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Impact of Prone Position on Oxygen Saturation and Dyspnea Patients : Systematic Review

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Abstract

Impact of Prone Position on Oxygen Saturation and Dyspnea Patients : Systematic Review

Background. Respiratory distress is one of the leading causes of morbidity and mortality, especially in vulnerable populations such as patients with chronic lung disease, pneumoniaand acute respiratory distress syndrome (ARDS). One non-invasive approach that has been shown to be effective in increasing oxygen saturation and reducing shortness of breath is the prone position. This position refers to the prone sleeping position, where the patient lies face down. Objective to increase oxygen saturation and reduce shortness of breath Method A systematic review approach through searching articles tailored to the formulation of researchquestions with the PEO formulation in seven databases namely Scopus, ScienceDirect, Pubmed, Proquest, Sage Journals, Oxford, Wiley Results in the analysis it was found that theprone position is very effective in increasing oxygen saturation and reducing patientshortness of breath especially when combined with other pharmacological treatments.Conclusion is that the prone position performed for 12 hours/day is very effective in increasing saturation,
increasing oxygenation and reducing the number of intubated patients

Introduction

Respiratory disorders are one of the main causes of morbidity and mortality, especially in vulnerable populations such as patients with chronic lung disease, pneumonia, and acute respiratory distress syndrome (ARDS). In 2019, chronic respiratory diseases were one of the leading causes of death in the world, ranking third, affecting around 454 million people. The cases continue to increase from year to year. Based on the 2019 Global Burden of Diseases report released by the Institute for Health Metrics and Evaluation (IHME), Indonesia has a fairly high number of respiratory disease cases, including pneumonia, asthma, chronic obstructive pulmonary disease (COPD) and lung cancer. Specifically, the incidence of several respiratory diseases in Indonesia is: pneumonia reaching 5,900 cases per 100 thousand population, asthma as many as 504 cases per 100 thousand population, COPD recorded 145 cases per 100 thousand population, and lung cancer as many as 18 cases per 100 thousand population (PDPI, 2024).

One non-invasive approach that has been shown to be effective in increasing oxygen saturation and reducing shortness of breath is the prone position. This position refers to the prone sleeping position, where the patient lies face down. (Sunarti, 2022).

Acute respiratory distress syndrome (ARDS) continues to be a major cause of morbidity and mortality in critically ill patients, with mortality rates reaching 40% in severe cases. Currently available therapies include the use of neuromuscular blocking agents (NMBs) and prone positioning. The goal of these strategies is to reduce transpulmonary pressure, lung stress, and tissue strain. In addition, NMB use can reduce oxygen consumption by reducing muscle activity, thereby increasing systemic oxygenation. However, the application of the prone position and NMB in clinical practice varies. The prone position is recommended for use in the early stages of moderate to severe ARDS for more than 16 hours. On the other hand, there is no clear guidance on the role of NMB in patients receiving ventilation in the prone position (Rollinson et al., 2024).

The results of the study showed that the prone position can increase lung perfusion and distribution of ventilation, which in turn can improve oxygen saturation. By changing body position, pressure on the lungs can be reduced, allowing previously compressed alveoli to open, thereby improving ventilation and perfusion in the area healthy lungs. This is very important, especially in patients with respiratory disorders who experience hypoxemia (low blood oxygen levels) (Guérin et al., 2015).

Several studies have shown that patients with ARDS or pneumonia experience significant improvements in oxygen saturation and decreased shortness of breath after being placed in the prone position. However, despite these proven benefits, not all patients can tolerate this position, so it is important to carefully evaluate patient's condition before applying it. Research conducted by (Wang et al., 2024), stated that compared to the supine position the prone position increases distribution of ventilation, reducing ventilation in the dorsal area and moving the center of ventilation from ventral to the dorsal area. They found that EIT captured changes in the distribution of real-time lung ventilation. The prone position can significantly increase COV and the distribution of ventilation moves from the ventral to the dorsal area.

According to (Chaudri et al., 2024)4) the prone position remains one of the few interventions proven to reduce mortality in Acute Respiratory Distress Syndrome (ARDS). They discussed a complex case of abdominal compartment syndrome (ACS) requiring fascial release and open abdomen complicated by severe ARDS. Where patients with ARDS and ACS with an open abdomen were successfully treated with prone safely and successfully. Based on this description, researchers are interested in examining the effect of the prone position in increasing oxygen saturation and reducing shortness of breath in patients with respiratory disorders. The aim of this study was to find prone position interventions that can increase oxygen saturation and reduce tightness.

Method

Design and

Objectives This research uses a systematic article review approach. Screening of articles considered worthy and of high quality as references in this study was carried out using the *Joanna Briggs Institute* (JBI) methodology to find prone position interventions that can increase oxygen saturation and reduce shortness of breath.

Search method

The article search in this study was carried out systematically and carefully to find several research articles that examined the prone position with *a randomized controlled trial and cohort design*. The article search was carried out on seven databases, namely Scopus, ScienceDirect, Pubmed, Proquest, Sage Journals, Oxford, Wiley using the keywords *"Prone Position AND Respiratory Disorder AND Dyrpnea"*.

Article Selection Criteria

Selection of articles is based on the PIO method which consists of (1) Population: Patients with respiratory disorders (2) Intervention: prone position (3) Outcome; increased oxygen saturation and reduced shortness of breath. The included research designs are *randomized controlled trials and cohorts*, with the language of instruction being English, published from 2014 to 2024. Apart from the criteria mentioned, the article will not be included in the review.

Data Extraction and Quality Assurance

Articles that have passed the selection criteria are then evaluated for quality using the assessment instrument for *randomized controlled trials and cohorts* released by the proven institution, namely *the Joanna Briggs Institute (JBI).*

Results

Characteristics of the

Study the search began by obtaining as many as 367,249 articles, after selection using the year, type of article, English only, *full text, randomized controlled trial, Cohort, Cross sectional,* open access and *respiratory* area specialty 291 were obtained, then re-selection based on the title and abstract obtained 14 articles, screening continued for articles that were not in the form of protocols and research plans and duplication obtained 5 articles. These five articles through critical appraisal have met the requirements so that they are included in the review (Figure 1)

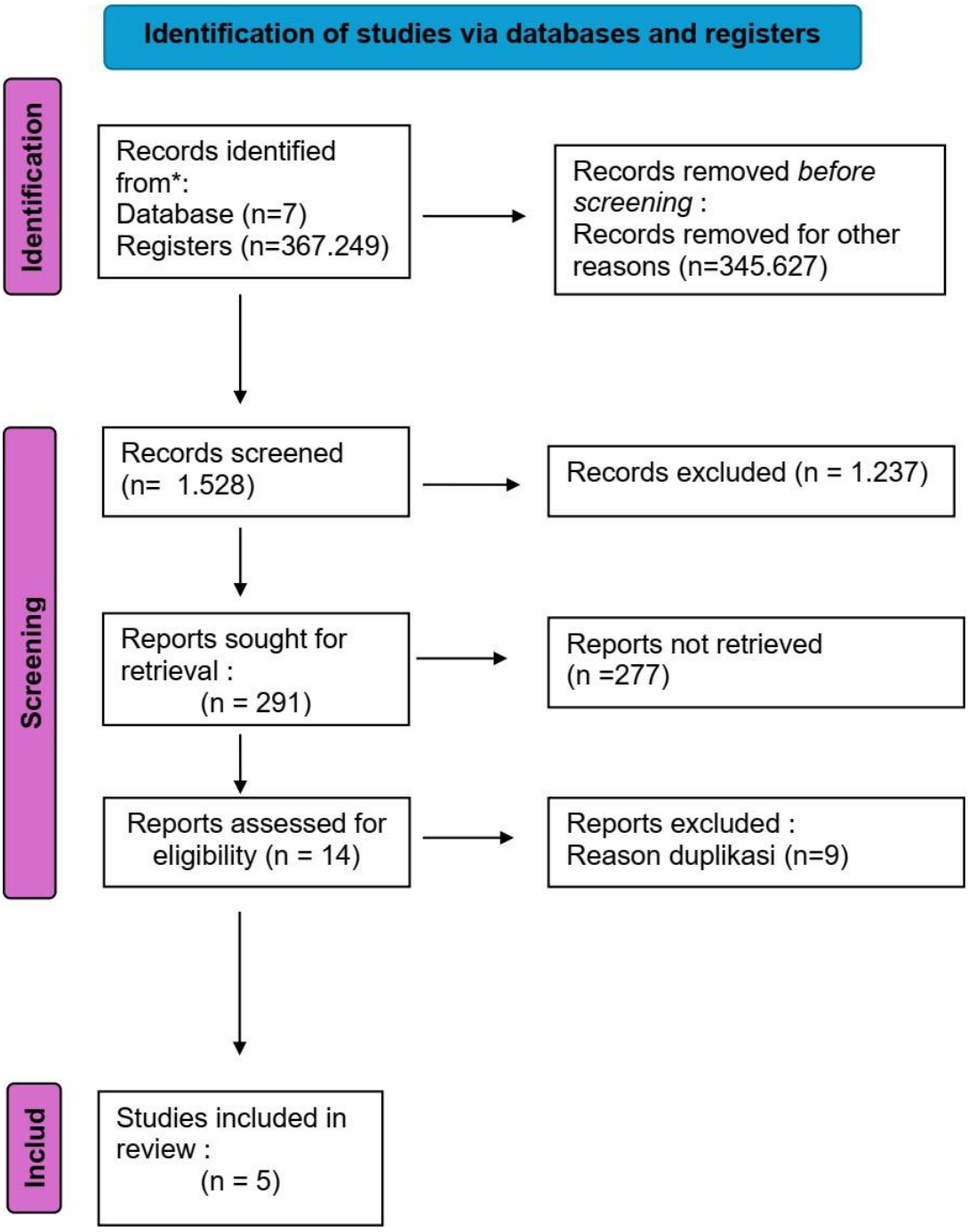

Figure 1. Prisma Flowchart in the Search and Selection Process

Tabel 1 Rekap Hasil Penelusuran Artikel

No	Data base	Authors, Quality of origins, year of published	Article Title, Journal Title	Purpose, Design, Sample	Result
1	PubMed	Miguel Ibarra-Estrada Jie L, Ivan Pavlov, Yonatan Perez, Oriol Roca, Elsa Tavernier, Bairbre cNicholas, David Vines, Miguel Marín - Rosales, Alexandra Vargas Obieta, Roxana García- Salcido, Sara A. Aguirre-Díaz, José Pulgarín,Quetzalcóatl Chávez- Peña, Julio C. Mijangos Méndez,Guadalupe Aguirre-Avalos, Stephan Ehrmann, and John G. Laffe (Mexico, 2022)	Factors for Success of awake prone positioning in patients with COVID-19-induced acute hypoxemic respiratory failure: analysis of a randomized controlled trial. Critical Care 2022) *26:84*	To reduce endotracheal intubation in patients with acute hypoxemic respiratory failure (AHRF) associated with coronavirus disease 2019 (COVID-19) Randomized Controlled Study The calculated sample size was 468 patients (234 per group) to detect an absolute difference of 12% to provide a statistical power of 80% and β=0.05. Inclusion criteria were the requirement of fraction of inspired oxygen (FI O2) ÿ0.3 via HFNC at maximum tolerated flow to maintain SpO2 ÿ90%. Exclusion criteria included severe respiratory failure requiring immediate intubation, do not intubate/resuscitate order, laparotomy within 2 weeks, pregnancy, requirement of vasopressors to maintain median arterial pressure >65 mmHg and refusal to participate	Among 430 patients randomized, 216 patients were assigned to APP and 214 patients were assigned to Standard Care. The APP group had a lower intubation rate (30% vs 43%, relative risk [RR] 0.70; CI95 0.54–0.90, P=0.006) and shorter hospital stay (11interquartile range [IQR, 9–14] vs 13 [IQR, 10–17] days, P=0.001). Respiratory rate ÿ25 bpm at enrollment, increase in ROX index >1.25 after the first APP session, APP duration >8 hours/day and decrease in lung ultrasound score ÿ2 within the first 3 days were significantly associated with successful treatment for APP.
2	Pubmed	Ling Liu, Qin Sun, Hongsheng Zhao, Weili Liu, Xuehua Pu, Jibin Han, Jiangquan Yu, Jun Jin, Yali Chao, Sicong Wang, Yu Liu, Bin Wu, Ying Zhu, Yang Li, Wei Chang, Tao Chen, Jianfeng Xie, Yi Yang, Haibo Qiu and ArthurSlutsky. (China, 2024)	Prolonged vs horter awake prone positioning for COVID-19 patients with acute respiratory failure: a multicenter, randomised controlled trial *Intensive care Med (2024) 50:1298–1309*	To reduce endotracheal intubation in patients with acute hypoxemic respiratory failure (AHRF) associated with coronavirus disease 2019 (COVID-19). Randomized Controlled Study The calculated sample size was 409 patients. Inclusion criteria were non-intubated patients between the ages of 18 and 85 years with confirmed COVID-19 pneumonia-associated AHRF were eligible for enrollment. AHRF was defined as SpO2 93% with ambient air or a ratio of arterial oxygen partial pressure (PaO2) to FiO2 (PaO2/FiO2) 300 mmHg. Exclusion criteria included patients with any of the following: expected intolerance to the awake prone position (eg, pregnancy, limb deformity, recent fracture, open thoracic or abdominal surgery), morbid obesity (body mass index >40 kg/m2), hemodynamic instability (receiving norepinephrine >20 ug/min), cardiac dysfunction (New York Heart Association [NYHA] Grade III or IV), impaired consciousness (Glasgow Coma Scale <13, delirium, dementia), severe hemoptysis, had undergone long-term home oxygenation or continuous positive airway pressure (CPAP); or	A total of 409 patients were enrolled and randomly assigned to prolonged prone positioning (n=205) or standard care (n=204). In the first 7 days after randomization, the median duration of prone positioning was 12 h/d (interquartile range [IQR] 12–14 h/d) in the prolonged prone positioning group vs. 5 h/d (IQR 2–8 h/d) in the standard care group. In the intent-to-treat analysis, intubation occurred in 35 (17%) patients assigned to prolonged prone positioning and in 56 (27%) patients assigned to standard care (relative risk 0.62 [95% confidence interval (CI) 0.42–0.9]). The hazard ratio (HR) for intubation was 0.56 (0.37–0.86), and for mortality was 0.63 (0.42–0.96) for prolonged prone versus standard care, at 28 days. The incidence of prespecified adverse events was low and similar in both groups.

No	Data base	Authors, Quality of origins, year of published	Article Title, Journal Title	Purpose, Design, Sample	Result
				who have a "do not intubate" or "do not resuscitate" order	
3	Scopus	Ahmad Mahdi Ahmad, Neveen Mohammed Nawar, Hossam Mohammed Dabess, Mona Abulraouf Gallab. (Kairo, 2023)	Effect of diaphragm manual release versus conventional breathing exercises and prone positioning on physical functional performance in women with COVID-19: A randomized trial Journal of Bodywork & Movement Therapies	To compare the effects of manual diaphragmatic release with the effects of conventional breathing exercises and prone position on physical functional performance in women with COVID-19. Randomized Controlled Study The calculated sample size was 25 patients per group. Inclusion criteria were female, COVID-19 infection diagnosed by a pulmonary specialist, moderate COVID-19 disease defined by a decrease in O2 reaching levels above 93% in room air and clinical evidence of lower respiratory tract disease (i.e., manifestations of dyspnea) (Gandhi et al., 2020), dyspnea on exertion confirmed by the Medical Research Council dyspnea scale, general fatigue confirmed by the fatigue assessment scale, age ranging from 35 to 45 years, and body mass index from 25 to 34 kg/m2 Exclusion criteria included mild disease with no dyspnea on exertion, severe disease requiring ICU admission, respiratory failure, septic shock, continuous oxygen therapy, concomitant chest disease, chest wall pain/problems preventing intervention, cognitive disabilities preventing questionnaire response, and inability to tolerate the prone position	Both groups showed significant improvements in all outcome measures compared to baseline ($p < (0.001)$. Compared to group B, group A showed more significant improvements in 6MWD (MD, 22.75 m; 95% CI, 15.21 to 30.29; $p < 0.001$), chest expansion (MD, 0.80 cm; 95% CI, 0.46 to 1.14; $p < 0.001$), BI (MD, 9.50; 95% CI, 5.69 to 13.31; $p < 0.001$), O2 saturation (MD, 1.3%; 95% CI, 0.71 to 1.89; $p < 0.001$), FAS (MD, -4.70; 95% CI, -6.69 to -2.71; $p < 0.001$), and severity of dyspnea assessed by the MRC dyspnea scale ($p = 0.001$). 0.013) post-intervention.
4	Sience Direct	Thomas C. Rollinson, Luke A. McDonald, Joleen Rose, Glenn Eastwood, Rahul Costa-Pinto, Lucy Modra, Akinori Maeda, Zoe bacolas, James Anstey, Samantha Bates, Scott Bradley, Jodi Dumbrell, Craig French, Angaj Ghosh, Kimberley Haines, Tim Haydon, Carol L. Hodgson, Jennifer holmes, Nina Leggett, Forbes McGain, Cara Moore, Kathleen Nelson, Jeffrey	Neuromuscular blockade and oxygenation changes during prone positioning in COVID-19 Journal of Critical Care	To facilitate mechanical ventilation in COVID-19-related ARDS. Observational Cohort Study The calculated sample size was 220 patients. Inclusion criteria were patients aged 18 years or older who were admitted to the ICU with ARDS secondary to COVID-19 pneumonia and who received at least one episode of prone positioning. Exclusion criteria included patients without arterial blood gas (ABG) analysis performed during prone positioning	Of 548 prone episodes in 220 patients (mean age 54 years, 61% male) of whom 164 (75%) received NMB. The mean PaO2:FiO2 (P/F ratio) during the first prone episode with NMB was 208 ± 63 mmHg compared with 161 ± 66 mmHg without NMB (mean = 47 ± 5 mmHg) for an absolute increase from baseline of 76 ± 56 mmHg versus 55 ± 56 mmHg (padj < 0.001). The mean P/F ratio on return to the supine position was 190 ±63 mmHg in the NMB group versus 141 ± 64 mmHg in the non-NMB group, which was an absolute increase from the baseline of 59 ± 58 mmHg versus 34 ± 56 mmHg (padj < 0.001)

No	Data base	Authors, Quality of origins, year of published	Article Title, Journal Title	Purpose, Design, Sample	Result
		Presneill, Hannah Rotherham, Simone Said, Meredith Young, Peinan Zhao, Andrew Udy, Ary Serpa Neto, Anis Chaba, Rinaldo Bellomo. (Australia, 2023)			
5	Sience Direct	WanLing Li, RN, MMSc, Na Xu, RN, MMSc, Jia Wei, MD, PhD d, WenJuan Zhu, RN, MMSc, YanBin Niu, RN, MMSc, Jing Wei, RN, BSc, Qi Mei, MD, PhD f, XiuMei Wang, RN, BSc, Hui Wang, RN, BSc (China, 2024)	Doseerespons e relationship between awake prone-positioning duration and PaO2/ FiO2 changes and risk of disease aggravation in patients with severe COVID-19: A prospective cohort study Australian Critical Care	To characterize and explore the relationship between duration of awake prone position with the ratio of arterial partial pressure of oxygen to fraction of inspired oxygen (PaO2/FiO2 [P/F]) and risk of disease progression. Prospective cohort study The calculated sample size was 412 patients Inclusion criteria were patients who met the diagnostic criteria for COVID-19, patients who showed signs of respiratory distress, resting respiratory rate ≥30 times/min, no oxygen inhalation, arterial oxygen saturation ¼ 93%, P/F ≥300 mmHg, worsening clinical symptoms, and lung imaging showing significant lesion progression of 50% within 24e48 hours7,28,30, patients with APP once or more times a day within 5 days after hospitalization28, patients aged ≥18 years, clear consciousness and non-mechanical ventilation. Exclusion criteria included pregnancy, severe hemodynamic instability, intracranial hypertension, acute hemorrhagic disease, limited mobility due to orthopedic disease, abdominal surgery requiring limited restraint or severe abdominal burns, postoperative facial trauma, intolerance to the prone position and refusal of arterial blood gas (ABG) test on the sixth day.	A total of 408 patients with severe COVID-19 were analyzed. The daily prone duration was 4.57 ± 2.74 h/day, and the P/F change was 67.63 ± 69.17 mmHg. On the sixth day of hospitalization, the condition of 52 (12.8%) patients deteriorated. There was a positive and nonlinear dose-response relationship (Poverall < 0.001, Pnonlinearity ¼ 0.041) and a strong and significant positive correlation (b ¼ 29.286, t ¼ 4.302, P < 0.001) between the prone duration and the P/F change. The risk of disease worsening gradually decreased with increasing prone duration. However, the prone duration was not statistically associated with disease worsening (odds ratio ¼ 0.986, 95% confidence interval: 0.514e1.895).

Discussion

This systematic review aims to determine the effectiveness of prone position interventions. Respiratory disorders are one of the main causes of morbidity and mortality, especially in vulnerable populations such as patients with chronic lung disease, pneumonia and acute respiratory distress syndrome (ARDS). One non-invasive approach that has been shown to be effective in increasing oxygen saturation and reducing shortness of breath is the prone position. This position refers to the prone sleeping position, where the patient lies face down. (Sunarti, 2022).

The findings obtained from this study are that many patients suffering from ARDS must fall into an intubated condition. Of the five articles used, three of them were found to have succeeded in reducing the severe shortness of breath suffered by patients so that patients did not need to be intubated. The study was conducted by (Ibarra-Estrada et al., 2022) showing that APP reduced intubation rates and length of hospital stay among patients with AHRF due to COVID-19 requiring HFNC support, compared with standard care. Longer daily APP duration, lower respiratory rate before APP and positive response to APP within the first three days were associated with higher treatment success. Our results support the use of APP as a treatment standards are applied as early and as long as possible, with a goal of at least 8 hours/day.

The same thing was also obtained from research conducted by (Li et al., 2024) which The results of a study conducted on 408 patients with severe COVID-19, the prone position given for a long period of time can improve patient oxygenation, but does not reduce the risk of worsening the disease. Another study conducted by (Liu et al., 2024) on 409 patients (204 with standard care and 205 with prone position) this was given to conscious patients with a duration of 12 hours/day. Which prone position was able to reduce the intubation rate without significant danger. This was also successful in patients with Covid-19-related AHRF.

The results of a study conducted by (Ahmad et al., 2023b) stated that manual diaphragm release combined with pharmacological treatment can be superior in improving physical functional performance, chest expansion, activities of daily living, O2 saturation and measures of fatigue and dyspnea in middle-aged women with disease, COVID-19 is moderate, compared to conventional breathing exercises and prone position. Meanwhile (Rollinson et al., 2024) in a study conducted on 548 patients who where 164 patients were given the prone position with a combination of NMB which can increase oxygenation with the effects continuing after the patient returns to the supine position.

Conclusion and Recommendations

In this systematic review, it was found that prone position interventions were carried out for 12 hours/day is very effective in increasing saturation, improving oxygenation and reducing intubated patient numbers. And this prone position intervention will provide better results. maximum if combined with pharmacological treatment by administering NMB (Neuromuscular blockade). So that patients can be treated well.

Establishing effective interventions is very important for patients with respiratory disorders, especially in severe cases. Patient recovery is highly dependent on the patient and the surrounding environment. Recovery can be achieved if there is interaction and good cooperation between patients, patient families, nurses, doctors and everyone involved in patient care.

It is hoped that health workers can implement effective interventions to help patients with respiratory disorders overcome the shortness of breath they experience, so that patients with respiratory disorders can have their oxygen saturation increased and not suffer from more severe shortness of breath.

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