQR 1-7) versus 1 day (IQR 0-2) in those without recent alcohol use, and subsequently remained in the intensive care unit almost 3 times as long as those without recent alcohol use (p=0.008), (Table 3). There were no significant differences in graft dysfunction or death by recent alcohol use to account for these differences seen in LOS. In order to examine the post-transplant complications which accounted for the increase in LOS, each individual with recent alcohol use, their age, pulmonary diagnosis, wait list time and LAS, and subsequent post-lung transplant complications are listed in Table 4. Post-lung transplant complications in those with recent alcohol use were numerous and did not show a specific trend, although

complications which were present in more than one patient, and that could prolong LOS included atrial arrhythmia, acute kidney injury, and acute cellular rejection (Table 4).

Discussion

Alcohol use among people with advanced lung disease has sparsely been investigated previously and therefore knowledge about the drinking habits in this patient population is limited. In this novel investigation, we found that the majority of people with advanced lung disease pursuing lung transplant are not drinking alcohol. Only one patient self-reported alcohol misuse amongst this cohort and all objective measures of alcohol use indicated only low-moderate alcohol use amongst those who were drinking. We found that 34% of patients with advanced lung disease undergoing evaluation for lung transplant are drinking moderately, with 10% of these patients drinking up until the lung transplant surgery is performed. Importantly, those patients who continued to drink alcohol up to the days prior to their lung transplant surgery, required mechanical ventilation and ICU monitoring three times longer than those lung transplant candidates who did not drink alcohol in the days prior to surgery. Subsequently, those who drank alcohol prior to lung transplant surgery had a prolonged hospital LOS.

It is reassuring to note that most of the cohort is abstaining or has very little use of alcohol while awaiting lung transplant. At our center, the patients pursuing lung transplant are counseled to limit alcohol intake in order to optimize their health and prepare to abstain after transplant, given the many potential drug interactions. We found a similar rate of alcohol consumption in patients with advanced lung disease pursuing lung transplant (34%) as a previous investigation, which found alcohol use rates of 25% and 33% in their non-CF and CF patient cohorts, respectively.⁹ In the non-CF lung transplant group, mean number of drinks per week was 5.6, with only 2.0 drinks per week recorded in the CF lung transplant group. These rates of alcohol use were similar to what was observed in heart transplant candidates and higher than liver transplant candidates (6%).^{24,25} The lower rate in liver transplantation is likely due to the strongly encouraged or requirement of alcohol abstinence in liver transplantation.

The gold standard for quantifying alcohol use is by patient self-report.¹¹ We did find that amongst those lung transplant candidates with positive alcohol biomarkers, the AUDIT score was more likely to be increased. The AUDIT is a 10-question survey which is easily administered during any clinical encounter. Its primary goal is to screen for alcohol misuse. But in a low-moderate drinking cohort, as we saw in patients with advanced lung disease, administration of the AUDIT can start a conversation between the provider and patient about the implications of alcohol use on their health and surgical outcomes. In lung transplantation, there are several opportunities where alcohol use is discussed, including the physician evaluation as well as the social worker assessment of alcohol use.

The addition of objective alcohol biomarkers can provide another layer of information about the patient's alcohol use. Clinically utilized alcohol biomarkers, such as AST, ALT, GGT, and MCV, all lack specificity for quantifying low to moderate alcohol use and are easily impacted by the individual patient's demographics and medical comorbidities.¹⁰ Blood

alcohol content is metabolized within hours of alcohol ingestion and is not a good screen for alcohol use in the clinic.¹⁰ EtG, which is present in the urine for approximately 2-4 days and has a very high sensitivity and specificity for recent alcohol use, is a good clinically available screening test.²³ The direct alcohol biomarker, PEth, which is also extremely sensitive and specific for recent alcohol use and is detected in the blood 3-12 days after a single ingestion of an alcoholic drink, is not yet clinically available. PEth can be detected up to 3 weeks when large quantities of alcohol are imbibed.¹⁷ In liver transplantation, monitoring wait-list candidates for alcohol use is essential given the devastating effects that alcohol use can have on the liver post-transplant. A recent investigation into various alcohol use self-report tools and alcohol biomarkers revealed that utilization of the short form AUDIT (AUDIT-c) along with urine EtG was most useful for detecting alcohol consumption in these potential transplant candidates.²⁵ In our investigation, we utilized positive EtG or PEth to represent recent drinking as the sensitivity and specificities of these two tests to detect alcohol use in the days prior to transplant surgery are superior at detecting low to moderate alcohol use.^{10,16,18}

The subgroup of patients with advanced lung disease who self-reported both previous and current social use was also the subgroup which had the highest number of patients with objective evidence of recent alcohol use at the time of transplant. Social drinking is a vague term to indicate moderate levels of drinking. It is the patients in this subgroup who may benefit from more specific quantification and additional counseling by lung transplant staff to minimize or abstain from alcohol in preparation for the lung transplant surgery and post-transplant care. In our investigation, patient self-report did occasionally conflict with their report on AUDIT or positive alcohol biomarkers, including self-report to the social worker of no alcohol use, but at transplant indicating AUDIT scores ≥ 1 or positive alcohol biomarkers. The inconsistencies were most obvious in the group that reported previous excessive use and no current use, where almost a quarter of the patients reported alcohol use at the time of lung transplant. This suggests that self-report of alcohol use can be influenced by status on the transplant list, as during the social work interview the patient is likely motivated in their responses, knowing that judgement about becoming a transplant candidate depends, in part, on the answers to the questions during the interview; as opposed to the self-report just prior to transplant surgery, when the transplant is imminent.

It is well known that heavy consumption of alcohol prior to surgery leads to poorer outcomes and an increased LOS. Consumption of more than two drinks of alcohol per day was a risk factor for increasing LOS in a cohort of veterans undergoing elective head and neck surgery, as well as increasing ICU stays due to pneumonia and sepsis in a cohort of patients after resection of upper digestive tract cancers.^{26,27} A query of the American College of Surgeons' National Surgical Quality Improvement Program revealed that alcohol use prior to elective surgeries were associated with longer median hospital stays and longer LOS after surgery.²⁸ Factors that drive ICU LOS and overall hospitalization LOS following lung transplant are not well described, although many factors which are associated with poor surgical outcomes are also associated with increased LOS such as increasing age, pre-transplant mechanical ventilation, increasing obesity, and multiple comorbidities.^{2,26,29} There are International guidelines published about acceptable lung transplant candidates which aim to minimize the risk of post-transplant complications in such patients.² However,

these guidelines identify major risk factors for death in the post-operative period, and did not identify risk factors for possible prolonged hospital LOS after lung transplant. Complications after lung transplantation are numerous and include primary graft dysfunction (PGD), acute cellular rejection, pneumonia, infections, venous thromboembolism, surgical wound dehiscence, and atrial arrhythmias, to name a few.³⁰ The cost of hospitalization following lung transplant is estimated at \$566,900 for bilateral transplant.³¹ Each additional day of ICU observation or longer duration of the hospitalization increases that cost. An investigation looking at discharge disposition after lung transplant found that increased ICU and hospital LOS were independent predictors of need for discharge to an inpatient rehabilitation unit instead of home.²⁹ The findings in our investigation suggest that abstaining from alcohol while awaiting lung transplant may be one additional factor that the patient can control in order to stay healthy and prepared for surgery and potentially optimizing their lung transplant outcome.

It is not clear in this investigation why the patients with recent alcohol use had prolonged mechanical ventilation and LOS. Alcohol use does effect the inflammatory response and increases the risk for infections and pneumonias.³ Our group, amongst others, have noted that in lung donors, heavy alcohol use is associated with an increased risk of PGD, an early complication following lung transplant which can increase morbidity and mortality in lung transplant recipients.^{30,32-34} However, the recent alcohol use patients did not have an increased rate of PGD, nor was there a difference in the drinking habits of their lung donors (data not shown). In the recent alcohol use group, there were no observations of alcohol withdrawal causing delirium or an increase number of deaths. Certainly, the patients with recent alcohol use acquired several post-transplant complications, and perhaps their ability to recover quickly from these complications is lower. This investigation is limited by the small cohort size and the limited amount of alcohol use observed. It is reassuring that such a small portion of the cohort had evidence of alcohol use at transplant, and none at levels that would be considered alcohol misuse. However, there was a significant portion of transplant recipients who either declined participation or were not approached. Additionally, there were nine participants who had AUDITs collected without biomarkers. This increases the likelihood that drinking alcohol while awaiting lung transplant may be underrepresented in this sample. Despite this limitation, the findings of this investigation have important implications for people with advanced lung disease, in maintaining optimal health for potentially ideal outcomes after lung transplant. We are also planning a future investigation with a larger sample size.

In conclusion, the majority of patients with advanced lung disease undergoing lung transplantation are abstaining or minimizing their alcohol use. Those who admit to current social drinking, or a history of previous excessive use had the largest percentage of objective alcohol use while awaiting lung transplant. Lung transplant recipients with evidence of recent alcohol use at transplant had a prolonged duration on mechanical ventilation, longer ICU and hospital LOS compared to those without evidence of recent alcohol use. Further investigation in larger cohorts is necessary to fully understand the risk of alcohol use while awaiting lung transplant.

Acknowledgments

This research was supported by the National Institute of Alcohol Abuse and Alcoholism, K23AA022126 (EML) and the National Institute on Alcohol Abuse and Alcoholism R21AA023193 (EJK). We would like to thank the lung transplant recipients at Loyola University Medical Center for their participation, and for the assistance of the lung transplant team.

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Figure 1. AUDIT scores in a cohort of patients with advanced lung disease

AUDIT scores at lung transplant in a cohort of patients with advanced lung disease. Figure 1A shows the percentage of patients in the cohort and their corresponding AUDIT scores. Only 1/86 patients scored AUDIT positive for alcohol misuse. Figure 1B assesses which questions (Q) were answered affirmatively by the patients with advanced lung disease. Questions Q1-3 cover the domain measuring frequency of alcohol consumption, questions Q4-6 measure alcohol dependence and questions Q7-10 measure alcohol related problems.

Figure 2. Patient self-report, AUDIT and alcohol biomarkers

Alcohol self-report to the transplant social was grouped into 5 alcohol use sub-categories.

Figure 2A shows the number of patients with AUDIT score <3 compared to AUDIT score

3 ($n=83$) within each alcohol use sub-category. Figure 2B compares the number of patients in each alcohol use sub-category, with the number of positive or negative alcohol biomarkers ($n=74$) within each group.

Table 1
Demographic and clinical characteristics

	Overall n=86
Age, mean (SD)	55 (13)
Female, n (%)	35 (41)
Non-Caucasian, n (%)	12 (14)
Diagnosis, n (%)	
COPD	29 (34)
IPF	17 (20)
CF	10 (12)
IIP	14 (16)
Other	16 (19)
Bilateral transplant, n (%)	48 (56)
History of use reported to social worker, n (%) (n=83)	45 (54)
Current use reported to social worker, n (%) (n=83)	28 (34)
Months from SW interview to transplant, median (IQR)	6.5 (2.9-12.8)
Positive direct alcohol biomarkers, n (%) (n=77)	8 (10)
Urine EtG (n=73)	4 (6)
PEth. (n=50)	5 (10)

Missing values: n=9 alcohol biomarkers, n=3 Social worker history/current use, Abbreviations: SD: standard deviation; COPD: chronic obstructive pulmonary disease; IPF: idiopathic pulmonary fibrosis; CF: cystic fibrosis; IIP: idiopathic interstitial pneumonia; IQR: interquartile range; ETG: ethylglucuronide; PEth: phosphatidylethanol.

Table 2
Demographics of cohort with positive alcohol biomarkers

	No recent alcohol use n=69	Recent alcohol use n=8	p-value
Age, mean (SD)	55 (12)	60 (7)	0.19
Female, n (%)	31 (45)	1 (13)	0.13
Non-Caucasian, n (%)	9 (13)	0 (0)	0.59
BMI, median (IQR)	24.6 (21.1-28.1)	27.3 (25.0-29.6)	0.08
Diagnosis, n (%)			
COPD	23 (33)	4 (50)	0.93
IPF	13 (19)	2 (25)	
CF	6 (9)	0 (0)	
IIP	12 (17)	2 (25)	
Other	15 (22)	0 (0)	
AUDIT score, median (IQR)	0 (0-1)	2.5 (0.5-4.0)	0.005
Waitlist days, median (IQR)	67 (23-183)	86 (15-262)	0.89
Donor alcohol use, n (%)	9 (13)	1 (13)	0.97
LAS score, median (IQR)	44.1 (36.4-53.7)	39.3 (34.4-59.5)	0.64
Bilateral transplant, n (%)	39 (57)	3 (38)	0.46
Albumin, median (IQR)	3.1 (2.7-3.5)	2.95 (2.35-3.75)	0.68
Total Bilirubin, median (IQR)	0.9 (0.6-1.8)	0.75 (0.6-1.85)	0.93
Coronary artery disease	12 (17)	1 (13)	0.72
Atrial fibrillation	2 (3)	0	0.63
Alcohol biomarkers			
MCV, median (IQR)	87.9 (83.4-92.0)	88.6 (86.8-92.4)	0.24
%CDT, median (IQR)	1.4 (1.0-1.9)	1.3 (1.0-2.2)	0.99
ALT, median (IQR)	19 (15-27)	20 (17-36)	0.62
AST, median (IQR)	32 (23-52)	29 (26-41)	0.64
EtG, median (IQR)	0 (0-0)	1087 (878-31,254)	<0.005
PEth, median (IQR)	0 (0-0)	19 (13-27)	<0.005

Missing values: n=9 alcohol biomarkers, n=7 CDT, n=2 AST/ALT

Abbreviations: SD: standard deviation; BMI: body mass index; COPD: chronic obstructive pulmonary disease; IPF: idiopathic pulmonary fibrosis; CF: cystic fibrosis; IIP: idiopathic interstitial pneumonia; IQR: interquartile range; LAS: lung allocation score; MCV: mean corpuscular volume; CDT: carbohydrate deficient transferrin; ALT: alanine aminotransferase; AST: aspartate aminotransferase; ETG: ethylglucuronide; PEth: phosphatidylethanol.

Table 3
Recent alcohol use and transplant outcomes

	No recent alcohol use n=69	Recent alcohol use n=8	p-value
Outcomes			
Length of stay, days, median (IQR)	15 (11-24)	23 (19-39)	0.028
ICU days, median (IQR)	5 (3-8)	14 (9-17)	0.008
Days requiring mechanical ventilation, median (IQR)	1 (0-2)	3 (1-7)	0.037
Primary Graft Dysfunction grade 3, n (%)			
48 hours	8 (12)	1 (13)	0.99
72 hours	6 (9)	1 (13)	0.57
Died, n (%)	10 (15)	1 (13)	0.99

Abbreviations: IQR: interquartile range; ICU: intensive care unit.

Table 4**Post-operative complications in recipients with recent alcohol use**

	Age	Pulmonary Disease	Waitlist, days	LAS	Transplant Type	ICU LOS	Hospital LOS	
1	69	IPF	19	42.0607	S	8	14	Atrial fibrillation ACR with mild hypoxia
2	64	COPD	257	32.9289	S	4	49	Atrial fibrillation Pseudomonas Pneumonia Decortication Left hemidiaphragm paralysis Peritonitis post-PEG placement
3	56	COPD	349	34.0805	S	14	22	Persistent pneumothorax Cecal serosal tear s/p ileocecectomy Acute kidney injury
4	70	IIP	35	71.9269	S	17	21	Respiratory failure due to pulmonary hypertension Acute renal failure Deconditioning
5	51	COPD	137	68.1309	S	10	16	Respiratory failure due to ACR Acute kidney injury
6	61	IPF	7	50.9474	B	35	58	PGD grade 3 Respiratory failure Acute kidney injury Right lung ischemia
7	59	IIP	266	36.5231	B	14	29	Bleeding Atrial fibrillation
8	52	COPD	10	34.7247	B	16	24	Atrial fibrillation Acute kidney injury Urinary retention

Abbreviations: LAS: lung allocation score; ICU: intensive care unit; LOS: length of stay; IPF: idiopathic pulmonary fibrosis; COPD: chronic obstructive pulmonary disease; IIP: idiopathic interstitial pneumonia; ACR: acute cellular rejection; PEG: percutaneous enteral gastrostomy tube; PGD: primary graft dysfunction.