Original Article

Comparative Assessment of Depression, Quality of Sleep, and Respiratory Functions among Tuberculosis Patients with their Nontuberculosis Family Contacts

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Abstract

Context: Tuberculosis (TB) patients may present depression as comorbidity. This presents great challenges including the stigma of increased risk of developing TB in tackling such patients. **Aims:** The main aim of the study was to assess the lung function, sleep quality, and extent of depression in TB patients as compared to non-TB family contacts. **Methods:** TB patients and their family contacts (60 each) stopping by specialized directly observed therapy short-course center at a tertiary care hospital were assessed for depression and quality of sleep. Pulmonary functions were analyzed by spirometry. Descriptive statistics and *t*-tests were applied using SPSS version 19.0. $P \leq 0.05$ was considered significant. **Results:** Depression with a significantly higher mean Patient Health Questionnaire-9 score was more prevalent among TB patients (73.3%) when compared to their family contacts (46.7%). TB patients presented with significantly higher levels of mean global Pittsburgh Sleep Quality Index score (9.56 ± 3.97) compared to their non-TB family contacts (4.36 ± 2.07), indicating a poorer sleep quality and also the sleep disturbance and daytime dysfunction were significantly more in TB patients ($P = 0.000$). The lung function measures were reduced in TB patients, and the difference was significant compared to their non-TB family contacts. **Conclusions:** The present study shows that TB patients have a poor quality of sleep, higher depression levels, and reduced lung functions compared to their non-TB family contacts. This calls for well-organized screening strategies to screen the in-apparent symptoms of adverse mental conditions among TB patients and their family caregivers/contacts with aid of mental health professionals to enable better management of this population.

Keywords: Caregivers, depression, pulmonary function tests, sleep, tuberculosis

Introduction

Tuberculosis (TB), often thought a disease from the past, is still rampant in large parts of the world. With 1.5 million deaths annually, it is the most important global killer due to an infectious disease. India accounts for 27% of the world's cases which is ranked first in the World Health Organization (WHO) list of countries with the highest TB burden.[1,2] Depression affects nearly 350 million people worldwide and expected to rank second to heart disease among various contributors of disability-adjusted life year, measured among different strata of age and genders by the end of the year 2020.[3,4] Several studies have suggested that comorbid depression is a usual find among TB patients and ranges from 25% to 33% along with other chronic health outcomes. With such high prevalence, this condition shows an increasing trend, especially with increasing severity of the disease. This poses a tremendous challenge in managing such patients and disorders.[5]

Many studies have shown that pulmonary TB can lead to obstruction of airflow. Prospective studies have shown that a significant percentage of patients with pulmonary TB treated show evidence of permanent obstruction or restrictive

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Access this article online

Quick Response Code:

Website: www.ijrc.in

DOI: 10.4103/ijrc.ijrc_54_21

How to cite this article: Itagi AB, Dharmalingam A, Yunus GY, Velou SM, Subramanian SK, Sundareswaran L. Comparative assessment of depression, quality of sleep, and respiratory functions among tuberculosis patients with their nontuberculosis family contacts. Indian J Respir Care 2021;10:312-7.

Received: 24-04-2021 **Revised:** 01-05-2021

Accepted: 17-07-2021 **Published:** 13-09-2021

airflow impairment.[5] Post-TB pulmonary dysfunction has therefore emerged as a distinct clinical entity that subsequently impairs the quality of life of patients with TB.[6] Sleep is a vital physiological phenomenon and approximately 7–8 h of adequate sleep is essential for maintaining a healthy and quality livelihood. Chronic disease conditions lead to sleep deprivation, affecting the physical and/or cognitive function of humans and thus jeopardizes the quality of life.[7-9]

TB is a chronic disease condition, where the patients suffer from comorbid depression, anxiety and ultimately may lead to sleep deprivation.[10,11] Several studies have postulated the prevalence of comorbid depression and anxiety among TB patients, but there exists a dearth of literature associated with the sleep quality among TB patients.[12-14] Family contacts who are in close contact with TB patients as compared to the general population create a stigma and fear for acquiring the disease among such close ones.[15,16] The perception of TB stigma and fear of acquiring infection is also associated with serious socioeconomic consequences.[17] In the existing period, those who stay in proximity to the TB patients are regularly examined and tested to screen for active TB, and the same protocol is being carried out for high-risk groups.[18] However, no mental health surveys on TB contacts have been conducted in the past. Thus, the real risk of mental distress among close contacts remains unclear. However, it can be hypothesized that family contacts of TB patients may develop depressive disorder due to stigma and fear of acquiring the disease among themselves with the sur-fuelling issue of socioeconomic stress if the index cases of TB are a family or living with them.

This observational study aims to assess the quality of sleep with their comorbid depression, pulmonary function parameters among TB patients, and their family contacts visiting a tertiary care health facility.

Methods

This study was commenced after obtaining Institutional Review Board approval. It was undertaken at the "Directly Observed Therapy Short-course (DOTS)" center of outpatient Department/DOTS Center of Medical Institution and Tertiary Health Care Facility in Andhra Pradesh, India. Patients with pulmonary TB above 18 years of age attending designated DOTS center and providing consent to participate were selected as cases. Comparison groups consisted of family members who accompanied the cases and consented to participate.

The sample size determination was carried out by using Gpower statistical software (Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behavior Research Methods, 2007; 39, 175-91) (Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. Behavior Research Methods, 2009; 41, 1149-60) for analysis. With an effect size of the study at 0.7 (medium; desired = <1), keeping the power of the study as 0.95 (95%) and significance level (*P* value) at 0.05, the estimated minimum sample was 55 in each group. However, a total sample size of 120 subjects (60 in each group) was included in the study after obtaining written informed consent after explaining the purpose and procedures in detail. A self-administered questionnaire was created and was pretested in both Telugu and English languages for ensuring comprehension by all subjects. TB patients or family members with preexisting asthma/chronic obstructive pulmonary disease, paraplegia, heart failure, stroke, extrapulmonary TB, spine deformities (kyphosis, scoliosis), chest deformities, obstructive sleep apnea, pregnancy, and subjects taking treatment of any kind of depression before the study were excluded.

Assessment of depression

Nine-item "Patient Health Questionnaire" (PHQ)-9 was used as the screening instrument of choice for depression because of its brevity, ease of scoring and because of its good psychometric properties when compared to other validated instruments. It is specifically designed for use in primary care and outpatient settings and has been widely used in both for clinical practice and research. The reliability of the PHQ-9 questionnaire items in Telugu was tested using Cronbach's alpha, which was found to be 0.81 indicating as a reliable tool for assessment. PHQ-9 questionnaire was administered to be answered by selected TB patients and their family contacts, and the level of depression was calculated using the fourth edition Diagnostic and Statistical Manual of Mental Disorders intravenous criteria for major depressive disorder.[19]

Quality of sleep

A self-rated, 21-item Pittsburgh Sleep Quality Index (PSQI) questionnaire consisting of seven components, subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleep medications, and daytime dysfunction, was administered to evaluate sleep quality in all the participants. Each PSQI item was scored on a scale of 0–3, with higher scores indicating worse sleep quality. The PSQI global score was calculated as the number of these items (range: 0–21). A PSQI score of > 5 was used to distinguish good sleepers (≤5) from bad sleepers (>5). A global PSQI score of >5 has been shown to have diagnostic sensitivity and precision and is used to differentiate good sleepers from poor sleepers.[20]

Pulmonary functions

The pulmonary function tests were performed using a portable, computerized, precalibrated, electronic, dry type of machine – Easy on-PC, a PC spirometer from NDD Medical Technologies (Royal Medi systems). As a precautionary measure, face masks and gloves were used to protect the investigator/assistants. Disposable mouthpiece/filter (Spirette/filter) per participant was used to avoid cross-contamination. Spirometry was performed in an isolated room with open sunlight. The forced expiratory maneuvers were explained to the participants before they underwent spirometry. The subjects were made to sit comfortably and relaxed in an armed chair

with a straight back and were asked to inhale atmospheric air deeply. The nose clip was placed immediately and keeping the Spirette inside the mouth with lips tightly sealed around it, the subject was asked to blow out air as fast and as hard as possible, for a minimum of 6 seconds, followed by deep inhalation with the Spirette still inside the mouth (to form a loop). The best of 3 trials performed with an interval of 5 min was taken for analysis.

The forced vital capacity (FVC) and forced expiratory volume in one second (FEV1) were measured, and further forced expiratory flow (FEF) between 25% and 75% of FVC (FEF 25%–75%), peak expiratory flow rate (PEFR), and maximal voluntary ventilation (MVV) were determined. The lung function impairment pattern and severity were assessed from spirometry results using a percentage of the predicted values of FEV1/FVC and FVC.

Statistical analysis

Statistical analyses were performed using the SPSS version 19 (IBM Corp. Released 2010. IBM SPSS Statistics for Windows, Version 19.0. Armonk, NY, USA: IBM Corp.). Kolmogorov–Smirnov test was used for the determination of the data distribution. Results of demographic data and respiratory parameters were expressed as mean ± standard deviation (SD) and range values for both groups. The difference in parameters between the two groups was analyzed using an unpaired/independent *t*-test. At a confidence interval of 95%, the test was considered "highly significant" if it yielded $P < 0.001$. $P \leq 0.05$ is taken as "significant."

Results

The distribution of the TB patients and their accompanying non-TB family contacts ($n = 60$ each) according to their sociodemographic characteristics are as shown in Table 1. More TB patients (73.3%) had some degree of depression when compared to their family contacts (46.7%). Moderate-to-severe depression was observed in 36.7% of the TB patients and 26.6% of family contacts, whereas 23.3% of the TB patients and 13.3% of family contacts had moderate depression, and 6.7% of family contacts presented with mild depression. TB patients had a significantly higher mean PHQ-9 score when compared to their non-TB family contacts [Table 2 and Figure 1].

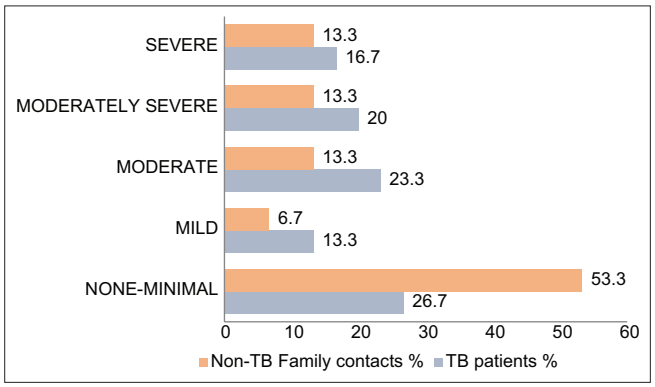

Figure 1: Frequency of level of depression among the tuberculosis patients and nontuberculosis family contacts

Table 1: Sociodemographic characteristics of participants

Characteristics	TB patients, *n* (%)	Non-TB family contacts, *n* (%)
Age		
≤24	4 (6.67)	10 (16.67)
25-44	25 (41.67)	22 (36.67)
45-59	23 (38.33)	26 (43.33)
≥60	8 (13.33)	2 (3.33)
Sex		
Male	46 (76.67)	24 (40.0)
Female	14 (23.33)	36 (60.0)
Marital status		
Married	54 (90.0)	50 (83.33)
Single	6 (10.0)	8 (13.33)
Separated/widowed	0	2 (3.33)
Education		
No formal education	0	0
Primary education	8 (13.33)	12 (20.0)
Secondary and above	52 (86.67)	48 (80.0)
Occupation		
Employed	0	0
Private	28 (46.67)	18 (30.0)
Student	0	6 (10.0)
Farmer/daily laborers	26 (43.33)	20 (33.33)
Unemployed	6 (10.0)	16 (26.67)
Family size		
1-2	0	0
3-5	42 (70.0)	42 (70.0)
>5	18 (30.0)	18 (30.0)
TB treatment duration (months)		
<3	10 (16.67)	NA
3-6	32 (53.33)	NA
>6	18 (30.0)	NA

NA: Not applicable, TB: Tuberculosis

Table 2: Comparison of depression and quality of sleep among the tuberculosis patients and nontuberculosis family contacts

Quality of sleep	Mean±SD		Significance (*P*)
	TB patients	Non-TB family contacts	
SSQ	1.70±1.07	0.45±0.50	0.000*
SL	1.96±0.95	1.43±1.01	0.004*
SD	2.10±1.11	0.76±0.53	0.000*
HSE	1.20±1.2	0.68±0.96	0.011*
SDi	1.66±0.70	0.91±0.69	0.000*
DD	1.33±1.01	0.16±0.375	0.000*
Global PSQI	9.56±3.97	4.36±2.07	0.000*
Depression (PHQ-9)	11.8±7.82	7.13±7.46	0.001*

*$P \leq 0.05$=Significant. SSQ: Subjective sleep quality score, SL: Sleep latency score, SD: Sleep duration score, HSE: Sleep efficiency score, SDi: Sleep disturbance component score, DD: Day time dysfunction score, TB: Tuberculosis, SD: Standard deviation, PSQI: Pittsburgh sleep quality index, PHQ-9: Patient health questionnaire-9

TB patients had a significantly higher mean global PSQI score compared to their non-TB family contacts ($P = 0.000$), similarly subjective sleep quality, sleep duration, sleep disturbance, and daytime dysfunction were also significantly more in TB patients, indicating a poorer sleep quality ($P = 0.000$). However, the PSQI sleep latency means that score among TB patients was high but with a comparatively lesser difference score among non-TB contacts ($P < 0.05$) [Table 2 and Figure 2].

Lung function measures were reduced in TB patients and the difference was significant compared to their non-TB family contacts [Tables 3 and 4]. Predicted mean FVC, FEV1, FEV1/FVC ratio, FEF 25%–75%, PEFR, and MVV were analyzed for both TB patients and their non-TB family contacts. Values for all measurements are expressed as mean (%) ± SD [Table 4]. Mean FVC and FEV1/FVC of TB patients were lower compared to non-TB family contacts; however, the difference was not statistically significant. Similarly, it was found that mean FEV1, FEF 25%–75%, and PEFR of TB patients were significantly lower than that of their non-TB family contacts [Table 4]. A significantly higher mean of MVV was observed among non-TB family contacts as compared to TB patients.

Table 3: Pulmonary function measures among the tuberculosis patients and their nontuberculosis family contacts

PFT parameter	Mean±SD	
	TB patients	Family contacts
FVC predicted	3.043±0.73	2.970±0.57
FVC actual	2.002±0.99	2.213±0.90
FVC (% pred)	65.20±26.5	72.20±19.1
FEV1 predicted	2.533±0.61	2.543±0.48
FEV1 actual	1.485±0.56	1.824±0.67
FEV1 (% pred)*	57.73±21.5	69.53±15.8
FEV1/FVC predicted	82.35±1.45	85.68±3.05
FEV1/FVC actual	76.38±18.9	83.13±11.6
FEV1/FVC (% pred)	92.93±23.3	98.11±12.8
$FEF_{25\%-75\%}$ predicted	3.116±0.69	3.286±0.61
$FEF_{25\%-75\%}$ actual	1.415±1.44	1.869±0.81
$FEF_{25\%-75\%}$ (% pred)*	38.76±21.9	56.05±19.8
PEFR predicted	7.264±1.14	6.589±1.16
PEFR actual	2.344±1.08	2.873±1.24
PEFR (% pred)*	31.23±12.7	43.03±14.5
MVV predicted	99.40±22.9	97.43±16.5
MVV actual	50.48±24.4	58.13±22.1
MVV (% pred)*	48.03±19.2	57.88±16.3

*$P \leq 0.05$=Significant. % pred: Percentage predicted value, TB: Tuberculosis, SD: Standard deviation, FVC: Forced vital capacity, FEV1: Forced expiratory volume in 1 s, PEFR: Peak expiratory flow rate, MVV: Maximal voluntary ventilation, FEF: Forced expiratory flow

Table 4: Comparison of pulmonary function measures among the tuberculosis patients and nontuberculosis family contacts

Quality of sleep	Mean±SD		Significance (*P*)
	TB patients	Non-TB family contacts	
FVC	65.2±26.5	72.2±19.06	0.100
FEV1	57.7±21.52	69.5±15.85	0.001*
FEV1/FVC	92.9±23.35	98.1±12.88	0.135
$FEF_{25\%-75\%}$	38.7±21.94	56.0±19.83	0.000*
PEFR	31.2±12.73	43.0±14.49	0.000*
MVV	48.0±19.27	57.8±16.34	0.003*

*$P \leq 0.05$=Significant. TB: Tuberculosis, SD: Standard deviation, FVC: Forced vital capacity, FEV1: Forced expiratory volume in 1 s, PEFR: Peak expiratory flow rate, MVV: Maximal voluntary ventilation, FEF: Forced expiratory flow

Discussion

According to the WHO, any disease will impact not only on physical health but also on all other aspects of an individual's health. Thus, the present study was undertaken to assess the different psychological aspects and sleep quality of TB patients and their family contacts.

The relationship between TB and depression can be said to be complex as observed in the present study. These results are in line with Amy, Hyman, and Guruge's meta-analytical study, which looked at 31 studies on the prevalence of depression and other mental disorders in TB patients and found that 46%–72% of TB patients suffer from depression and anxiety, which has a direct impact on their quality of life.[21] In another research, Ruiz-Grosso *et al*. identified all grades of depression in TB patients (extreme, severe, and moderate).[12] In the study by Amole and others, higher rates of depression and anxiety were also recorded.[13] Several studies have shown that these patients have low self-esteem, social alienation, fear of prejudice, or acceptability that is higher than enacted stigma, all of which predispose them to common mental disorders.[14] In addition to the aforementioned causes, psychological and economic services available, as well as prolonged therapy with several potentially harmful medications, all contribute to active TB patients' poor quality of life.[22,23] The development of depressive disorder has been recognized as a cause of poor treatment compliance and poor disease outcomes, like

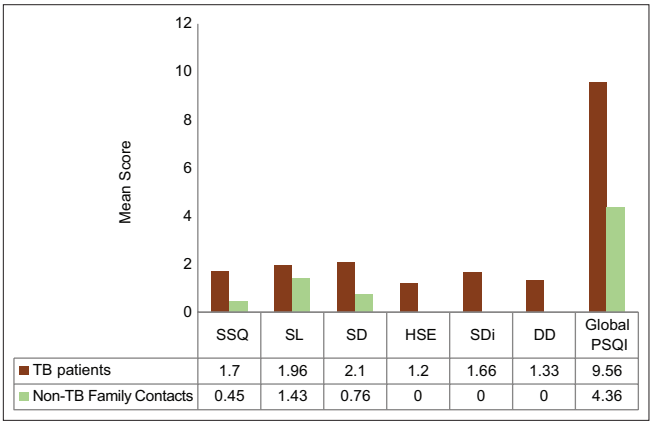

Figure 2: Quality of sleep among the tuberculosis patients and nontuberculosis family contacts

treatment default or death as observed in a retrospective cohort analysis among 440 patients suffering from TB.[24] Results reveal that 46.7% of primary caregivers (i.e., in the current scenario the family members) had some degree of depression thus highlighting the concerns regarding these public health problems.

Several potential factors such as worrying about TB infection in themselves, demand for continuous care for their household TB cases, and hence financial burdens due to reduced work opportunities, may explain the psychological distress and depression among family contacts in this study.[15,25] Under such stressful conditions imparting care becomes a day full-time activity for many caregivers.[26] When keeping in mind the extent of care provided and the sacrifices made, the adverse outcomes occurring in these caregivers such as depression seen in this study had made treating depression a great public health challenge and the same has been replicated in this study. However, those family members who require treatment for these adverse outcomes as evident from their clinical evaluation may not be interested to share in discussing these matters or taking the treatment for the same. The current scenario is that majority of caregivers who fall and meet the criteria for a psychiatric consultation do not have the opportunity or access to mental health treatment and do not consider this an additional concern. This study supports the notion that some protection against depression can be achieved through an extended family system.

It is well established that cognitive performance and work productivity, as well as physical, psychological, and emotional well-being in humans, are essentially associated with sleep quality.[7,8] Sleep disruption may involve a variety of phenomenological entities ranging from sleep disturbances (such as insomnia) and sleep disturbance (exemplified by arousals/awakenings, altered sleep onset or length, or irregular sleep architecture), to disrupted or delayed sleep due to physical symptoms such as pain, cough, or sputum secretion. Various diseases and increased all-cause mortality tend to arise from longer-term sleep deprivation. Several factors, more commonly, shift work, emotional stress, disrupted sleep, and chronic medical conditions may lead to restricted sleep duration and sleep fragmentation.[9]

Numerous studies have examined the function and mechanisms of sleep from a biomedical perspective, but few studies have systematically examined the experience of the quality of sleep.[10,11,27] Many studies have reported that the majority of patients with chronic diseases like obstructive lung diseases suffer from poor sleep quality. The reasons associated with sleep deprivation in such patients are multifactorial include respiratory symptoms, obstructive sleep apnea, psychiatric disorders, and medication-related insomnia. However, the factors resulting in sleep disturbance are not well understood. The disturbed sleep in chronic lung diseases is at times correlated with cough and dyspnea symptoms, and in addition, whether presently using pulmonary medications for chronic diseases could improve or impair sleep quality is not well known.[28] In TB patients, psychological disorders, mainly depression, are common and have a significant impact on people's lives, including sleep deprivation.[11] Chronic deprivation of sleep rather than acute lack of sleep may lead to depression that is potentially attributable to the neurochemical changes in the brain. Depression, on the other hand, can lead to deprivation of sleep that may manifest as a symptom of a mood disorder. Short sleep duration is increasing in prevalence worldwide with a concurrent increase in depressive symptoms, mainly among the population with chronic diseases.[29] Epidemiological reporting of sleep disturbance in TB patients is limited, and in our study, the cause of poor sleep quality among the TB patients is not entirely clear, however, it can be indirectly implied that depression and poor quality of sleep are closely linked and appear to have a bidirectional relationship where sleep deprivation exaggerates depression and vice versa.[11]

Damage to bronchi results from extensive fibrotic changes or endobronchial stricture, as tuberculous sequelae cause airflow obstruction.[3,4] TB accounts for a significant portion of chronic airflow obstruction, and hence to evaluate lung function and related clinical issues in patients who suffer from TB, and also have compared the various lung function parameters with their non-TB family contacts. In our study, a decrease in mean FVC and FEV1 among TB patients was evident when compared to their family contacts. This is similar to a study conducted in Dar es Salaam by Manji *et al*. which shows the reduction in FVC, in FEF, PEFR, MVV functions in TB patients when compared to their non-TB family contacts and also concluded that TB patients with a longer duration of TB have a very highly significant reduction in their FVC.[30] FEVI/FVC ratio is a more sensitive indicator of airway obstruction than FVC or FEV1 alone; however, it did not show a significant difference among TB patients when compared with their family contacts.

Limitations

This cross-sectional research was conducted at designated treatment sites to evaluate depression, sleep, and pulmonary function-related factors in TB patients and their non-TB family contacts, but it was unable to establish the predictors and their ways of impacting poor sleep quality. Although the sample sizes were moderate, they were adequate for comparisons within the site. Clinical samples were selected to represent the patient population of the well-functioning TB control programs at the study sites, but they were not intended to represent a profile of TB for the entire country or even the community where the treatment site is located. Because the study was based at diverse TB clinic sites, the question of how to generalize findings must be considered carefully.

Conclusions

The present study shows that TB patients may have poor lung function compared to their non-TB family contacts. There is a possible higher prevalence of depression and poor quality of

sleep in this population. Based on the study's overall findings, it is fair to conclude that TB and mental health problems may have a close relationship. If this dynamic relationship goes unnoticed, it may lead to worse TB prognoses. Our study findings can serve as important implications for the physicians and pneumologists to regularly formulate strategies for screening mental health problems in people with TB and others who care for them daily, for better outcomes and meeting treatment goals.

Acknowledgment

We thank Mr. Syed Ghouse Mohiuddin, Laboratory Technical Assistant, AIIMS, Mangalagiri for providing the technical support throughout the data collection.

Financial support and sponsorship

Partially funded by TB Association of India under Financial assistance to short-term research projects (2019–2020). (tbassnindia/boi/cheque no. 344278, dated December 5, 2019).

Conflicts of interest

There are no conflicts of interest.

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