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Research Article

Human Animal Bonds Create Better Physical Activities in Lung Transplant Patients – A Cross-Sectional Analysis of 517 Cases

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Abstract

Background: Companion animals may have a positive impact on physical activities and on quality of life (QoL) in individuals. However, many lung transplant (LTx) patients are advised against them due to the risk of zoonotic infections.

Methods: A single-center survey of 591 patients (response rate 87.0%) asked about current human animal bonds any time after LTx. Subgroups with, versus without, companion animals were compared regarding general QoL, physical activity levels, and clinical outcome parameters (FEV_1, rejection, BOS, hospitalization).

Results: Within a sample of 517 LTx patients, 25.1% (95% CI 21.7-29.2%) reported on having companion animals in their households. The majority reported to have dogs (n=84) or cats (n=38). Those caring for a companion animal were median 4.2 years post-transplant and more likely to engage in regular physical activities (OR 2.04; p=0.02; 95% CI 0.11-37.2), and to live in a family relationship (OR 1.62; p=0.004; 95% CI 1.45-1.89). Patients having companion animals did not differ in regard to clinical outcome, FEV1 (p=0.73), rejection (p=0.22), BOS (p=0.12), and hospitalization (p=0.81), compared to those without companion animals.

Conclusions: Our findings indicate that some patients after LTx have companion animals in their households. Careful management of companion animals in selected patients might alleviate the risk of zoonotic diseases, and might have a positive benefit on patients' physical activity levels.

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INTRODUCTION

Traditionally, the overall success of lung transplantation (LTx) has been measured by survival rates in the short-, medium, and long-term [1]. However, more recent research is taking the patient perspective into account to assess the benefit of the LTx procedure. Health-related quality of life (HRQoL), as an established patient reported outcome measure, provides information on the individuals' perceptions of the impact of disease and its treatment on their daily state of well-being [2,3]. Prospective, longitudinal studies indicate that LTx patients' HRQoL increases in the immediate period following transplant surgery and remains relatively stable thereafter[4-6]. However, the physical component of QoL remains below healthy norms, limiting patients in their ability to resume physically demanding roles and responsibilities [7-11]. Regular physical activity after transplant has been shown to increase muscle mass and thus, patient's capabilities in fulfilling physically demanding life roles [9,12,13]. Companion animals may be positive tools to motivate patients to increase their physical activity levels.

According to the Euro monitor [14], German inhabitants have overall 21.5million companion animals, or 262 pets per 1,000 inhabitants. These data rank Germany third when comparing different European countries inhabitants' habits to share their households and spend leisure time with companion animals. A nation-wide survey by the German Public Health Institute (former Robert Koch Institute [15]), looking at the effect of companion animals on health in different chronic conditions, revealed that pets may have a positive effect on the health status of individuals with different chronic conditions. More specifically, patients holding and caring for pets reported to have better QoL, a better physical and muscular condition, better social contacts, and better disease-specific parameters (e.g. blood pressure, blood cholesterol, blood glucose) compared to those without companion animals in their households.

Nevertheless, companion animals carry the risk for zoonotic infections in immune compromised patients [16-18], and despite advances in anti-infectious prevention and therapies, clinicians still hesitate to allow patients to have companion animals after LTx. As a result, most clinical protocols remain strict on this issue. Irani and associates (2006 [19]) challenged the community by publishing an article on the relationship between pets and physical health and QoL in a small sample of 46 LTx pet owners. Within their sample, pet ownership was not related to higher infectious complications, but to better QoL. Therefore, the purpose of our study was to verify these findings within a larger sample. Accordingly, we assessed the prevalence, and type of companion animals, its association with self-reported QoL, physical health, and with physical activities in patients after LTx.

METHODS

Design and setting

A cross-sectional study design was used in this study. All LTx patients with regular follow-up at our institution were invited to participate in this study during one of their follow-up visits in the outpatient clinic between a seven months period of time. Patient consent was obtained using a standardized questionnaire along with written instructions on how to fill in the questions. Within the outpatient setting, logged boxes were positioned to allow anonymous return of the questionnaires. As an alternative, patients were offered a pre-stamped, pre-addressed envelope to send their completed questionnaires back to the transplant center. In addition, patient confidentiality was assured to all patients. The study protocol was approved by our institutional review board. Data on this trial are reported in concordance with the STROBE Statement [20].

Study subjects

A sample of 591 patients were asked to participate when they met the following study inclusion criteria: LTx and regular follow-up at our center, being an outpatient, at least 18 years of age, and ability to respond to the questionnaire without support by another person. Overall, 517 patients chose to participate, leading to an 87.0% response rate.

Instruments

Self-report on physical health and companion animals: A brief questionnaire was developed specifically for this investigation. The self-report instrument consists of items on current physical activities (6 items), companion animals (2 items), and patient characteristics (5 items). An open answering category was incorporated into the questionnaire asking for which types of companion animals patients held at the time of the investigation. Multiple answers were allowed. Global QoL was assessed on a visual analog scale (VAS) asking the patient *"how satisfied are you with your current quality of life in general?"* VAS ranged from 0 to 100 with higher scores reflecting greater satisfaction with health.

Clinical variables and comorbidities: In addition to patient-reported outcome measures, relevant clinical variables, and comorbidities were addressed based on patient' chart documentations. These included type of transplant, time since transplant (in years), the best forced expiratory volume in one second (FEV1), the incidence of a bronchiolitis obliterans syndrome (BOS), time since diagnosis of BOS (in years post-transplant), acute rejection episodes (number within the last year), and hospitalizations (number within the last year).

Statistics

Statistics were performed using SPSS Version 22.0. Descriptive statistics were computed for descriptions of the sample characteristics. Prevalence rates were outlined along with 95% confidence intervals (95% CI), medians, and interquartile ranges (IQR). For the assessment of group differences between patients holding companion animals versus without companion animals, non-parametric Mann-Whitney U-Tests were applied. A binary logistic regression model using the forward selection mode was computed to assess a human companion animal bond benefit influencing variables. Patients with missing values in the dependent or independent variables were outlined. All test statistics were based on 2-tailed tests, the level of significance was set at $p<0.05$, if not stated otherwise.

RESULTS

Patient characteristics

Overall, the study sample consisted of 517 LTx patients, mean age was 52 (range 21-71 years), mean time since transplant was

4.3 (IQR 2.4; 8.0) years, 80.6% of the sample reported to live with other family members including partners, children, and/ or parents. The majority of 77.8% had received a bilateral LTx. Detailed patient characteristics have been depicted in table 1.

Prevalence of patients with an animal bond

The prevalence of a self-reported current LTx patient animal bond was 25.1% (n=130; 95% CI 21.7-29.2%) in this sample. Patients with an animal bond were more likely to live with another family member (p=0.002), and tended to have a higher monthly family income (p=0.06). The majority of patients with companion animals in their households reported to have dogs (n=84) or cats (n=38). Forty-one out of 130 patients (31.5%) had more than one companion animal, the number ranging between 1 and 6. Patients reported to have animal bonds with 9 types of animals (Table 2); three patients stated explicitly that they kept their animals outdoors.

Health status in patients with versus without an animal bond

Patients with an animal bond reported to engage more regularly in physical activities compared to those without animals (p=0.04). Otherwise, QoL ratings and the physical health status reported did not differ between those LTx patients with versus without companion animals (Table 3). Also, relevant outcome parameters showed no differences between the two subgroups. Binary logistic regression analysis revealed that those LTx patients engaging in regular physical activities (OR 2.04; p=0.02; 95% CI 0.11-37.2), and those with support from living in a family relationship (OR 1.62; p=0.004; 95% CI 1.45-1.89) were more likely to form an animal bond compared to their counterparts (Table 4).

DISCUSSION

This study assessed a human animal bond in 517 patients

Table 1: Patient Characteristics.

Variable*	Total Sample (n=517)	Companion animal owners (n=130)	Patients without companion animal (n=387)	**Group-Comparison p-value
Demographic variables				
Age (yrs) (median, IQR)	54 (43-63)	53 (44-63)	54 (43-62)	z=-0.43; p=0.67
Gender (%/ number)				
Male	52.0 (276)	56.9 (74)	50.4 (195)	z=-1.20; p=0.19
Family Status (%/ number)				
Single	19.4 (103)	8.5 (11)	23.8 (92)	z=-3.11; p=0.002
Married or living with partner	46.1 (245)	52.7 (68)	45.6 (176)	
Living with others (children/ parents)	34.5 (169)	38.8 (50)	30.6 (118)	
Professional Status (%/ number)				
Active (employed full- or part-time)	36.3 (193)	33.1 (43)	38.0 (147)	z=-1.03; p=0.31
Passive (unemployed or retired)	63.7 (324)	66.9 (87)	62.0 (240)	
Family income (Euro/ month) (median, IQR)	1,800 (1,100-2,800)	2,050 (1,200-2,900)	1,700 (1,000-2,800)	z=-1.66; p=0.09
Clinical variables				
Type of Transplantation (%/ number)				
Single Lung	12.2 (63)	11.5 (15)	12.4 (48)	z=-0.48; p=0.67
Double Lung	77.8 (403)	80.8 (105)	77.0 (298)	
Combined Heart- Lung	10.0 (51)	7.7 (10)	10.6 (41)	
Time since Transplant (yrs) (median, IQR)	3.88 (1.73-7.67)	4.24 (1.53-7.89)	3.84 (1.80-7.72)	z=-0.18; p=0.86
Underlying diagnosis for Transplant (%/ number)				
COPD and AAT	31.9 (163)	33.0 (43)	31.3 (121)	z=0.19; p=0.53
Cystic Fibrosis	24.1 (124)	24.6 (32)	24.8 (96)	
Idiopathic pulmonary Fibrosis	23.2 (121)	21.5 (28)	22.7 (88)	
Pulmonary HT and Eisenmenger	12.4 (65)	10.0 (13)	13.2 (51)	
Others	8.4 (44)	10.0 (14)	8.0 (31)	

Abbreviations: AAT = Alpha-1 Antitrypsin Deficiency; COPD= Chronic Obstructive Pulmonary Disease; HT= Hypertension; IQR= Interquartile Range; *less than 100% refers to missing data; ** group comparison based on Mann- Whitney- U- Test statistics

Table 2: Companion Animal Owners Responses regarding the Types of Companion Animals living in their Households (indoor and outdoor).

Types of Companion Animal	*Number of Response
Dog(s)	N=84
Cat(s)	N=38
Fishes/ aquarium	N=9
Turtle(s)	N=3
Rabbit(s)	N=3
Bird(s)	N=2
Other(s)	N=3

*multiple responses possible

Table 3: Comparison of current Health Status in Patients with versus without Companion Animals.

Variable	Companion animal owners (n=130)	Patients without companion animal (n=387)	*Group-Comparison p-value
Self-reported Quality of life (QoL) Perception			
Visual Analog Scale (median, IQR)	80 (60-90)	75 (60-90)	z=-1.50; p=0.13
Self-reported Physical Health Status (%/ number)			
Ability to climb a minimum of 2 levels of stairs (yes)	63.8 (83)	62.8 (241)	z=-0.53; p=0.74
Need for oxygen (yes)	6.2 (8)	6.5 (25)	z=-0.13; p=0.89
Need for mask ventilation (yes)	2.3 (3)	1.6 (6)	z=-0.56; p=0.57
Need of a walking aid (yes)	2.3 (3)	2.3 (9)	z=-0.20; p=0.98
Need of a wheel chair (yes)	3.1 (4)	4.1 (16)	z=-0.55; p=0.58
No need for aids at all (yes)	86.9 (113)	84.9 (327)	z=-0.56; p=0.57
Self-reported regular Physical Activities (%/ number)			
Regular physical activities (yes)	82.1 (107)	73.8 (285)	**z=-2.04; p=0.04**
Muscle training (yes)	3.8 (5)	4.9 (15)	z=-0.55; p=0.59
Endurance training (yes)	37.7 (49)	48.0 (146)	z=-0.66; p=0.57
Muscle and endurance training (yes)	32.3 (42)	47.0 (143)	z=-0.62; p=0.77
Clinical Physical Health Status and Comorbidities (%/ number)			
Best FEV1 (median, IQR)	2740 (2300-3450)	2730 (2230-3310)	z=-0.34; p=0.73
BOS (yes)	28.5 (37)	35.9 (139)	z=-1.55; p=0.12
Occurrence of BOS in yrs post-tx	6.9 (9)	5.7 (22)	z=-0.51; p=0.60
Acute rejection episodes (Number, Range)	1 (0-3)	1 (1-3)	z=-0.71; p=0.22
Hospitalisations (Number, Range)	1 (0-2)	1 (0-2)	z=-0.28; p=0.81

Abbreviations: BOS= Bronchiolitis Obliterans Syndrome; FEV1= Forced Expiratory Volume in 1 second; IQR = Interquartile Range; Visual Analog Scale (score 0-100; higher scores indicate better QoL perceptions); *group comparison based on chi-square tests or t-test statistics depending on data level of variable

after LTx, the largest sample to date. The overall prevalence of self-reported formation of LTx patient animal bonds was 25.1% (95% CI 21.7-29.2%) with a longer median time since transplant being 4.24 years for those with companion animals compared to their counterparts. Patients with an animal bond were more likely to live with other family members, tended to have a higher monthly family income, and engaged more regularly in physical activities. The majority of patients with companion animals in their households reported to have dogs or cats. One third of those LTx patients with companion animals cared for more than one.

Due to the life-long immunosuppressive therapy of LTx patients, keeping them at a higher risk for infectious diseases of any types, many LTx programs are restrictive with respect to human animal bonds. Yet, to the best of our knowledge evidence assessing this specific topic is very limited to date. Irani and associates (2006 [19]) were the first to publish on this issue, although they reported data from a cross-sectional study with a relatively small sample size. The authors found that 52% of their LTx patients were pet owners with higher scores of perceived QoL and life satisfaction ratings, but without higher somatic complication rates in those holding companion animals compared to those without pets. Our findings confirm that LTx patients forming an animal bond were not at a higher risk for complications following transplant compared to those without animals. Potentially, this might have been related to the fact that in this sample, those with companion animals were more likely to live in a family setting, where other family members might

Table 4: Binary logistic regression analysis on independent correlates on Companion Animal Ownership.

Variable	β	SE	Wald	p-value	OR	95% CI
QoL (Visual Analog Scale)	0.44	0.77	1.23	0.06	1.04	0.99-1.19
Need of a wheel chair (yes)	-3.1	1.15	7.26	0.007	0.45	0.25-0.58
No need for aids at all (yes)	-2.13	1.03	4.26	0.03	1.19	1.16-1.89
Regular physical activities (yes)	-0.65	0.23	4.96	0.02	2.04	0.11-37.2
Living in a family relationship (yes)	-0.46	0.16	8.22	0.004	1.62	1.45-1.89
Living with children (yes)	0.43	0.23	3.32	0.06	1.54	0.96-2.44
Constant	3.67	0.91	1.68	0.03	38.73	

Abbreviations: CI= Confidence Interval; OR= Odds Ratio; SE; Standard Error; QoL= Quality of Life

have cared for cleaning the cages and other tasks associated with higher risks for a contamination with zoonotic germs and subsequent infectious complications. Interestingly, in the sample by Irani and associates (2006 [19]), pet owners and no pet owners agreed on the belief that "pets have a positive influence on well-being". Since one of the major goals of LTx is to increase lifetime and quality of life, current lung transplant program recommendations, in this regard, should be carefully re-assessed. Additionally, further research is warranted to provide evidence for more tailored patient education on this topic.

Another recommendation of many LTx programs' educational content is the engagement into regular physical activities as many studies revealed that physical QoL levels remain below healthy norms, thus potentially limiting LTx patients' day-to-day tasks in the long-term following transplantation [5,6,8,11,21-23]. Since a number of immunosuppressant medications, including corticosteroids, have been found to have effects on the skeletal muscle function, physical activity becomes even more important for this patient population [24]. In our study, we found that those with companion animals reported to be significantly more physically active compared to those without pets. In addition, there was a trend toward more pet ownership in patient households with children. It might be argued, albeit with caution, that those with companion animals enjoyed the benefit of physical activities with their animals due to the daily needs of the animals, for example regular walks for dogs. Also, this hypothesis is supported by research performed in other patient populations indicating that companion animal ownership might have a positive impact on patients with chronic conditions [15].

Nevertheless, the medical and veterinarian literature has reported zoonotic infections transmitted by companion animals in immune compromised patients, such as LTx recipients [17,18,25,26]. Some clinical data concerning the diseases transmitted from pets to these patient's, and a recent publication of the Centers for Disease Control (CDC [26]) provide some guidance on how to inform and educate patients on this topic. More specifically, detailed information on which zoonotic infections can be transmitted by which animal types, and how these risks can be limited by patients and their family members might be a more balanced way to handle the potential risks and benefits of transplanted patient's needs.

Our study has several limitations. First, we report data from a single-center with a cross-sectional study design, in a large, but convenient patient sample. Especially, restrictive center-related clinical standards regarding companion animal ownership for patients after LTx may have impacted the data. Also, longitudinal data investigating the time period, when stabile LTx patients create animal bonds would have provided more insights. Second, our data provide no details whether patients kept their companion animals from the pre-transplant period or became pet owners post-transplant. Third, assessment of companion animal bonds was based on patient self-report with no standardized and validated instrument available for this investigation, a clear limitation for this study. Future research is needed to develop and test psychometrically sound instruments on this topic addressing the specific needs of immune compromised patients. Fourth, other confounding variables not controlled within this study might have impacted our findings. This is specifically the case for infectious diseases and outcome variables that might be triggered by zoonotic germs beside those taken into consideration. Also, the number of hospitalizations might be underestimated due to being retrospectively obtained during patient regular outpatient visits. Patients may not have remembered it and thus may not have reported it. Finally, due to the cross-sectional design of this study, a survivor selection bias of patients surviving until study entry cannot be excluded.

In conclusion, this study assessed a human animal bond in the largest sample of 517 patients after LTx to date. According to patient self-report, the overall prevalence of LTx patient animal bonds was 25.1% (95% CI 21.7-29.2%). Patients with an animal bond were more likely to live with other family members, tended to have a higher monthly family income, and engaged more regularly into physical activities. Patients with companion animals had no higher complication rates in terms of FEV1 and BOS compared to those without animal bond.

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