Prone positioning in ARDS

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Supplementary information

Table S1. Physiologic effects of prone positioning in non-intubated patients with different respiratory support

Respiratory support	Study	No. of patients	PP duration, hr	V/Q or lung aeration	WOB / inspiratory effort
HFNC / Nasal Cannula / Face Mask	Liu 2022 [1]	14	3.0-5.8	Improved V/Q matching	Not assessed
	Ibarra-Estrada 2022 [2]	71	4.3	Improved LUS	Not assessed
	Lehingue 2022 [3]	17	2.0	Not assessed	WOB ↓, but ΔPes unchanged
	Brunelle 2023 [4]	20	2.0	The GI index unchanged	Not assessed
	Jacquet-Lagrèze 2023 [5]	26	1.0-3.0	Cardiac index ↑	Not assessed
	Grieco 2023 [6]	15	2.0	EELI ↑, dorsal ventilation redistribution, reduced dynamic strain	RR ↓ but ΔPes ↑
	Chao 2024 [7]	24	2.0	Improved V/Q matching; focal ARDS: ↓ dead space; non-focal ARDS: ↓ shunt	Not assessed
CPAP	Chiumello 2021 [8]	40	3.0	Not assessed	WOB ↓, but ΔPes unchanged
	Fossali 2024 [9]	16	0.33	No major change in global ventilation distribution; regional compliance, dead space, and ventilatory ratio improved	No significant change in WOB and ΔPes
NIV	Cammarota 2021 [10]	20	1.0	Improved LUS	Diaphragmatic thickening fraction ↑
	Rocha 2022 [11]	13	1.0	No change in regional aeration distribution	Not assessed
	Bianchi 2023 [12]	12	4.0 (2.9-4.6)	Not assessed	Inspiratory effort ↓
Mixed	Rosén 2024 (5 HFNC, 5 NIV) [13]	10	1.0	dEELI ↑ (transient recruitment) without major ventilation redistribution	Not assessed

PP = Prone Positioning; HFNC = High-Flow Nasal Cannula; NC = Nasal Cannula; FM = Face Mask; CPAP = Continuous Positive Airway Pressure; NIV = Noninvasive Ventilation; V/Q = Ventilation/Perfusion; LUS = Lung Ultrasound Score; GI = Global Inhomogeneity Index; WOB = Work of Breathing; ARDS = Acute Respiratory Distress Syndrome; EELI = End-Expiratory Lung Impedance; dEELI = Change in End-Expiratory Lung Impedance; ΔPes = Esophageal Pressure Swing

Table S2. Studies evaluating physiologic response to prone positioning and clinical outcomes

Physiologic criterion	Study	Population	Definition of response	Outcome association	Key finding
Oxygenation improvement during PP	Langer 2021 [14]	Intubated COVID-19 ARDS	PaO_2/FiO_2 increase ≥ 20 mmHg during PP	ICU mortality	ICU mortality (11/17 vs. 23/61, $p = 0.047$) was higher in O_2-Non-Responders.
Oxygenation improvement	Camporota 2022 [15]	Intubated ARDS (COVID-19 and non- COVID-19)	Pao_2/Fio_2 response to PP	Mortality	OR 0.97 (95%CI 0.95-0.99), p=0.002
Oxygenation improvement during the 2nd PP session	Weiss 2020 [16]	Intubated COVID-19 ARDS	PaO_2/FiO_2 ratio incremental change during the 2nd PP session	Survival without receiving ECMO	OR 1.03 (95%CI 1.0-1.05), p = 0.03
Oxygenation improvement	Liang 2024 [17]	Intubated ARDS	PaO_2/FiO_2 change from baseline to the 3rd PP	Hospital mortality	AUC 0.71 (95% CI 0.61–0.81); p < 0.001
Oxygenation improvement after resupination	Scaramuzzo 2021 [18]	Intubated COVID-19 ARDS	Persistent PaO_2/FiO_2 improvement after supine repositioning	Ventilator-free days	HR 1.563 (95% CI 1.329—1.838, P < 0.001)
Oxygenation or $PaCO_2$ change during PP	Albert 2014 (PROSEVA secondary analyses) [19]	Intubated ARDS	PaO_2/FiO_2 increase ≥20 mmHg or $PaCO_2$ decrease ≥1 mmHg during PP	Survival	No difference in survival was observed when examining the changes in PaO_2/FiO_2 or $PaCO_2$
$PaCO_2$ response	Gattinoni 2003 [20]	Intubated ARDS	Decrease in $PaCO_2$ ≥ 1 mmHg during PP	28-day mortality	RR 1.48 (95%CI 1.07-2.05), p=0.02
Oxygenation and Cst after resupination	Park 2021 [21]	Intubated ARDS (COVID-19 and non- COVID-19)	PaO_2/FiO_2 ratio and Cst after the 1st PP	Successful discontinuation of mechanical ventilation	PaO_2/FiO_2 ratio: AUC 0.893 (0.754–1.000); Crs: AUC 0.866 (0.714–1.000)
Oxygenation and Cst during PP and after resupination	De Rosa 2025 [22]	Intubated COVID-19 ARDS	PaO_2/FiO_2 changes during PP and after resupination, and Crs change during PP	ICU mortality	PaO_2/FiO_2 during PP: OR 0.48 (95%CI: 0.38-0.59); PaO_2/FiO_2 after resupination: OR 0.60 (95%CI: 0.52-0.68); Crs change during PP: OR 0.80 (95% CI: 0.65-0.98)

EIT-based V/Q response	Wang 2025 [23]	Intubated moderate-to-severe ARDS	Improvement in V/Q matching ≥10% within 4 h of the first PP session	ICU mortality	OR 0.790 (95% CI, 0.681-0.917), P = 0.002
Oxygenation improvement after resupination	Coppo 2020 (PRON-COVID) [24]	Awake COVID-19 AHRF	PaO_2/FiO_2 improvement after awake PP	Intubation risk	Oxygenation responders did not consistently have lower intubation rates
Oxygenation improvement	Olmos 2024 (secondary analysis) [25]	Awake COVID-19 AHRF on HFNC	ROX index change within 6hr of the 1st awake PP	Intubation or death within 7 days of the first PP	OR 0.37 (95% CI 0.25, 0.54)
Oxygenation improvement during awake PP in the 2nd day	Mirza 2022 (secondary analysis) [26]	Awake COVID-19 AHRF on HFNC	SpO_2/F_IO_2 improvement during awake PP in the 2nd day	Survival without intubation	OR 1.051 (95%CI 1.016-1.087), p = 0.004
LUS score change after resupination	Ibarra-Estrada 2022 [2]	Awake COVID-19 AHRF on HFNC	Decrease in dorsal LUS score >1 after the first Awake PP session	Intubation risk	RR 0.25 [0.09–0.69]
PP = Prone Positioning; ARDS = Acute Respiratory Distress Syndrome; V/Q = Ventilation/Perfusion; EIT = Electronic Impedance Tomography; AHRF = Acute Hypoxemic Respiratory Failure; LUS = Lung Ultrasound Score; HFNC = High-Flow Nasal Cannula; RR = Relative Risk; OR = Odds Ratio; HR = hazard ratio; AUC = area under the receiver operating characteristic curve; Cst = Static Compliance of respiratory system; ECMO = extracorporeal membrane oxygenation					

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