

# Depression, anxiety, fear of progression, and emotional arousal in couples after left ventricular assist device implantation

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## Abstract

**Aims** Left ventricular assist device (LVAD) is a common treatment option for patients with heart failure waiting for a donor heart. Living with an LVAD is associated with many burdens and worries. Patients often depend on the support of their relatives, usually their spouses. This can also put a strain on the spouses and be associated with psychological stress for both. In couples, communication proves to be an important form of emotional support. Besides verbal aspects of communication, the extent of emotional arousal ( $f_0$ ) that is vocally encoded plays an essential role as a non-verbal aspect of communication. This study aims to investigate the psychological impact of LVAD on couples in investigating to what extent depression, anxiety, and fear of progression (FoP) differ between patients and partners, the intrapersonal and interpersonal associations of anxiety, depression, and FoP, and differences in emotional arousal.

**Methods and results** In this cross-sectional study, male LVAD patients and their female partners ( $N = 21$  couples) responded to self-report questionnaires on depression, anxiety, and FoP. Emotional arousal ( $f_0$ ) was evaluated during social support interactions between both spouses. Female partners experienced more anxiety than male patients ( $P = 0.016$ ). No differences occurred in depression ( $P = 0.967$ ) and FoP ( $P = 0.084$ ). Regarding intrapersonal associations, for patients, correlations appeared between anxiety and depression ( $r = 0.859$ ,  $P = 0.000$ ), anxiety and FoP ( $r = 0.730$ ,  $P = 0.000$ ), and depression and FoP ( $r = 0.608$ ,  $P = 0.004$ ). For caregivers, correlations appeared between anxiety and depression ( $r = 0.906$ ,  $P = 0.000$ ), anxiety and FoP ( $r = 0.665$ ,  $P = 0.001$ ), and depression and FoP ( $r = 0.734$ ,  $P = 0.000$ ). Regarding interpersonal associations, correlations were found between patient's anxiety and caregiver's anxiety ( $r = 0.461$ ,  $P = 0.041$ ), caregiver's depression ( $r = 0.510$ ,  $P = 0.018$ ), and caregiver's FoP ( $r = 0.524$ ,  $P = 0.015$ ). Non-significant correlations were found for caregiver's anxiety and patient's FoP ( $r = 0.404$ ,  $P = 0.078$ ) and patient's depression ( $r = 0.286$ ,  $P = 0.236$ ). Patient's depression was associated with caregiver's FoP ( $r = 0.526$ ,  $P = 0.017$ ), but not with caregiver's depression ( $r = 0.337$ ,  $P = 0.146$ ). No significant correlations were found between caregiver's depression and patient's FoP ( $r = 0.386$ ,  $P = 0.084$ ) and patient's depression ( $r = 0.337$ ,  $P = 0.146$ ). Patient's and caregiver's FoP showed significant associations ( $r = 0.482$ ,  $P = 0.027$ ). Patient's and partner's  $f_0$  were interrelated. Patient's  $f_0$  was positively related with his own and his partner's psychological distress. Partner's  $f_0$  showed associations to her own depression and FoP.

**Conclusions** Findings indicate that women of LVAD patients are burdened similarly or even to a greater extent than men themselves. Women's psychological distress has an impact on patients' psychological distress and vice versa. Early interventions for both patient and partner represent a necessary intervention target.

**Keywords** LVAD; Anxiety; Depression; Fear of progression; Fundamental frequency ( $f_0$ ); Partner

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## Introduction

Left ventricular assist device (LVAD) therapy often remains the last option for patients with end-stage heart failure.<sup>1</sup> LVAD therapy leads to improved quality of life as well as prolonged survival.<sup>2</sup> However, it can be considered as a stressor, which may burden the patient's psychological well-being. In comparison with transplants, artificial hearts show certain limitations reminding patients of their illness daily. The driveline is susceptible to infection and must therefore be handled with particular care. It can also disturb the patient's sleep and cause pain. In addition, patients lose independence and must redefine their role within their families. As a result, depression and anxiety are commonly reported in heart failure patients<sup>3</sup> and remain after LVAD therapy. Anxiety and depression do not only affect the patients' quality of life but also increase mortality.<sup>3</sup> Moreover, fear of progression (FoP) can occur as the specific fear that the disease may proceed with all consequences. However, FoP has not yet been studied in patients with LVAD.

The patient's support network assumes an important role for treatment success. Bruce *et al.*<sup>4</sup> showed a three-fold increased mortality risk for LVAD patients living alone. Therefore, in most LVAD centres, a caring family member is a necessary condition for treatment, who in most cases is the partner.<sup>5</sup> Spousal support has a significant positive impact on survival,<sup>4</sup> adherence, and quality of life,<sup>6</sup> thus directly influencing outcome after LVAD implantation.

Left ventricular assist device is a burden not only on patients but also on their partners, who may experience distress, anxiety, or depression.<sup>7</sup> For couples, it should be considered that the stress of one can also influence that of the other.<sup>8</sup> In several studies, the well-being of patients has been linked to the well-being of their caregivers,<sup>8</sup> and less psychological distress of the spouse has a positive impact on the patients' long-term prognosis.<sup>9</sup> However, little is known about the interdependence of depression, anxiety, and FoP in LVAD patients and their partners.

In couples, communication proves to be an important form of emotional support. Besides verbal aspects of communication, the extent of emotional arousal that is vocally encoded plays an essential role as a non-verbal aspect of communication. Comparable with facial expressions, the speaker's voice maintains a large amount of information about his emotional state and goes far beyond pure semantic contents.<sup>10</sup> The fundamental frequency ( $f_0$ ) is a measurable characteristic of the sound of the human voice. It represents a valid, objective, and reliable method to record emotional arousal.<sup>11,12</sup> Several indices like the mean or range of a speaker's  $f_0$  can be calculated. These indices correlate with various other physiological measures of arousal such as blood pressure, cortisol level, or heart rate.<sup>13</sup> A high  $f_0$  indicates greater emotional arousal.<sup>12</sup> In supportive, illness-related couple interactions, high emotional arousal refers to a shared stressor. In this case, high

levels of emotional arousal may be seen as an indicator of social support, given that both partners are willing to share negative emotions.<sup>14</sup> A first study in couples with kidney transplantation showed that in male kidney transplants, high levels of emotional arousal indicated poor emotional regulation strategies. In female kidney transplants, high levels of emotional arousal indicated adaptive emotional regulation strategies.<sup>15</sup>

The aims of the present study are to investigate (i) to what extent depression, anxiety, and FoP differ between LVAD patients and their partners. Based on current knowledge, female caregivers are expected to be significantly more anxious than male LVAD patients.<sup>7,16</sup> With regard to FoP, however, we expect male LVAD patients and female caregivers to be affected to a similar extent. (ii) Furthermore, the interdependence of anxiety, depression, and FoP in patients and partners will be investigated. (iii) Moreover, differences in emotional arousal in couples will be investigated. It is assumed that higher  $f_0$  values are associated with higher psychological stress in patients and partners.

## Methods

### Participants and procedure

$N = 39$  couples where one partner had an LVAD implantation were recruited at an artificial heart clinic for this cross-sectional study. The eligibility criteria included  $>3$  months since the implantation,  $>1$  year in a heterosexual relationship, and sufficient knowledge of German. Potential participants were contacted via phone call by a study team member prior to their annual check-up appointment. A total of 97 couples met the inclusion criteria, of which 58 declined to participate (recruitment rate = 40%) due to lack of interest or health reasons.

Self-report questionnaires were completed separately by patient and partner. The couples were then asked to have two 7 min conversations with their partner, which were recorded on video or audio. One partner was the speaker, and one was the listener. The speaker was asked to talk about a stressful situation in relation to the implantation. The listener was to react to the other's statements in the same way as he usually does. Afterwards the roles were switched. Of the 39 couples, 15 declined participation in the conversations. Reasons were unwillingness to re-experience their emotions related to the implantation again or difficulties to put their emotions into words. In total, 24 couples completed both the questionnaires and the video recording, of which 3 patients were female and 21 male. In order to avoid a confounding of role and sex, only the  $N = 21$  couples with male patients and female relatives were considered for the present study (*Table 1*).

**Table 1** Sample characteristics ( $N = 21$ )

	LVAD patients	Female caregiver
Mean age (SD, range)	62.24 (10.1, 45–78)	61.00 (9.5, 46–77)
Employment, $n$ (%)		
Employed (full-time)	1 (4.8)	5 (25)
Employed (part-time)	2 (9.5)	6 (30)
Incapable of work	2 (9.5)	0 (0)
Retired	13 (61.9)	7 (35)
Other	3 (14.3)	2 (10)
Education, $n$ (%)		
<9 years	8 (38.1)	9 (45)
10 years	8 (38.1)	10 (50)
>10 years	5 (23.8)	1 (5)
Time since LVAD implantation in years (SD, range)	3.66 (2.3, 0.30–8.29)	—
Relationship length in years (SD, range)	35.25 (14.3, 12–57)	—
Number of children (SD)	1.52 (1.0)	—

LVAD, left ventricular assist device.

The study conforms with the principles outlined in the Declaration of Helsinki. It was approved by the ethics committee of Hannover Medical School (No. 3550-2017), and all participants provided their written informed consent.

## Measurements

### Depression

The Patient Health Questionnaire Depression Scale<sup>17</sup> measures depressive symptoms with nine items. Total scores vary between 0 and 27 referring to no (0–4), mild (5–9), moderate (10–14), moderately severe (15–19), and severe (20–27) depression. Cronbach's alpha in the current sample is 0.90.

### Anxiety

The General Anxiety Disorder Questionnaire contains seven items referring to the patient's general anxiety.<sup>18</sup> Total score ranges from 0 to 21 referring to minimal (0–4), mild (5–9), moderate (10–14), and serious (14–20) anxiety. Cronbach's alpha is 0.92.

### Fear of progression

Fear of progression was assessed with the 12-item Fear of Progression Questionnaire Short Form (PA-F-SF) for patients and partners.<sup>19,20</sup> Higher scores indicate higher FoP. Cronbach's alpha is 0.88.

### Emotional arousal ( $f_0$ )

The recorded conversations were separated into male and female speakers and listeners by using Adobe Premiere. The  $f_0$ -range (difference between maximum and minimum of  $f_0$  scores) was calculated for male and female speakers and listeners continuously for every quarter second by using Praat.<sup>21</sup> Because there is a significant difference due to sex, it is important to detect  $f_0$  separately for male and female participants. While women's  $f_0$  variates around a medium of 210 Hertz, values around 120 Hertz were described for men.<sup>22</sup>

## Statistical analysis

All statistical analysis was carried out using IBM SPSS Statistics 25.0. For descriptive statistics, percentages, frequencies, mean values, and standard deviations were calculated. *t*-tests for dependent samples were computed, in order to determine differences between members of a dyad. Pearson's correlations were used to assess the association between depression, FoP, anxiety, and  $f_0$ . The evaluation of  $f_0$  was dependent on role (patient vs. partner) and sex. A significance level of  $P < 0.05$  was used.

## Results

### Differences regarding depression, anxiety, and fear of progression

No differences were found for depression between male patients and female caregivers [ $M_{\text{patient}} = 4.80$ ,  $SD = 5.23$ ;  $M_{\text{partner}} = 5.20$ ,  $SD = 4.24$ ;  $t(19) = 0.042$ ,  $P = 0.967$ ]. Regarding anxiety, female caregivers ( $M = 5.55$ ,  $SD = 4.56$ ) showed significantly higher anxiety than male patients [ $M = 2.95$ ,  $SD = 3.45$ ;  $t(19) = -2.65$ ,  $P = 0.016$ ]. Regarding FoP, only marginally significant differences between patients ( $M = 30.81$ ,  $SD = 7.53$ ) and their spouses occurred [ $M = 34.29$ ,  $SD = 9.39$ ;  $t(20) = -1.82$ ,  $P = 0.084$ ].

### Intrapersonal associations between anxiety, depression, and fear of progression

Significant positive correlations appeared between patients' anxiety and depression ( $r = 0.859$ ,  $P = 0.000$ ) and patients' anxiety and FoP ( $r = 0.730$ ,  $P = 0.000$ ). Patient's depression was positively associated with FoP ( $r = 0.608$ ,  $P = 0.004$ ). Positive correlations appeared between caregivers' anxiety and depression ( $r = 0.906$ ,  $P = 0.000$ ) and caregivers' anxiety

and FoP ( $r = 0.665$ ,  $P = 0.001$ ). Caregiver's depression was positively related to FoP ( $r = 0.734$ ,  $P = 0.000$ ).

### Interpersonal associations between anxiety, depression, and fear of progression

The interdependence between patient and partner showed significant positive correlations between patient's anxiety and caregiver's anxiety ( $r = 0.461$ ,  $P = 0.041$ ), caregiver's depression ( $r = 0.510$ ,  $P = 0.018$ ), and caregiver's FoP ( $r = 0.524$ ,  $P = 0.015$ ). Non-significant correlations were found for caregiver's anxiety and patient's FoP ( $r = 0.404$ ,  $P = 0.078$ ) and patient's depression ( $r = 0.286$ ,  $P = 0.236$ ).

Patient's depression was positively associated with caregiver's FoP ( $r = 0.526$ ,  $P = 0.017$ ), but not with caregiver's depression ( $r = 0.337$ ,  $P = 0.146$ ). No significant correlations were found between caregiver's depression and patient's FoP ( $r = 0.386$ ,  $P = 0.084$ ) and patient's depression ( $r = 0.337$ ,  $P = 0.146$ ).

Patient's and caregiver's FoP showed significant positive associations ( $r = 0.482$ ,  $P = 0.027$ ).

### Emotional arousal ( $f_0$ )

Between patient and spouse,  $f_0$ -ranges did not differ significantly regardless of their role as speaker [ $M_{\text{male}} = 32.73$ ,  $SD = 8.58$ ;  $M_{\text{female}} = 36.08$ ,  $SD = 9.45$ ;  $t(15) = -0.551$ ,  $P = 0.59$ ] or listener [ $M_{\text{male}} = 35.44$ ,  $SD = 8.18$ ;  $M_{\text{female}} = 36.93$ ,  $SD = 14.05$ ;  $t(12) = -1.242$ ,  $P = 0.24$ ]. Additionally, no significant difference in  $f_0$ -range for the patient as speaker and the spouse as listener [ $t(14) = -1.725$ ,  $P = 0.10$ ], nor for the spouse as speaker and the patient as listener [ $t(15) = 0.801$ ,  $P = 0.44$ ], could be found.

Positive correlations appeared between  $f_0$ -range of the men as speaker and  $f_0$ -range of the women as listener ( $r = 0.654$ ,  $P = 0.008$ ) as well as between  $f_0$ -range of the women as speaker and the  $f_0$ -range of the men as listener ( $r = 0.765$ ,  $P = 0.001$ ). A significant positive correlation (Table 2) appeared between patient's  $f_0$ -range as listener and his caregiver's depression ( $r = 0.634$ ,  $P = 0.008$ ). Concurrently,  $f_0$ -range of the female caregiver as speaker showed positive associations with her own depression ( $r = 0.476$ ,  $P = 0.034$ ). Patient's  $f_0$ -range as listener showed significant positive correlations with his own anxiety ( $r = 0.595$ ,  $P = 0.015$ ).

With the patient being the listener, his  $f_0$ -range showed a moderate positive correlation with the caregiver's FoP ( $r = 0.588$ ,  $P = 0.017$ ). The caregiver's  $f_0$ -range as listener was negatively related to her own FoP ( $r = -0.502$ ,  $P = 0.040$ ).

## Discussion

The aim of the present study was to gain a deeper understanding of the emotional experience of couples after LVAD implantation. More precisely, we investigated how male LVAD patients and their female caregivers differ in terms of depression, anxiety, and FoP. Also, we shed light on the intrapersonal and interpersonal associations of psychological distress within both members of the couple. Furthermore, we evaluated a physiological indicator to disclose psychological distress in couples and investigated the association of depression, anxiety, FoP, and vocally encoded emotional arousal ( $f_0$ ).

### Differences regarding depression, anxiety, and fear of progression

The assumption that female caregivers experience more stress than patients could be confirmed for anxiety, but not for depression and only marginally for FoP. The findings regarding anxiety are consistent with a previous study<sup>16</sup> stating that partners from LVAD patients suffer more from anxiety than patients themselves. In fact, men are less likely to be affected by anxiety disorders than women.<sup>23</sup> Because the majority of LVAD patients tend to be male, partners are mostly female and therefore at higher risk of developing anxiety due to their sex.

Additionally, a former study highlighted the unique burden experienced by LVAD caregivers compared with caregivers of other diseases.<sup>24</sup> LVAD caregivers live with the responsibility of having to follow highly hygienic standards during dressing changes, perform elaborate technical routines, and react within a few minutes in case of device failure. This unique fear of being responsible for the partner's life and its underlying threat of loss may explain why LVAD caregivers experience higher degrees of anxiety than patients themselves. Spouses as caregivers are at risk of developing anxiety not only due to their sex but also due to their caregiving role.

Studies on depression in LVAD patients and their partners are scarce. While some studies<sup>25</sup> describe more symptoms of depression in LVAD partners than LVAD patients, others reported no significant differences.<sup>7</sup>

### Intrapersonal and interpersonal associations between anxiety, depression, and fear of progression

Strong associations were found both for the psychological distress variables within a person (intrapersonal associations) and between patient and partner (interpersonal associations). Depression and anxiety are strongly related to each other in LVAD patients and in their partners, which was also supported by previous research.<sup>7</sup> The current study adds to

**Table 2** Correlations between emotional arousal, anxiety, depression, and fear of progression within the couple—male left ventricular assist device recipients and female partners

	Emotional arousal											
	GAD				PHQ				FoP			
	fo patient speaker	fo patient listener	fo spouse listener	fo spouse speaker	GAD patient	GAD spouse	PHQ patient	PHQ spouse	FoP patient	FoP spouse	FoP patient	FoP spouse
fo <sup>a</sup> p <sup>♂</sup> -speaker	1											
fo s <sup>♀</sup> -listener			<b>0.654<sup>***</sup></b> (0.008)		0.009 (0.971)	-0.299 (0.261)	0.048 (0.854)	0.151 (0.564)	<b>0.481<sup>†</sup></b> (0.051)	0.363 (0.152)		
fo p <sup>♂</sup> -listener			1		0.218 (0.400)	0.314 (0.237)	0.120 (0.646)	-0.297 (0.248)	0.079 (0.763)	-0.502 <sup>*</sup> (0.040)		
fo s <sup>♀</sup> -speaker		1		<b>0.765<sup>**</sup></b> (0.001)	<b>0.595<sup>†</sup></b> (0.015)	<b>0.459<sup>†</sup></b> (0.085)	0.413 (0.126)	<b>0.634<sup>**</sup></b> (0.008)	<b>0.442<sup>†</sup></b> (0.087)	<b>0.588<sup>†</sup></b> (0.017)		
GAD <sup>a</sup> patient				1	0.337 (0.147)	0.345 (0.148)	0.041 (0.867)	<b>0.476<sup>*</sup></b> (0.034)	0.076 (0.750)	0.360 (0.119)		
GAD <sup>a</sup> spouse					1	<b>0.461<sup>†</sup></b> (0.041)	<b>0.859<sup>**</sup></b> (0.000)	<b>0.510<sup>*</sup></b> (0.018)	<b>0.730<sup>**</sup></b> (0.000)	<b>0.524<sup>*</sup></b> (0.015)		
PHQ <sup>a</sup> patient						1	0.286 (0.236)	<b>0.906<sup>**</sup></b> (0.000)	<b>0.404<sup>†</sup></b> (0.078)	<b>0.665<sup>**</sup></b> (0.001)		
PHQ <sup>a</sup> spouse							1	0.337 (0.146)	<b>0.608<sup>*</sup></b> (0.004)	<b>0.526<sup>*</sup></b> (0.017)		
FoP <sup>a</sup> patient								1	<b>0.386<sup>†</sup></b> (0.084)	<b>0.734<sup>**</sup></b> (0.000)		
FoP <sup>a</sup> spouse									1	<b>0.482<sup>*</sup></b> (0.027)		

<sup>a</sup>fo, speech frequency/vocally encoded emotional arousal.

<sup>b</sup>p, male patient.

<sup>c</sup>s, female spouse.

<sup>d</sup>GAD, General Anxiety Disorder Scale-7.

<sup>e</sup>PHQ, Patient Health Questionnaire-9.

<sup>f</sup>FoP, Fear of Progression Questionnaire.

<sup>†</sup>P < 0.1.

<sup>\*</sup>P < 0.05.

<sup>\*\*</sup>P < 0.01.

<sup>\*\*\*</sup>significant correlations in bold

the existing literature how FoP correlates with depression and anxiety within the LVAD population. Studies on FoP in LVAD patients and their partners are scarce. Investigations of cancer patients also reflect positive relations between FoP and anxiety as well as between FoP and depression.<sup>26</sup>

Noteworthy, it must be considered that emotions reciprocally influence both members of a dyad, particularly within intimate relationships. Negative experiences, especially with one partner suffering from health problems, can provoke crossover effects in the other partner. A study by Brouwers *et al.*<sup>7</sup> supports our findings of patient’s anxiety relating to partner’s depression. Additionally, the results that patient’s and partner’s anxiety are mutually interrelated are in line with existing literature on the interdependence of anxiety within LVAD couples.<sup>27</sup>

In contrast to other studies on LVAD patients and their partners, no significant relation between patients’ and their partners’ depression were found.<sup>7</sup> Regarding the moderate but non-significant correlation, it seems plausible that the small sample size and the consequently limited power might explain these differing results.

Given that psychological distress also embraces FoP, we expected it to be related within LVAD patients and their partners. In line with these expectations, we found moderate to strong correlations between patient’s FoP and caregiver’s FoP, depression, and anxiety. While the correlations between patient’s FoP and caregiver’s depression and anxiety barely failed to reach significance, it is striking that all investigated components of patient’s psychological distress—his anxiety, depression, and FoP—are strongly and significantly related to his spouse’s FoP. This finding may reflect the high receptiveness of women to their partner’s feelings.<sup>28</sup>

### Emotional arousal (fo)

The results indicate a strong relation between LVAD patients’ and their partners’ vocally encoded emotional arousal. This was expected because fo is a measurement of emotional arousal and both partners are likely to experience psychological distress after LVAD implantation and during the conversation about this topic. In this case, the emotional arousal refers to a stressor shared by both. The results indicate that the male LVAD patient’s emotional arousal is equally related to his female caregiver’s emotional arousal and vice versa. In line with the study by Peters *et al.*,<sup>15</sup> female caregivers displayed a wider fo-range than male LVAD patients, regardless of their role as speaker or listener.

### Limitations and future prospects

The limitations of this study include the small sample size, leading to a limited power and generalizability. It was not



possible to stratify our results for age or time since implantation. Data were drawn from a single site, and the non-diverse sample consisted of male patients and their female spouses. Regarding the sex bias, experiences for female patients and male spouses may vary. Multisite studies including a larger sample with male spouses as well as same-sex partners are needed to identify the role of sex. Another point to be considered is that psychological distress is no static value. Previous studies showed that patients' and caregivers' scores of anxiety and depression change over course of time.<sup>7</sup> The cross-sectional design of the present study only permits a keystone prevalence and does not allow causal inferences. Therefore, longitudinal data are required. Further limitation may be seen in the selection bias. Partners and patients who refused study participation might have suffered from higher or lower psychological distress, with the risk that the results on depression, anxiety, and FoP could be an overestimation or underestimation compared with the total LVAD population and their spousal caregivers. Results on emotional arousal were conducted on couple interactions. It must be taken into consideration that these interactions were mainly dependent on the couples' implementation of instructions, which might have been influenced by, for example, recall bias. Additionally, in future studies with larger sample sizes, a separate evaluation split in supportive, conflictual, or neutral couple interaction should be considered. This would better reflect that the meaning of  $f_0$  depends on context. The findings on the association between male LVAD patients' and their female caregivers' psychological distress provide an important target for future interventions. For the patient's outcome, it is of enormous importance to consider the

couple and the psychological distress they experience as a whole where one influences the other. This seems especially important due to the connection between psychological distress and physical health within patient-partner dyads.<sup>29</sup>

## Conclusions

Hence, greater emphasis should be placed on a therapeutic approach targeting psychological distress such as depression, anxiety, and FoP of both partners. Not only is a depressed caregiver assumedly less able to provide sufficient caregiver tasks, but given the impact of psychological distress in LVAD patients on adverse outcomes, such as increased hospital readmissions and consequentially even mortality,<sup>30</sup> psychotherapeutic treatment for both members of the couple will benefit the patient's physical health in the long term.

## Conflict of interest

None declared.

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