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EFFECTIVENESS OF THE ACTIVE CYCLE OF BREATHING TECHNIQUE ON SPUTUM EXCRETION AND AIRWAY CLEARANCE IN PATIENTS WITH COPD: A SYSTEMATIC REVIEW

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ABSTRACT
The Active Cycle of Breathing Technique (ACBT) is a non-invasive technique for clearing the airways. It consists of three main components: breathing control, thoracic expansion, and forced expiration techniques (huffing and coughing). This method is used in patients with lung disorders to reduce congestion, help expel secretions, increase oxygen flow to the lungs, and restore respiratory muscle function. This study aims to compare ACBT therapy in COPD patients with sputum excretion and airway clearance. A systematic review was conducted on 8 research articles from various databases such as ScienceDirect, Clinical Key, EBSCOhost, ProQuest, Sage Journals, Scopus, Cocharane, Mendeley. The selected research design used a randomized controlled trial and quasi-experimental between 2009 - 2023 with a sampling technique using purposive sampling, which discussed ACBT in COPD patients. Data were collected through a database search using the keywords ("Active Cycle of Breathing Technique" OR "ACBT") AND ("Chronic Obstructive Pulmonary Disease" OR "COPD. From 315 identified articles, 48 were screened based on title and abstract, and 8 articles met the inclusion criteria for analysis. The inclusion criteria were adult COPD patients, ACBT intervention (alone or combined), and outcomes related to sputum expectoration or airway clearance. Each article was critically appraised using the Joanna Briggs Institute (JBI) Critical Appraisal Tool to ensure quality and minimize bias. The majority of studies have shown that ACBT significantly contributes to increased expected sputum volume, improved lung function (FEV1/FVC), increased oxygen saturation, and patient comfort and satisfaction. However, there are also some studies that show similar effectiveness between ACBT and other techniques such as the Flutter device or conventional therapy. ACBT is an effective, safe, and feasible nursing intervention that can be integrated into the management of COPD patients, especially for improving airway clearance and sputum expectoration

Keywords: ACBT; airway clearance; breathing techniques; COPD; sputum

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INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is defined as a heterogeneous pulmonary disorder characterized by chronic respiratory symptoms (dyspnea, cough, sputum production) due to airway (bronchitis, bronchiolitis) and/or alveolar (emphysema) abnormalities, leading to persistent and often progressive airflow limitation (Budhi Antariksa et al., 2023). Its symptoms include cough—sometimes with sputum—shortness of breath, wheezing, and fatigue (World Health Organization, 2024). COPD is the fourth leading cause of death worldwide, accounting for 3.5 million deaths in 2021 and approximately 5% of all global deaths. In low- and middle-income countries, nearly 90% of COPD-related deaths occur in individuals under the age of 70 (World Health Organization, 2024). In Indonesia, an estimated 4.8 million people live with COPD, with a prevalence rate of 5.6%, according to the Indonesian Guidelines for the Diagnosis and Management of COPD published by PDPI in 2023 (GSK, 2023).

The Active Cycle of Breathing Technique (ACBT) is an airway clearance technique consisting of three main components: breathing control, thoracic expansion exercises, and the forced expiration technique (huffing and coughing). This method is applied in patients with pulmonary disorders to reduce dyspnea, facilitate sputum expectoration, improve oxygen flow to the lungs, and restore respiratory muscle function (Aditya Denny Pratama, 2021). A study by Endria et al. (2022) demonstrated that implementing ACBT in pulmonary tuberculosis patients with bronchiectasis for seven days improved oxygenation status, reduced sputum volume, and alleviated dyspnea, indicating the technique's effectiveness in enhancing airway clearance.

Although several studies have evaluated the effectiveness of ACBT in COPD patients, the results remain inconsistent. Some studies reported that ACBT improved sputum production, pulmonary function, and oxygen saturation (Shen, Guo, et al., 2021; Abdel Halim et al., 2016), while others found no significant differences compared to conventional physiotherapy (Syed et al., 2009; Gulati, 2020). Furthermore, combined approaches—such as ACBT with phonophoresis or autogenic drainage—have been emerged, requiring further investigation to evaluate additional benefits. These inconsistencies highlight the need for a systematic review to synthesize the existing scientific evidence regarding the effectiveness of ACBT. The aim of this systematic review is to critically and comprehensively evaluate the effectiveness of ACBT in improving airway clearance in patients with COPD, with a specific focus on measurable sputum outcomes.

METHOD

This review was structured using the PICO framework. The study population consisted of adult patients diagnosed with Chronic Obstructive Pulmonary Disease (COPD). The intervention examined was the Active Cycle of Breathing Technique (ACBT), either administered alone or in combination with other interventions. Comparisons were made with standard interventions such as chest physiotherapy, flutter devices, O-PEP therapy, or control groups without intervention. The primary outcomes assessed were sputum expectoration and airway clearance. In addition, several secondary outcomes were analyzed, including lung function (FEV1/FVC, PEFR), oxygen saturation, respiratory symptoms (dyspnea, cough), quality of life, patient comfort, and self-efficacy.

Inclusion and Exclusion Criteria

This review included studies that met the following inclusion criteria: adult patients diagnosed with COPD; ACBT as the main intervention, either used alone or combined with other methods; studies comparing ACBT with conventional care or a control group without intervention; and studies that evaluated at least one relevant clinical outcome such as sputum volume or viscosity, lung function (FEV1/FVC, PEFR), oxygen saturation, quality of life, respiratory symptoms (dyspnea and cough), patient comfort, exercise adherence, or self-efficacy.

Studies were excluded if they did not evaluate ACBT as a main component of the intervention, involved pediatric or adolescent populations, did not assess clinical outcomes related to airway clearance, or if the full text was unavailable or data were insufficient for systematic analysis.

Study Identification

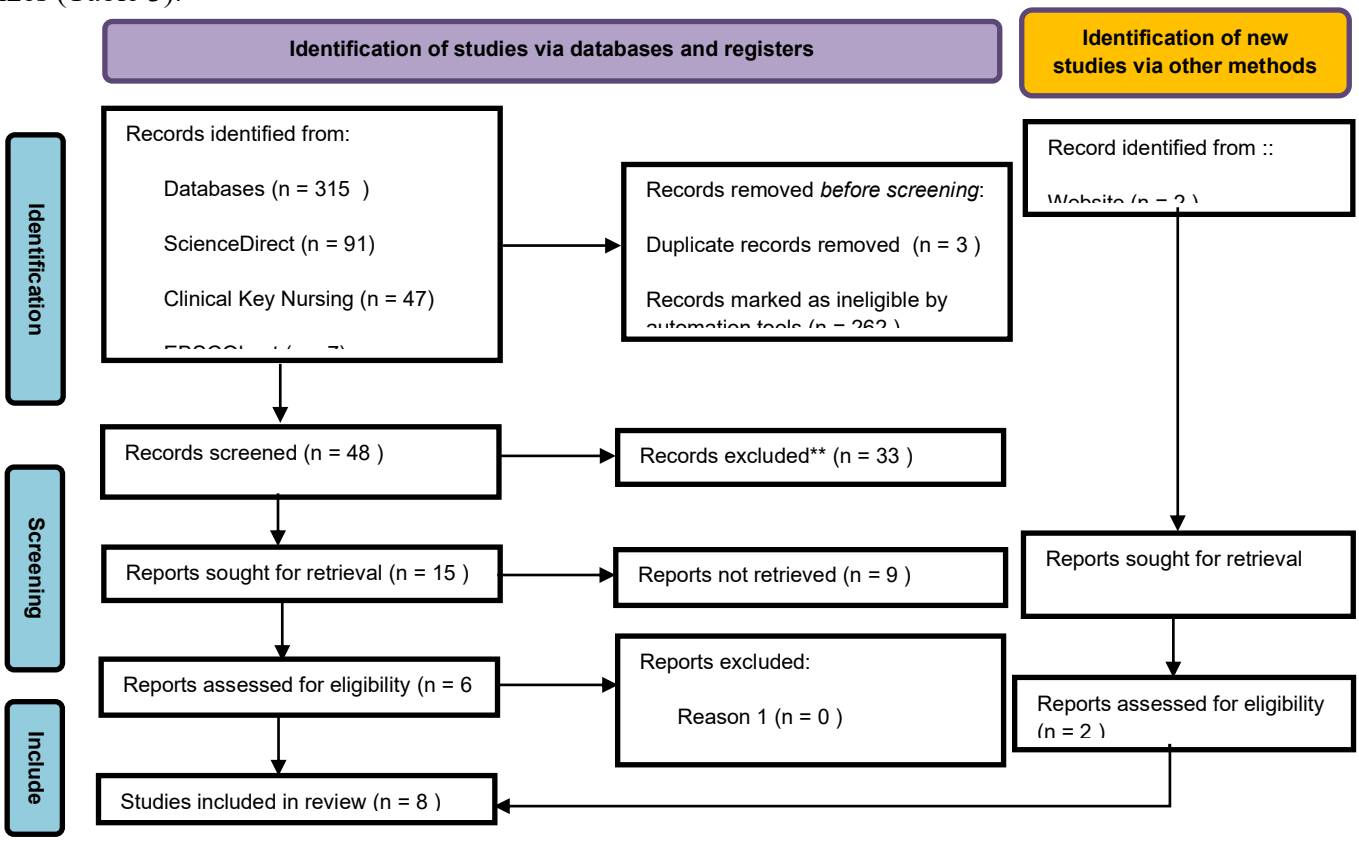
A total of eight studies met the inclusion criteria, with varied research designs including randomized controlled trials (RCTs) and quasi-experimental studies. These studies were conducted in various countries—China, India, Egypt, and Australia—reflecting diverse clinical and patient backgrounds. Shen, Li, et al. (2021) conducted a pragmatic RCT evaluating the effectiveness of ACBT on sputum production and viscosity, FEV1/FVC ratio, and oxygen saturation among COPD patients. Shen, Guo, et al. (2021) examined ACBT combined with phonophoresis and found that the combination was more effective than ACBT alone in improving lung function and airway clearance.

Li et al. (2024) used a quasi-experimental design in China, combining ACBT with a psychosocial approach based on hope theory, which significantly improved exercise adherence, cough effectiveness, sputum expectations, and self-efficacy.

From India, Gulati (2020) compared ACBT and autogenic drainage with conventional physiotherapy. Both groups showed symptom improvement, but the ACBT group demonstrated better results in reducing cough frequency. Earlier, Syed et al. (2009) compared ACBT with conventional chest physiotherapy in bronchiectasis patients and found no significant differences in sputum volume or lung function; however, patients rated ACBT as more comfortable. In Egypt, Abdel Halim et al. (2016) conducted a quasi-experimental study comparing ACBT combined with postural drainage versus conventional physiotherapy in bronchiectasis patients, showing significant improvements in sputum volume and PaO_2. Phillips et al. (2023) from Australia developed an RCT protocol comparing ACBT, O-PEP therapy, and walking with huffing in bronchiectasis patients. Although data collection is ongoing, the study provides a comprehensive framework for evaluating sputum clearance, quality of life, and exacerbation outcomes. Finally, Katke and Anthikat (2020) conducted a comparative experimental study between ACBT and the flutter device in COPD patients, finding that the flutter device was significantly more effective in improving the FEV1/FVC ratio and reducing dyspnea.

Study Selection

The systematic review was conducted through a comprehensive literature search across major databases including ScienceDirect, ClinicalKey, EBSCOhost, ProQuest, Sage Journals, Scopus, Cochrane, and Mendeley. Boolean operators used were: ("Active Cycle of Breathing Technique" OR "ACBT") AND ("Chronic Obstructive Pulmonary Disease" OR "COPD"). The inclusion criteria for articles were RCTs or quasi-experimental designs, adult COPD patients, airway clearance outcomes, and full-text availability. Study quality was assessed using the Joanna Briggs Institute (JBI) Critical Appraisal Tool. Most studies demonstrated good methodological quality, although some limitations were identified regarding randomization, blinding, and small sample sizes (Table 3).



Picture. 1. PRISMA Flowchart

Only full-text and open-access studies focusing on ACBT among COPD patients were included. The article selection process followed the PRISMA flow diagram (Figure 1), consisting of identification, screening, eligibility assessment, and inclusion stages. Some articles were retrieved manually due to restricted database access. The selected studies were then analyzed based on objectives, methods, samples, measurement tools, and relevant findings.

Data Extraction

The extracted information was as follows: study design, authors and year of publication, number, age and sex of patients, disease type, type of intervention and comparator, participant preferences, and outcome measures. Data extracted from the studies included in the systematic review are presented in Tables 1 and 2.

Table 1.
Research Design, Duration and Participant Characteristics

Study	Study design	Duration of intervention	Participants' number and gender	Participants' disease and age
Shen et al., 2021	RCT	1 week, 2x/day (15-20 minutes)	42 p/58 w	COPD (54.89 ± 12.06 years)
Meng Li et al., 2021	*Quasi-experiment*	8 weeks	53 p/12 w	COPD <60 years, n=5 (7.7%) 60–69 years: n=21(32.3%) 70–79 years: n= 39(60%)
Nafeez Syed, Arun G. Maiya, & Siva Kumar T., 2009	RCT	Each session lasts one day, with a minimum of 12 hours between sessions. Each session lasts 20–30 minutes, every 3 hours during waking hours (approximately 1 hour per session).	27 p/8 w	COPD (45.8 ± 11.2 years)
Hesyam Abdel Halim et al., 2015	*Quasi-experiment*		20 p/10 w	COPD (51.56 ± 15 years)
Shen et al., 2021	RCT	1 week (during hospitalization). Twice a day (20 minutes)	75 participants	COPD Adult. Age (Not stated)
Mohit Gulati et al., 2020	RCT	-	20 participants	COPD (40 – 70 years)
Jennifer Phillips et al., 2023	RCT	inpatient period + 6 months follow-up	51 participants	Age: ≥18 years (adult), no upper age limit
Sneha Katke and Manal, 2020	RCT	2 weeks (15 minutes, one session per day)	60 participants	COPD. Age: 35–45 years

Table 2.
Outcome Measurement

Study	Intervention and Comparators	Sputum viscosity	Sputum production	(FEV1/FVC ratio)	Arterial oxygen saturation	COPD assessment test (Quality of life)	Dyspnea	self-efficacy.	VASE
Shen et al., 2021	ACBT (n=50) vs Usual Care (n=50)	Measured using a viscometer, with the results being changes in sputum viscosity values from baseline to the end of the intervention.	the volume of sputum collected by the patient within 1 hour and 24 hours after the intervention, using a special calibrated container	Describes lung function and is measured repeatedly, then the three best results are taken.	pulse oximeter while the patient is at rest	Chronic Obstructive Pulmonary Disease Assessment Test (CAT), a COPD-specific questionnaire			
Meng Li et al., 2021	Snyder's Hope Theory, with ACBT (n=35) vs Routine care (Effective coughing exercises) (n=35)		Coughing ability and sputum evacuation were compared between the two groups after 14 days	The patient's peak expiratory flow rate was measured with a peak velocity meter from				The internal consistency of the Chinese version of the Ex-SRES was	

Study	Intervention and Comparators	Sputum viscosity	Sputum production	(FEV1/FVC ratio)	Arterial oxygen saturation	COPD assessment test (Quality of life)	Dyspnea	self-efficacy.	VASE
			of admission.	Shanghai Marubo Technology, China.				0.925, indicating good homogeneity reliability.	
Nafeez Syed et al.,2009	ACBT and CPT		No statistically significant differences were found between ACBT (p = 0.751), ACT (p = 0.630).	Significant increase in FEV1/FVC ratio pre- and post-therapy in both groups, but no significant difference between the two techniques					ACBT comfort (p = 0.004). The majority of patients felt more comfortable with ACBT than conventional therapy.
Hesyam Abdel Halim et al., 2015	ACBT (n=15) + Postural Drainage Vs Conventional Chest Physiotherapy (n=15)		ACBT + Postural Drainage was significantly more effective in increasing the volume of wet sputum expelled than conventional therapy.	There was no significant difference in pulmonary function results after the intervention.	The ACBT group showed better improvements in PaO2 and PAO2 than the conventional group. PAO2: t = -6.775, p = 0.000 (significant)				
Shen et al., 2021	ACBT + Phonophoresis (n=25) vs ACBT (n=25) vs Phonophoresis (n=25)	The combination of ACBT + phonophoresis is predicted to be the most effective compared to single intervention	sputum volume within 1 hour and 24 hours after intervention	spirometry: FEV1, FVC, FEV1/FVC ratio	SPO2				
Mohit Gulati et al., 2020	ACBT + Autogenic Drainage (n=10) vs Conventional Physiotherapy		Direct comparison between the two groups did not show a significant difference (p=1.00), possibly due to the small sample size.				There was no statistically significant difference between the two groups for the reduction of dyspnea (t-value: -1.244. p-value: 0.229) (not significant)		
Jennifer Phillips et al., 2023	ACBT vs O-PEP therapy vs Walking with huffing		Measured during and 1 hour after the therapy session, as			Health-related quality of life (HRQOL)			

Study	Intervention and Comparators	Sputum viscosity	Sputum production	(FEV1/FVC ratio)	Arterial oxygen saturation	COPD assessment test (Quality of life)	Dyspnea	self-efficacy.	VASE
	(control)		well as within 24 hours						
Sneha Katke and Manal, 2020	ACBT (n=30) vs Flutter devices (n=30)			Flutter: 65.87 ± 6.02 vs ACBT: 55.73 ± 4.27 p-value: <0.001 (Flutter is more effective in increasing FEV1/FVC)					Flutter: 2.60 ± 0.99 vs ACBT: 4.67 ± 0.90 p-value: <0.001 (Flutter is more effective in reducing breathlessness)

Quality Assessment

Table 3.
Study Quality Methodology Assessed Based on the JBI Scale

Studies	Random allocation	allocation to treatment	Baseline comparability	Blind Treatment	Blind therapists	Treatment groups	Blind assessors	Outcomes measured in the same way	Outcomes measured in a reliable way	Follow up	Analysed in the groups	Appropriate statistical	Trial design appropriate	SUM
Shen et al.,2021	YES	YES	YES	NO	NO	NO	YES	YES	YES	YES	YES	YES	YES	10
Nafeez Syed et al.,2009	YES	NO	YES	NO	UC	YES	UC	YES	YES	YES	YES	YES	YES	9
Shen et al.,2021	YES	UC	YES	UC	UC	YES	UC	YES	YES	YES	YES	YES	YES	9
Mohit Gulati et al.,2020	UC	UC	YES	NO	NO	YES	NO	YES	YES	YES	YES	YES	YES	8
Jennifer Phillips et al.,2023	YES	YES	YES	NO	NO	YES	YES	YES	YES	YES	YES	YES	YES	11

Table 4.
Methodological quality of studies assessed by JBI scale on quasi-experimental

Studies	Cause and effect	control group	Comparison of partisipant	comparisons receiving similar treatment	measurements of the outcome	outcomes of participants	outcomes measured in a reliable	Follow up	statistical analysis	SUM
Meng Li et al.,2021	YES	YES	YES	YES	YES	YES	YES	YES	YES	9
Hesyam Abdel Halim et al.,2015	YES	YES	YES	YES	YES	YES	YES	YES	YES	9
Sneha Katke and Manal,2020	YES	YES	YES	YES	YES	YES	YES	YES	YES	9

Data Analysis

Eight studies that met the inclusion criteria were analyzed descriptively to illustrate the patterns of findings and the effectiveness of the Active Cycle of Breathing Technique (ACBT) on airway clearance and respiratory function in patients with chronic lung diseases such as COPD. Data collected from these studies indicated that most employed quantitative experimental methods, primarily randomized controlled trials and quasi-experimental designs, with sample sizes ranging from 20 to over 100 participants. The duration and frequency of ACBT interventions varied, from one session per day for two weeks to twice daily during hospitalization, reflecting differences in

protocol implementation. The analysis focused on the primary outcomes of sputum expectoration and airway clearance. Secondary outcomes include lung function (FEV1/FVC, PEFR), oxygen saturation, respiratory symptoms (dyspnea, cough), quality of life, patient comfort, and self-efficacy. The findings from each study were compared and analyzed based on the reported results without conducting a meta-analysis, as not all studies presented data in a standardized statistical format (eg, mean ± SD, confidence interval, or uniform effect size). All data were manually extracted into a summary table containing study characteristics, intervention and control groups, and key outcomes. These results were then used to identify patterns of effectiveness, similarities and differences among studies, and the potential clinical benefits of implementing ACBT in patients with chronic pulmonary disorders.

RESULT

Overall, most studies demonstrated that ACBT contributed to increased sputum expectoration and improved airway clearance—the primary outcomes of this review. For example, Shen, Li, et al. (2021) reported a significant increase in sputum volume within 24 hours in the ACBT group compared to the control group ($p = 0.025$), along with improved FEV1/FVC ratio and oxygen saturation ($p < 0.0001$ and $p = 0.003$). Similarly, Abdel Halim et al. (2016) found that ACBT combined with postural drainage significantly improved sputum volume and PaO_2 compared to conventional chest physiotherapy ($p < 0.05$).

Beyond the primary outcomes, several studies reported additional benefits on secondary outcomes. Shen, Guo, et al. (2021) demonstrated that combining ACBT with phonophoresis was more effective than either intervention alone in improving lung function and reducing sputum viscosity ($p < 0.05$). Likewise, Li et al. (2024), who integrated ACBT with a psychosocial "hope theory" approach, reported significant improvements in exercise adherence, cough ability, sputum clearance, and self-efficacy ($p < 0.05$). However, not all studies yielded consistent results. Syed et al. (2009) found no significant differences between ACBT and conventional physiotherapy in sputum volume or lung function, although ACBT was rated more comfortable by patients ($p = 0.004$). Similarly, Gulati (2020) found that ACBT with autogenic drainage was better at reducing cough than conventional physiotherapy, but no significant difference was observed in dyspnea reduction.

A comparative study by Katke and Anthikat (2020) revealed that the flutter device was significantly more effective than ACBT in reducing dyspnea and improving FEV1/FVC ($p < 0.001$). Phillips et al. (2023) designed a long-term RCT protocol comparing ACBT, oscillating PEP therapy, and walking with huffing among bronchiectasis patients, focusing on sputum clearance, quality of life, and exacerbation rates over six months, although final results are pending. Overall, the review indicates that ACBT is an effective intervention for enhancing sputum expectoration and airway clearance. Its effectiveness also extends to secondary outcomes such as improved lung function, oxygen saturation, quality of life, and patient comfort. However, in some cases, alternative interventions like flutter devices appear superior in improving pulmonary function and reducing respiratory symptoms—especially when used in combination. The variability in outcomes, small sample sizes, and differences in measurement methods highlight the need for further research with stronger designs and larger populations.

DISCUSSION

The findings of this review demonstrate that ACBT consistently improves sputum clearance and airway patency, supporting its primary role in respiratory physiotherapy to mobilize and eliminate secretions. Additionally, several studies reported secondary benefits, including improved lung function (FEV1/FVC), oxygen saturation, reduced dyspnea, enhanced quality of life, and greater comfort. Combining ACBT with other interventions—such as phonophoresis or psychosocial approaches—yielded better outcomes than ACBT alone, suggesting that multimodal approaches

may optimize therapeutic benefits. However, not all studies found significant differences. The study by Syed et al. reported no marked distinction between ACBT and conventional chest physiotherapy, possibly due to short intervention duration and small sample size, implying that ACBT effectiveness may depend on treatment frequency and consistency.

Nevertheless, some limitations must be acknowledged. Most studies had small sample sizes, limiting generalizability. Variations in intervention duration and frequency also reduced comparability across studies. Additionally, incomplete reporting of randomization and blinding methods introduced potential bias, while differing measurement tools and analytic approaches made synthesis difficult. Future research should therefore employ stronger RCT designs, larger samples, and longer follow-up periods. Studies exploring ACBT combined with psychological or mechanical adjuncts could further identify the most effective strategies for optimizing airway clearance and quality of life in chronic lung disease patients.

CONCLUSION

This review concludes that ACBT effectively improves sputum expectations and airway clearance (primary outcomes) and positively impacts lung function, oxygen saturation, quality of life, and patient comfort (secondary outcomes). The technique is safe, simple to teach, and feasible for integration into nursing practice. Within evidence-based nursing practice (EBP), ACBT can be incorporated as a routine intervention in pulmonary rehabilitation programs across healthcare settings or home care. However, variations in study results indicate the need for further large-scale and long-term research to confirm its effectiveness and explore innovative combinations of ACBT with other interventions tailored to patient conditions.

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