# Evidence Search Service Results of your search request:

## “Issues in relation to proning Covid patients and how that was risk assessed and management method evolved”

**ID of request:** 24674; **Date of request:** 11th August, 2020; **Date of completion:** 20th August, 2020

If you would like to request any articles or any further help, please contact:  Adam Tocock at [adam.tocock@nhs.net](mailto:adam.tocock@nhs.net)

Please acknowledge this work in any resulting paper or presentation as: Evidence search: Issues in relation to Proning Covid patients and how that was risk assessed and management method evolved. Adam Tocock. (20th August, 2020). LONDON, UK: Barts Health Knowledge and Library Services.

**Date range used** (5 years, 10 years): 2000-   
**Limits used** (gender, article/study type, etc.): English language only, adult populations only.   
**Search terms and notes**: full search strategy for database searches at the end of this document.

## Contents

[A. National and International Guidance](#Content1)

British Thoracic Society (BTS)

[Respiratory advice for the non-respiratory physician in the time of COVID-19](#Research726679)

Frontiers of medicine

[Successful management of seven cases of critical COVID-19 with early noninvasive-invasive sequential ventilation algorithm and bundle pharmacotherapy](#Research726691)

Intensive Care Society

[ICS guidance for prone positioning of the conscious COVID patient](#Research726677)

Intensive Care Society and British Dietetic Association

[BDA critical care specialist group COVID-19 best practice guidance: enteral feeding in prone position](#Research726678)

Surviving Sepsis Campaign

[Surviving Sepsis Campaign: guidelines on the management of critically ill adults with Coronavirus Disease 2019 (COVID-19)](#Research726680)

BMJ open respiratory research

[Guidelines on the management of acute respiratory distress syndrome.](#Research726709)

American Thoracic Society/European Society of Intensive Care Medicine/Society of Critical Care Medicine

[An Official American Thoracic Society/European Society of Intensive Care Medicine/Society of Critical Care Medicine Clinical Practice Guideline: Mechanical Ventilation in Adult Patients with Acute Respiratory Distress Syndrome.](#Research726744)

The Japanese Society of Respiratory Care Medicine and the Japanese Society of Intensive Care Medicine

[The clinical practice guideline for the management of ARDS in Japan](#Research726743)

Journal of Critical Care

[One-year experience with an acute respiratory distress syndrome standard operating procedure on intensive care unit](#Research726758) [featuring care algorithm]

Journal of Critical Care

[Comprehensive evidence-based clinical practice guidelines for ventilator-associated pneumonia: Prevention](#Research726780)

Chinese Society of Critical Care Medicine, Chinese Medical Association

[[Guidelines for management of acute lung injury/acute respiratory distress syndrome: an evidence-based update by the Chinese Society of Critical Care Medicine (2006)].](#Research726784)

Annals of internal medicine

[Evidence-based clinical practice guideline for the prevention of ventilator-associated pneumonia.](#Research726792)

Nursing in critical care

[Development of clinical guidelines for prone positioning in critically ill adults](#Research726789)

Intensive & Critical Care Nursing

[Clinical guidelines for the use of the prone position in acute respiratory distress syndrome.](#Research726799)

[B. Synopses or Summaries](#Content2)

BMJ Best Practice

[Coronavirus disease 2019 (COVID-19)](#Research726673)

Dynamed

[COVID-19 (Novel Coronavirus)](#Research726675)

UpToDate

[Prone ventilation for adult patients with acute respiratory distress syndrome](#Research726666)

[C. Review Articles](#Content3)

BestBETs

[BestBETs: Prone positioning in awake patients with hypoxaemic respiratory failure](#Research726681)

Intensive & Critical Care Nursing

[Nursing issues in enteral nutrition during prone position in critically ill patients: A systematic review of the literature](#Research726689)

Journal of intensive care medicine

[Proning in Non-Intubated (PINI) in Times of COVID-19: Case Series and a Review.](#Research726693)

Southern African Journal of Anaesthesia and Analgesia

[Risk factors and interventions associated with mortality or survival in adult covid-19 patients admitted to critical care: A systematic review and meta-analysis](#Research726684)

Journal of Pharmacy Practice

[Moderate to Severe Acute Respiratory Distress Syndrome Management Strategies: A Narrative Review.](#Research726715)

Annals of the American Thoracic Society

[Prone Position for Acute Respiratory Distress Syndrome. A Systematic Review and Meta-Analysis.](#Research726738)

The Cochrane database of systematic reviews

[Lateral positioning for critically ill adult patients.](#Research726750)

Chest

[Use of rescue therapies during the H1N1 pandemic: A systematic review exploring global differences in the management of severe acute respiratory distress syndrome](#Research726759)

Medicina intensiva

[The effects of prone position ventilation in patients with acute respiratory distress syndrome. A systematic review and metaanalysis.](#Research726754)

The Cochrane database of systematic reviews

[Prone position for acute respiratory failure in adults.](#Research726757)

Journal of Critical Care

[Impact of patient position on the incidence of ventilator-associated pneumonia: A meta-analysis of randomized controlled trials](#Research726776)

Journal of critical care

[Prone positioning in hypoxemic respiratory failure: meta-analysis of randomized controlled trials.](#Research726777)

American journal of health-system pharmacy: official journal of the American Society of Health-System Pharmacists

[Recent developments in the management of acute respiratory distress syndrome in adults.](#Research726781)

Health SA Gesondheid

[Evidence-based nursing interventions and guidelines for prone positioning of adult, ventilated patients: a systematic review.](#Research726779)

Critical Care Medicine

[Mechanical ventilation in sepsis-induced acute lung injury/acute respiratory distress syndrome: An evidence-based review](#Research726790)

[D. Original Research](#Content5)

1. ["How I Do It: High Flow, Non-invasive ventilation and Awake (non-intubation) Proning in Covid-19 Patients with Respiratory Failure"](#Research726696)
2. [Awake prone positioning for non-intubated oxygen dependent COVID-19 pneumonia patients.](#Research726699)
3. [Benefits of conscious proning of patients with Covid-19.](#Research726703)
4. [Early application of prone position for management of Covid-19 patients.](#Research726708)
5. [Early Self-Proning in Awake, Non-intubated Patients in the Emergency Department: A Single ED's Experience During the COVID-19 Pandemic](#Research726705)
6. [Feasibility and physiological effects of prone positioning in non-intubated patients with acute respiratory failure due to COVID-19 (PRON-COVID): a prospective cohort study.](#Research726694)
7. [Helmet continuous positive airway pressure and prone positioning: A proposal for an early management of COVID-19 patients](#Research726685)
8. [Implementing Automated Prone Ventilation for Acute Respiratory Distress Syndrome via Simulation-Based Training](#Research726706)
9. [Intubation and Ventilation amid the COVID-19 Outbreak: Wuhan's Experience](#Research726687)
10. [Nursing management of severe COVID-19 patients undergoing extracorporeal membrane oxygenation combined with prone position ventilation](#Research726700)
11. [Optimising Ventilator Use during the COVID-19 Pandemic](#Research726701)
12. [Planning for a COVID-19 crisis](#Research726707)
13. [Prevention of pressure ulcers among individuals cared for in the prone position: lessons for the COVID-19 emergency.](#Research726702)
14. [Prone Position and Lung Ventilation and Perfusion Matching in Acute Respiratory Failure due to COVID-19](#Research726695)
15. [Prone Position in Acute Respiratory Distress Syndrome Patients: A Retrospective Analysis of Complications](#Research726804)
16. [Prone Positioning in Awake, Nonintubated Patients With COVID-19 Hypoxemic Respiratory Failure.](#Research726704)
17. [Prone positioning monitored by electrical impedance tomography in patients with severe acute respiratory distress syndrome on veno-venous ECMO](#Research726688)
18. [Prone positioning to improve oxygenation and relieve respiratory symptoms in awake, spontaneously breathing non-intubated patients with COVID-19 pneumonia](#Research726686)
19. [Prone ventilation in a 27 week pregnant woman with COVID-19 severe ards](#Research726683)
20. [Proning reduces ventilation heterogeneity in patients with elevated BMI: Implications for COVID-19 pneumonia management?](#Research726682)
21. [Rationale and significance of patient selection in awake prone positioning for COVID-19 pneumonia](#Research726697)
22. [The care of patients through the lens of the fundamentals into times of the COVID-19 outbreak](#Research726690)
23. [The use of exoskeletons to help with prone positioning in the intensive care unit during COVID-19.](#Research726698)
24. [Use of awake proning to avoid invasive ventilation in a patient with severe COVID-19 pneumonitis](#Research726692)
25. [A novel application of healthcare simulation: Developing and implementing a prone ventilation protocol for severe acute respiratory distress syndrome (ARDS)](#Research726717)
26. [Effect of Prone Positioning on Intraocular Pressure in Patients With Acute Respiratory Distress Syndrome.](#Research726713)
27. [Impact of interprofessional simulation training on barriers to implementation of prone position ventilation for ARDS](#Research726718)
28. [Not prone to prone? A review of patient characteristics to understand current use of prone position therapy in moderate to severe acute respiratory distress syndrome](#Research726716)
29. [Pressure ulcers following prone positioning in ARDS patients undergoing ECMO treatment](#Research726712)
30. [Prone positioning and extracorporeal membrane oxygenation for severe acute respiratory distress syndrome: time for a randomized trial?](#Research726714)
31. [Prone positioning before extracorporeal membrane oxygenation for severe acute respiratory distress syndrome: A retrospective multicenter study.](#Research726710)
32. [Routine prone position mechanical ventilation for severe acute respiratory distress syndrome. 10 year outcomes](#Research726719)
33. [The Cost-Effectiveness of Interventions to Increase Utilization of Prone Positioning for Severe Acute Respiratory Distress Syndrome.](#Research726721)
34. [What comes out on top: Prone positioning versus extracorporeal membrane oxygenation for severe acute respiratory distress syndrome at large quaternary regional center](#Research726720)
35. [Why Prone? Why Now? Improving Outcomes for ARDS Patients.](#Research726711)
36. [A retrospective observational study of prone positioning practices in the management of acute respiratory distress syndrome (ARDS) over a 2 year period in a single adult district general hospital (DGH) intensive care unit (ICU)](#Research726727)
37. [Acute Respiratory Distress Syndrome and Prone Positioning.](#Research726724)
38. [Acute respiratory distress syndrome diagnosis and management: Assessment of current practice in a tertiary care center intensive care unit](#Research726729)
39. [Acute Respiratory Distress Syndrome: Advances in Diagnosis and Treatment.](#Research726734)
40. [Application of prone position in hypoxaemic patients supported by veno-venous ECMO.](#Research726731)
41. [Comparing Outcomes in Manual and Automatic Prone Positioning Therapy for Acute Respiratory Distress Syndrome...2018 National Teaching Institute Research Abstracts Presented at the AACN National Teaching Institute in Boston, Massachusetts, May 21-24, 2018.](#Research726732)
42. [Evaluation of effective emergency airway management for accidental extubation in a patient with head fixed in the prone position: A randomized crossover manikin study](#Research726733)
43. [Feasibility of prone ventilation in resource limited setting in rural based hospital in India: A pilot study](#Research726723)
44. [Mechanical Ventilation and Extracorporeal Membrane Oxygenation in Acute Respiratory Insufficiency.](#Research726726)
45. [Predictors of survival in patients with influenza pneumonia-related severe acute respiratory distress syndrome treated with prone positioning](#Research726725)
46. [Prone positioning in patients with acute respiratory distress syndrome: Predictors of ICU mortality](#Research726736)
47. [Prone positioning is a safe and effective method in the management of acute lung injury after cardiac surgery](#Research726735)
48. [Protocol driven management improves outcomes in acute respiratory distress syndrome](#Research726730)
49. [Use of prone positioning and airway pressure release ventilation (APRV) for patients with acute respiratory distress syndrome (ARDS) in intensive care units in London and the South-East of England](#Research726728)
50. [Variation in US management practices in moderate-to-severe ARDS: The severe ARDS: Generating evidence (SAGE) study](#Research726722)
51. [Analysis of complications of prone position in acute respiratory distress syndrome: quality standard, incidence and related factors.](#Research726737)
52. [Evaluation of the practice of proning in patients with ARDS across 22 Intensive Care Units in London, United Kingdom](#Research726739)
53. [Geo-economic variations in epidemiology, patterns of care, and outcomes in patients with acute respiratory distress syndrome: insights from the LUNG SAFE prospective cohort study](#Research726741)
54. [Prone positioning as a bridge to recovery from refractory hypoxaemia following lung transplantation.](#Research726742)
55. [Prone positioning in severe Acute Respiratory Distress Syndrome (ARDS)](#Research726740)
56. [Epidemiology, patterns of care, and mortality for patients with acute respiratory distress syndrome in intensive care units in 50 countries](#Research726752)
57. [Good practices for prone positioning at the bedside: Construction of a care protocol.](#Research726745)
58. [Increasing positive end-expiratory pressure (re-)improves intraoperative respiratory mechanics and lung ventilation after prone positioning](#Research726748)
59. [Patients with severe ARDS already positioned prone: why don't we leave them in the prone position during transport and CT scan?](#Research726749)
60. [Prone position and lung ultrasound (PROPLUS) in ARDS](#Research726747)
61. [Prone to inconsistency? What is the usage of prone ventilation amongst acute respiratory distress syndrome patients at a large district general hospital?](#Research726746)
62. [Ventilator-associated pneumonia in ARDS patients: the impact of prone positioning. A secondary analysis of the PROSEVA trial.](#Research726751)
63. [A Multicenter Retrospective Review of Prone Position Ventilation (PPV) in Treatment of Severe Human H7N9 Avian Flu.](#Research726753)
64. [Controversies in the Management of Severe ARDS: Optimal Ventilator Management and Use of Rescue Therapies](#Research726755)
65. [Prone Positioning of Patients With Acute Respiratory Distress Syndrome](#Research726756)
66. [Combination of positioning therapy and venovenous extracorporeal membrane oxygenation in ARDS patients](#Research726761)
67. [Prone positioning during veno-venous extracorporeal membrane oxygenation for severe acute respiratory distress syndrome in adults.](#Research726762)
68. [The impact of patient positioning on pressure ulcers in patients with severe ARDS: Results from a multicentre randomised controlled trial on prone positioning](#Research726760)
69. [Feasibility and effectiveness of prone position in morbidly obese patients with ARDS: a case-control clinical study.](#Research726764)
70. [Prone positioning use to hasten veno-venous ECMO weaning in ARDS](#Research726763)
71. [Clinical course of ICU patients with severe pandemic 2009 influenza a (H1N1) pneumonia: Single center experience with proning and pressure release ventilation](#Research726765)
72. [Long-term outcomes in survivors of acute respiratory distress syndrome ventilated in supine or prone position.](#Research726768)
73. [Prone positioning improves oxygenation in adult burn patients with severe acute respiratory distress syndrome.](#Research726767)
74. [Prone Positioning: Is It Safe and Effective?](#Research726766)
75. [Routine prone positioning in patients with severe ARDS: Feasibility and impact on prognosis](#Research726771)
76. [Short-term effects of combining upright and prone positions in patients with ARDS: a prospective randomized study.](#Research726769)
77. [Systematic approach for severe respiratory failure due to novel a (H1N1) influenza](#Research726770)
78. [Automated prone positioning and axial rotation in critically ill, nontrauma patients with acute respiratory distress syndrome (ARDS)](#Research726775)
79. [Before-after study of a standardized ICU protocol for early enteral feeding in patients turned in the prone position](#Research726774)
80. [Better postoperative oxygenation in thoracoscopic esophagectomy in prone positioning.](#Research726772)
81. [Variables affecting outcomes in critical care trials: Is prone positioning research exempt from these factors?](#Research726773)
82. [Prone positioning in acute respiratory distress syndrome: A multicenter randomized clinical trial](#Research726778)
83. [[Mechanical ventilation in Acute Lung Injury (ALI)/Acute Respiratory Discomfort Syndrome (ARDS)].](#Research726782)
84. [Effects of prone position on the oxygenation of patients with acute respiratory distress syndrome](#Research726783)
85. [Comparison of prone positioning and high-frequency oscillatory ventilation in patients with acute respiratory distress syndrome.](#Research726786)
86. [Prone position reduces lung stress and strain in severe acute respiratory distress syndrome](#Research726787)
87. [Recruitment maneuvers during prone positioning in patients with acute respiratory distress syndrome.](#Research726788)
88. [Ventilatory management of acute lung injury and acute respiratory distress syndrome](#Research726785)
89. [Non-ventilatory-based strategies in the management of acute respiratory distress syndrome.](#Research726791)
90. [Nursing patients with ARDS in the prone position](#Research726793)
91. [Prognostic factors in acute respiratory distress syndrome: A retrospective multivariate analysis including prone positioning in management strategy](#Research726795)
92. [[Techniques and complementary techniques. Complementary treatments: nitric oxide, prone positioning and surfactant].](#Research726794)
93. [Pro/con clinical debate: The use of prone positioning in the management of patients with acute respiratory distress syndrome](#Research726797)
94. [Prone position in acute respiratory distress syndrome.](#Research726798)
95. [What is the optimal duration of ventilation in the prone position in acute lung injury and acute respiratory distress syndrome?](#Research726796)
96. [Complications of prone ventilation in patients with multisystem trauma with fulminant acute respiratory distress syndrome](#Research726803)
97. [Postural technique in prone position: hemodynamic and respiratory parameters and complications.](#Research726802)
98. [Prone positioning for acute respiratory distress syndrome in the surgical intensive care unit: Who, when, and how long?](#Research726800)
99. [Proning patients in intensive care.](#Research726801)

### [E. Search History](#SearchHistory)

## A. National and International Guidance

#### British Thoracic Society (BTS)

**Respiratory advice for the non-respiratory physician in the time of COVID-19** (2020)

British Thoracic Society (BTS)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=948ec18bc3da8042957f23bd91180a04)

#### Frontiers of medicine

**Successful management of seven cases of critical COVID-19 with early noninvasive-invasive sequential ventilation algorithm and bundle pharmacotherapy** (2020)

Peng M., Zhong W., Liu X., Li J., Meng X., Ren D., Liu Y., Chen R., Lyu Y., Yu B.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=4706ea562e7294d530fc3f867c9dadd9)

We report the clinical and laboratory findings and successful management of seven patients with critical coronavirus disease 2019 (COVID-19) requiring mechanical ventilation (MV). The patients were diagnosed based on epidemiological history, clinical manifestations, and nucleic acid testing. Upon diagnosis with COVID-19 of critical severity, the patients were admitted to the intensive care unit, where they received early noninvasive-invasive sequential ventilation, early prone positioning, and bundle pharmacotherapy regimen, which consists of antiviral, anti-inflammation, immune-enhancing, and complication-prophylaxis medicines. The patients presented fever (n = 7, 100%), dry cough (n = 3, 42.9%), weakness (n = 2, 28.6%), chest tightness (n = 1, 14.3%), and/or muscle pain (n = 1, 14.3%). All patients had normal or lower than normal white blood cell count/lymphocyte count, and chest computed tomography scans showed bilateral patchy shadows or ground glass opacity in the lungs. Nucleic acid testing confirmed COVID-19 in all seven patients. The median MV duration and intensive care unit stay were 9.9 days (interquartile range, 6.5-14.6 days; range, 5-17 days) and 12.9 days (interquartile range, 9.7-17.6 days; range, 7-19 days), respectively. All seven patients were extubated, weaned off MV, transferred to the common ward, and discharged as of the writing of this report. Thus, we concluded that good outcomes for patients with critical COVID-19 can be achieved with early noninvasive-invasive sequential ventilation and bundle pharmacotherapy.

#### Intensive Care Society

**ICS guidance for prone positioning of the conscious COVID patient** (2020)

Intensive Care Society

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=dda453b3e41f839ed94739af341516b1)

#### Intensive Care Society and British Dietetic Association

**BDA critical care specialist group COVID-19 best practice guidance: enteral feeding in prone position** (2020)

Intensive Care Society and British Dietetic Association

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=6943e8a2603610b0ae1d1767ac3f9db3)

#### Surviving Sepsis Campaign

**Surviving Sepsis Campaign: guidelines on the management of critically ill adults with Coronavirus Disease 2019 (COVID-19)** (2020)

Waleed Alhazzani et al.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=8f11460625d2b4a8ee2fed5bd095b446)

#### BMJ open respiratory research

**Guidelines on the management of acute respiratory distress syndrome.** (2019)

Griffiths Mark J. D, McAuley Danny Francis, Perkins Gavin D., Barrett Nicholas, Blackwood Bronagh, Boyle Andrew, Chee Nigel, Connolly Bronwen, Dark Paul, Finney Simon, Salam Aemun, Silversides Jonathan, Tarmey Nick, Wise Matt P., Baudouin Simon V.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=1cf7c994834a3a6b6d68f62304320581)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=2a9f5525a1b113acbc94c22c2d85d4e6)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=b9d3143b6747ef992b84a41b70c8f025)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=703eeb715a931e0310ff54a7fba4d6ec)

The Faculty of Intensive Care Medicine and Intensive Care Society Guideline Development Group have used GRADE methodology to make the following recommendations for the management of adult patients with acute respiratory distress syndrome (ARDS). The British Thoracic Society supports the recommendations in this guideline. Where mechanical ventilation is required, the use of low tidal volumes (<6 ml/kg ideal body weight) and airway pressures (plateau pressure <30 cmH2O) was recommended. For patients with moderate/severe ARDS (PF ratio<20 kPa), prone positioning was recommended for at least 12 hours per day. By contrast, high frequency oscillation was not recommended and it was suggested that inhaled nitric oxide is not used. The use of a conservative fluid management strategy was suggested for all patients, whereas mechanical ventilation with high positive end-expiratory pressure and the use of the neuromuscular blocking agent cisatracurium for 48 hours was suggested for patients with ARDS with ratio of arterial oxygen partial pressure to fractional inspired oxygen (PF) ratios less than or equal to 27 and 20 kPa, respectively. Extracorporeal membrane oxygenation was suggested as an adjunct to protective mechanical ventilation for patients with very severe ARDS. In the absence of adequate evidence, research recommendations were made for the use of corticosteroids and extracorporeal carbon dioxide removal.

#### American Thoracic Society/European Society of Intensive Care Medicine/Society of Critical Care Medicine

**An Official American Thoracic Society/European Society of Intensive Care Medicine/Society of Critical Care Medicine Clinical Practice Guideline: Mechanical Ventilation in Adult Patients with Acute Respiratory Distress Syndrome.** (2017)

Fan Eddy, Del Sorbo Lorenzo, Goligher Ewan C., Hodgson Carol L., Munshi Laveena, Walkey Allan J., Adhikari Neill K. J, Amato Marcelo B. P, Branson Richard, Brower Roy G., Ferguson Niall D., Gajic Ognjen, Gattinoni Luciano, Hess Dean, Mancebo Jordi, Meade Maureen O., McAuley Daniel F., Pesenti Antonio, Ranieri V. Marco, Rubenfeld Gordon D., Rubin Eileen, Seckel Maureen, Slutsky Arthur S., Talmor Daniel, Thompson B. Taylor, Wunsch Hannah, Uleryk Elizabeth, Brozek Jan, Brochard Laurent J., American Thoracic Society European Society of Intensive Care Medicine and Society of Critical Care Medicine

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=d02f8258304b1ba538f8d97db032d8e1)

BACKGROUNDThis document provides evidence-based clinical practice guidelines on the use of mechanical ventilation in adult patients with acute respiratory distress syndrome (ARDS).METHODSA multidisciplinary panel conducted systematic reviews and metaanalyses of the relevant research and applied Grading of Recommendations, Assessment, Development, and Evaluation methodology for clinical recommendations.RESULTSFor all patients with ARDS, the recommendation is strong for mechanical ventilation using lower tidal volumes (4-8 ml/kg predicted body weight) and lower inspiratory pressures (plateau pressure < 30 cm H2O) (moderate confidence in effect estimates). For patients with severe ARDS, the recommendation is strong for prone positioning for more than 12 h/d (moderate confidence in effect estimates). For patients with moderate or severe ARDS, the recommendation is strong against routine use of high-frequency oscillatory ventilation (high confidence in effect estimates) and conditional for higher positive end-expiratory pressure (moderate confidence in effect estimates) and recruitment maneuvers (low confidence in effect estimates). Additional evidence is necessary to make a definitive recommendation for or against the use of extracorporeal membrane oxygenation in patients with severe ARDS.CONCLUSIONSThe panel formulated and provided the rationale for recommendations on selected ventilatory interventions for adult patients with ARDS. Clinicians managing patients with ARDS should personalize decisions for their patients, particularly regarding the conditional recommendations in this guideline.

#### The Japanese Society of Respiratory Care Medicine and the Japanese Society of Intensive Care Medicine

**The clinical practice guideline for the management of ARDS in Japan** (2017)

Hashimoto S., Sanui M., Egi M., Ohshimo S., Shiotsuka J., Seo R., Tanaka R., Tanaka Y., Norisue Y., Hayashi Y., Yasuda H., Nango E., Aoki Y., Andoh K., Iizuka Y., Imaizumi H., Okamori S., Kainuma M., Kataoka J., Kamo T., Kawaguchi A., Kumasawa J., Kurahashi K., Kooguchi K., Kondo Y., Sakuraya M., Shimoyama A., Suzuki S., Suzuki H., Sekino M., Nakajima M., Nishimura T., Fukuda T., Makino J., Miyashita R., Moriwaki R., Yoshitake S., Yamashita Y., Nakagawa Y., Suzuki T., Aokage T., Tajimi K., Yuasa H., Imanaka H., Ichikado K., Nozaki A., Kozu R., Unoki T., Takahashi Y., Serita A., Takezawa E., Fukuoka T., Yabuki T., Aihara M., Nakayama T.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=d80758275fa0d72469c7d2e83f08293e)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=58bc17ed2d20172697a84db0ea12f348)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=759c1ecf353b3ac5d88a06853750a299)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=11d577d265b218405737455e5f7ceec3)

Background: The Japanese Society of Respiratory Care Medicine and the Japanese Society of Intensive Care Medicine provide here a clinical practice guideline for the management of adult patients with ARDS in the ICU. <br/>Method(s): The guideline was developed applying the GRADE system for performing robust systematic reviews with plausible recommendations. The guideline consists of 13 clinical questions mainly regarding ventilator settings and drug therapies (the last question includes 11 medications that are not approved for clinical use in Japan). <br/>Result(s): The recommendations for adult patients with ARDS include: we suggest against early tracheostomy (GRADE 2C), we suggest using NPPV for early respiratory management (GRADE 2C), we recommend the use of low tidal volumes at 6-8 mL/kg (GRADE 1B), we suggest setting the plateau pressure at 30cmH<sub>2</sub>0 or less (GRADE2B), we suggest using PEEP within the range of plateau pressures less than or equal to 30cmH<sub>2</sub>O, without compromising hemodynamics (Grade 2B), and using higher PEEP levels in patients with moderate to severe ARDS (Grade 2B), we suggest using protocolized methods for liberation from mechanical ventilation (Grade 2D), we suggest prone positioning especially in patients with moderate to severe respiratory dysfunction (GRADE 2C), we suggest against the use of high frequency oscillation (GRADE 2C), we suggest the use of neuromuscular blocking agents in patients requiring mechanical ventilation under certain circumstances (GRADE 2B), we suggest fluid restriction in the management of ARDS (GRADE 2A), we do not suggest the use of neutrophil elastase inhibitors (GRADE 2D), we suggest the administration of steroids, equivalent to methylprednisolone 1-2mg/kg/ day (GRADE 2A), and we do not recommend other medications for the treatment of adult patients with ARDS (GRADE1B; inhaled/intravenous beta2 stimulants, prostaglandin E<sub>1</sub>, activated protein C, ketoconazole, and lisofylline, GRADE 1C; inhaled nitric oxide, GRADE 1D; surfactant, GRADE 2B; granulocyte macrophage colony-stimulating factor, N-acetylcysteine, GRADE 2C; Statin.) <br/>Conclusion(s): This article was translated from the Japanese version originally published as the ARDS clinical practice guidelines 2016 by the committee of ARDS clinical practice guideline (Tokyo, 2016, 293p, available from http://www.jsicm.org/ARDSGL/ARDSGL2016.pdf ). The original article, written for Japanese healthcare providers, provides points of view that are different from those in other countries.<br/>Copyright © 2017 The Author(s).

#### Journal of Critical Care

**One-year experience with an acute respiratory distress syndrome standard operating procedure on intensive care unit** [featuring care algorithm] (2015)

Luedike P., Totzeck M., Rammos C., Kelm M., Rassaf T., Kindgen-Milles D.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=aee5397c64bc51473da1180b8b7cdbc3)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=60db8e8c9c7482bec970d2e3fa155d0d)

Purpose: Mortality in acute respiratory distress syndrome (ARDS) patients remains unacceptable high, and there is substantial variation in the diagnostic and management strategies used. We recently established a standardized algorithm for the early identification and guideline conform therapy of ARDS on intensive care units (ICUs). We here present the results of a first-year observatory period after implementation of the ARDS bundle on our ICU. <br/>Methods and Results: A retrospective, observative, single-center case control study over a period of 4 years was performed. We analyzed the effects after implementation of an ARDS standard operating procedure (SOP) on prevalence of the diagnosis ARDS, mortality from ARDS, and therapy strategies. Implementation of the SOP led to an increased frequency of ARDS diagnosis (P < .05), increased application of early prone positioning (P < .05), and use of neuromuscular blockers (P < .02) in ARDS patients. An influence on mortality in ARDS patients could not be detected after implementation of the SOP (P = not significant). <br/>Conclusion(s): A standardized ARDS bundle fundamentally increases awareness of this clinical picture on ICU and facilitates application of evidence-based therapies like prone positioning and use of neuromuscular blockers. These data encourage evaluating our ARDS SOP in a prospective trial to identify potential effects on mortality.<br/>Copyright © 2015 Elsevier Inc.

**Comprehensive evidence-based clinical practice guidelines for ventilator-associated pneumonia: Prevention** (2008)

Muscedere John, Dodek Peter, Keenan Sean, Fowler Rob, Cook Deborah, Heyland Daren

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=c8ff09c376eb1ae973993046013a4084)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=3de64fa5dbb50eee3d348f707ae7c555)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=ebe6dc45d1e196700f601c2f5836cf5a)

  Ventilator-associated pneumonia (VAP) is an important cause of morbidity and mortality in ventilated critically ill patients. To develop evidence-based guidelines for the prevention of VAP. MEDLINE, EMBASE, CINAHL, and the Cochrane Database of Systematic Reviews and Register of Controlled Trials. The authors systematically searched for all relevant randomized, controlled trials and systematic reviews on the topic of prevention of VAP in adults that were published from 1980 to October 1, 2006. Independently and in duplicate, the panel scored the internal validity of each trial. Effect size, confidence intervals, and homogeneity of the results were scored using predefined definitions. Scores for the safety, feasibility, and economic issues were assigned based on consensus of the guideline panel. The following statements were used: recommend, consider, do not recommend, and no recommendation due to insufficient or conflicting evidence. To prevent VAP: We recommend: that the orotracheal route of intubation should be used for intubation; a new ventilator circuit for each patient; circuit changes if the circuit becomes soiled or damaged, but no scheduled changes; change of heat and moisture exchangers every 5 to 7 days or as clinically indicated; the use of a closed endotracheal suctioning system changed for each patient and as clinically indicated; subglottic secretion drainage in patients expected to be mechanically ventilated for more than 72 hours; head of bed elevation to 45° (when impossible, as near to 45° as possible should be considered). Consider\_ the use of rotating beds; oral antiseptic rinses. We do not recommend: use of bacterial filters; the use of iseganan We make no recommendations regarding: the use of a systematic search for sinusitis; type of airway humidification; timing of tracheostomy; prone positioning; aerosolized antibiotics; intranasal mupirocin; topical and/or intravenous antibiotics. There are a growing number of evidence-based strategies for VAP prevention, which, if applied in practice, may reduce the incidence of this serious nosocomial infection.   Ventilator-associated pneumonia (VAP) is an important cause of morbidity and mortality in ventilated critically ill patients. Despite a large amount of research evidence, the optimal diagnostic and treatment strategies for VAP remain controversial. The aim of this study was to develop evidence-based clinical practice guidelines for the diagnosis and treatment of VAP. Data sources include Medline, EMBASE, Cumulative Index to Nursing and Allied Health Literature, and the Cochrane Database of Systematic Reviews and Register of Controlled Trials. The authors systematically searched for all relevant randomized controlled trials and systematic reviews on the diagnosis and treatment of VAP in mechanically ventilated adults that were published from 1980 to October 1, 2006. Independently and in duplicate, the panel critically appraised each published trial. The effect size, confidence intervals, and homogeneity of the results were scored using predefined definitions. The full guideline development panel arrived at a consensus for scores on safety, feasibility, and economic issues. Based on the scores for each topic, the following statements of recommendation were used: recommend, consider, do not recommend, and no recommendation because of insufficient or conflicting evidence. For the diagnosis of VAP in immunocompetent patients, we recommend that endotracheal aspirates with nonquantitative cultures be used as the initial diagnostic strategy. When there is a suspicion of VAP, we recommend empiric antimicrobial therapy (in contrast to delayed or culture directed therapy) and appropriate single agent antimicrobial therapy for each potential pathogen as empiric therapy for VAP. Choice of antibiotics should be based on patient factors and local resistance patterns. We recommend that an antibiotic discontinuation strategy be used in patients who are treated of suspected VAP. For patients who receive adequate initial antibiotic therapy, we recommend 8 days of antibiotic therapy. We do not recommend nebulized endotracheal tobramycin or intratracheal instillation of tobramycin for the treatment of VAP. We present evidence-based recommendations for the diagnosis and treatment of VAP. Implementation of these recommendations into clinical practice may lessen the morbidity and mortality of patients who develop VAP.

#### Chinese Society of Critical Care Medicine, Chinese Medical Association

**[Guidelines for management of acute lung injury/acute respiratory distress syndrome: an evidence-based update by the Chinese Society of Critical Care Medicine (2006)].** (2006)

Chinese Society of Critical Care Medicine, Chinese Medical Association

OBJECTIVEIn 2006, Chinese critical care experts drafted management guidelines for diagnosis and therapy of acute lung injury (ALI)/acute respiratory distress syndrome (ARDS), that would be of practical use for the clinician, and this effort may serve to increase nationwide awareness and to improve the treatment result of ALI/ARDS.METHODSThe process included a modified Delphi method, a consensus conference, several subsequent smaller meetings of subgroups and key individuals, teleconferences, and electronic based discussion among subgroups and among the entire committee. The modified Delphi methodology used for grading recommendations was derived from a 2001 publication sponsored by the International Sepsis Forum. A systematic review of the literature was undertook, and the reported results were graded into five levels to create recommendation grading from A to E, with a being the highest grade.RESULTSIt is essential to control the primary disease in ALI/ARDS. Role of noninvasive positive-pressure ventilation in ALI/ARDS is undefined. Noninvasive positive-pressure ventilation can not be considered in patients with coma, shock and damage of airway clearance. Limitation of end-inspiratory plateau pressure is important in the management of ARDS and may be facilitated by permissive hypercapnia. Recruitment maneuver should be considered to open collapsed lung and improve oxygenation. A minimum amount of positive end-expiratory pressure (PEEP) should be set to prevent atelectasis at end expiration in ARDS. If it is possible, setting the level of PEEP may be guided by measurement of static pulmonary pressure-volume curve. Unless contraindicated, patients with ARDS should be maintained semi-recumbent. Prone positioning should be considered in the patients with severest ARDS. Sedation protocols should be used. Paralysis is not recommended. The limited fluid management strategy is beneficial for ARDS. Corticosteroid is not recommended for ARDS. The role of other drugs is uncertain in ARDS.CONCLUSIONEvidence-based recommendations can be made regarding many aspects of the acute management of ALI/ARDS that will hopefully translate into improved outcomes for the critically ill patient. The guidelines will be updated when some important new knowledge becomes available.

#### Annals of internal medicine

**Evidence-based clinical practice guideline for the prevention of ventilator-associated pneumonia.** (2004)

Dodek Peter, Keenan Sean, Cook Deborah, Heyland Daren, Jacka Michael, Hand Lori, Muscedere John, Foster Debra, Mehta Nav, Hall Richard, Brun-Buisson Christian, Canadian Critical Care Trials Group, Canadian Critical Care Society

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=830c7c40332b85060bc5cc97e0cec5da)

BACKGROUNDVentilator-associated pneumonia (VAP) is an important patient safety issue in critically ill patients.PURPOSETo develop an evidence-based guideline for the prevention of VAP.DATA SOURCESMEDLINE, EMBASE, and the Cochrane Database of Systematic Reviews.STUDY SELECTIONThe authors systematically searched for relevant randomized, controlled trials and systematic reviews that involved mechanically ventilated adults and were published before 1 April 2003.DATA EXTRACTIONPhysical, positional, and pharmacologic interventions that may influence the development of VAP were considered. Independently and in duplicate, the authors scored the validity of trials; the effect size and confidence intervals; the homogeneity of results; and safety, feasibility, and economic issues.DATA SYNTHESISRecommended: The orotracheal route of intubation, changes of ventilator circuits only for each new patient and if the circuits are soiled, use of closed endotracheal suction systems that are changed for each new patient and as clinically indicated, heat and moisture exchangers in the absence of contraindications, weekly changes of heat and moisture exchangers, and semi-recumbent positioning in the absence of contraindications. Consider subglottic secretion drainage and kinetic beds. Not recommended: Sucralfate to prevent VAP in patients at high risk for gastrointestinal bleeding and topical antibiotics to prevent VAP. Because of insufficient or conflicting evidence, no recommendations were made about systematically searching for maxillary sinusitis, chest physiotherapy, the timing of tracheostomy, prone positioning, prophylactic intravenous antibiotics, or intravenous plus topical antibiotics.LIMITATIONSNo formal economic analysis was performed, and patient perspectives were not considered.CONCLUSIONIf effectively implemented, this guideline may decrease the morbidity, mortality, and costs of VAP in mechanically ventilated patients.

#### Nursing in critical care

**Development of clinical guidelines for prone positioning in critically ill adults** (2004)

Rowe C.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=9864931aa2687ec3dbbc87b75096ab29)

Literature reveals evidence that prone positioning can improve the oxygenation of critically ill patients suffering from acute lung injury or acute respiratory distress syndrome. Multicentre evidence, however, does not support the claim that it improves patients' outcome. The implementation of multiprofessional guidelines by which to direct the manoeuvre will facilitate the safe and effective management of patients in the prone position. They will thus heighten multiprofessional awareness of the technique and promote its proactive use at such time so as to achieve maximum clinical benefit.

#### Intensive & Critical Care Nursing

**Clinical guidelines for the use of the prone position in acute respiratory distress syndrome.** (2001)

Research Fellow in Critical Care Nursing St. Bartholomew's School of Nursing and Midwifery City University Philpot Street London E1 2EA UK. E-mail: c.a.ball@city.ac.uk, Adams J., Boyce S., Robinson P.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=a1041731c90738ee128ad227718c0ec0)

The mortality associated with acute respiratory distress syndrome (ARDS) remains high. It has been suggested that use of the prone position may improve survival. However, approaches to the use of the position are often haphazard. The development of clinical guidelines indicating the need for the prone position in ARDS and the process by which the manoeuvre may be performed were thought to be important for two reasons. Primarily, we sought to improve oxygenation through the use of the prone position whilst promoting patient safety. Secondly, we wished to standardize our approach to the use of the prone position and make recommendations for practice so that its use was no longer seen as a last resort in the management of ARDS. The process associated with the development of clinical guidelines is first described. This is followed by presentation of the clinical guidelines. Included in these are the criteria and discussion which indicate consideration of the prone position, potential exclusion criteria, pre-turn considerations, the turning technique, monitoring the effectiveness of the prone position, passive movements and limb positioning and, finally, documentation of the problems associated with use of the prone position. The paper concludes with discussion concerning the potential for future research in this area. Copyright 2001 Harcourt Publishers Ltd

## B. Synopses or Summaries

#### BMJ Best Practice

**Coronavirus disease 2019 (COVID-19) View PDF** (2020)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=4f616fd550fe7f5bba1f8a30badd2284)

See "Management of severe COVID-19 -- Oxygen" section and "Management of critical COVID-19 -- Mechanical Ventilation" section

#### Dynamed

**COVID-19 (Novel Coronavirus)** (2020)

Vito Iacoviello MD, FIDSA

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=519799deea58e00ce8b0a9397f4e827b)

See "Management -- Supportive Management -- Management of Hypoxemia and Acute Respiratory Distress Syndrome (ARDS)" section

#### UpToDate

**Prone ventilation for adult patients with acute respiratory distress syndrome** (2020)

Atul Malhotra, MD; Robert M. Kacmarek, PhD, RRT

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=41139291346f137d21ab5178f88e6bf3)

## C. Review Articles

#### BestBETs

**BestBETs: Prone positioning in awake patients with hypoxaemic respiratory failure** (2020)

Jack Bell

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=d80320dc1fb1ab21b46b374a14a4448e)

#### Intensive & Critical Care Nursing

**Nursing issues in enteral nutrition during prone position in critically ill patients: A systematic review of the literature** (2020)

Bruni Andrea, Garofalo Eugenio, Grande Laura, Auletta Gaetano, Cubello Davide, Greco Manfredi, Lombardo Nicola, Garieri Pietro, Papaleo Anna, Doldo Patrizia, Spagnuolo Rocco, Longhini Federico

BackgroundEarly enteral nutrition (EN) and prone position may both improve the outcome of patients affected by moderate to severe Acute Respiratory Distress Syndrome. Recent guidelines suggest to administer early EN also during prone position. However, EN intolerance, such as high residual gastric volumes, regurgitation or vomiting, may occur during pronation.AimThis systematic review aims to assess the occurrence of high residual gastric volume, regurgitation or vomiting episodes, that can be encountered in patients receiving EN during prone position.MethodsWe have conducted a systematic review. We queried three scientific databases (MEDLINE, EMBASE and CINAHL) from inception until November 19, 2019 without language restrictions, using keywords and related MeSH terms. All relevant articles enrolling adult patients receiving invasive mechanical ventilation and evaluating the use of early EN during prone position were included.ResultsFrom 111 records obtained, we included six studies. All studies but one reported no differences with respect to gastric residual volumes between supine and prone positions. A 24-hours EN administration protocol seems to be better, as compared to an 18-hours feeding protocol. The need to stop EN and vomiting episodes were higher during prone position, although the rate of high gastric volume was similar between supine and prone positions. Ventilator associated pneumonia, lengths of stay and mortalities were similar between supine and prone positions. Only one study reported lower mortality in patients receiving EN throughout the entire day, as compared to an 18-hours administration protocol.ConclusionProtocols should be followed by healthcare providers in order to increase the enteral feeding volume, while avoiding EN intolerance (such as EN stops, high residual volume, regurgitation and vomiting).

#### Journal of intensive care medicine

**Proning in Non-Intubated (PINI) in Times of COVID-19: Case Series and a Review.** (2020)

Paul Vishesh, Patel Shawn, Royse Michelle, Odish Mazen, Malhotra Atul, Koenig Seth

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=f8265c4505049b6428feffc2db8e2716)

It has been well known for decades that prone positioning (PP) improves oxygenation. However, it has gained widespread acceptance only in the last few years since studies have shown significant survival benefit. Many centers have established prone ventilation in their treatment algorithm for mechanically ventilated patients with severe acute respiratory distress syndrome (ARDS). Physiologically, PP should also benefit awake, non-intubated patients with acute hypoxemic respiratory failure. However, proning in non-intubated (PINI) patients did not gain any momentum until a few months ago when the Coronavirus disease 2019 (COVID-19) pandemic surged. A large number of sick patients overwhelmed the health care system, and many centers faced a dearth of ventilators. In addition, outcomes of patients placed on mechanical ventilation because of COVID-19 infection have been highly variable and often dismal. Hence, increased focus has shifted to using various strategies to prevent intubation, such as PINI. There is accumulating evidence that PINI is a low-risk intervention that can be performed even outside intensive care unit with minimal assistance and may prevent intubation in certain patients with ARDS. It can also be performed safely at smaller centers and, therefore, may reduce the patient transfer to larger institutions that are overwhelmed in the current crisis. We present a case series of 2 patients with acute hypoxemic respiratory failure who experienced significant improvements in oxygenation with PP. In addition, the physiology of PP is described, and concerns such as proning in obese and patient's anxiety are addressed; an educational pamphlet that may be useful for both patients and health care providers is provided.

#### Southern African Journal of Anaesthesia and Analgesia

**Risk factors and interventions associated with mortality or survival in adult covid-19 patients admitted to critical care: A systematic review and meta-analysis** (2020)

Taylor E.H., Hofmeyr R., Nejthardt M., Isaacs M., Gerber C., van der Spuy K., Chen A., Swanevelder J., Biccard B.M., Torborg A., van Tonder C., Boden R., Earle E., Kabambi K.F., Usenbo A., Mrara B., Ndhlovu T., Coetzee J.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=902bf656049194b3e4e74fe9d52692be)

Background: Patients with confirmed COVID-19 admitted to intensive care units have a high mortality rate, which appears to be associated with increasing age, male sex, smoking history, hypertension and diabetes mellitus. <br/>Method(s): A systematic review to determine risk factors and interventions associated with mortality/survival in adult patients admitted to an intensive care unit (ICU) with confirmed COVID-19/SARS-CoV-2 infection. The protocol was registered with PROSPERO (CRD42020181185). <br/>Result(s): The search identified 483 abstracts between 1 January and 7 April 2020, of which nine studies were included in the final review. Only one study was of low bias. Advanced age (odds ratio [OR] 11.99, 95% confidence interval [CI] 5.35-18.62) and a history of hypertension were associated with mortality (OR 4.17, 95% CI 2.90-5.99). Sex was not associated with mortality. There was insufficient data to assess the association between other comorbidities, laboratory results or critical care risk indices and mortality. The critical care interventions of mechanical ventilation (OR 6.25, 95% CI 0.75-51.93), prone positioning during ventilation (OR 2.06, 95% CI 0.20-21.72), and extracorporeal membrane oxygenation (ECMO) (OR 8.00, 95% CI 0.69, 92.33) were not associated with mortality. The sample size was insufficient to conclusively determine the association between these interventions and ICU mortality. The need for inotropes or vasopressors was associated with mortality (OR 6.36, 95% CI 1.89-21.36). <br/>Conclusion(s): The studies provided little granular data to inform risk stratification or prognostication of patients requiring intensive care admission. Larger collaborative research is needed to address this limitation.<br/>Copyright © 2020 The Author(s).

#### Journal of Pharmacy Practice

**Moderate to Severe Acute Respiratory Distress Syndrome Management Strategies: A Narrative Review.** (2019)

Buckley , Dzierba Amy L., Muir Justin, Gonzales Jeffrey P.

Acute respiratory distress syndrome (ARDS) remains a common complication associated with significant negative outcomes in critically ill patients. Lung-protective mechanical ventilation strategies remain the cornerstone in the management of ARDS. Several therapeutic options are currently available including fluid management, neuromuscular blocking agents, prone positioning, extracorporeal membrane oxygenation, corticosteroids, and inhaled pulmonary vasodilating agents (prostacyclins and nitric oxide). Unfortunately, an evidence-based, standard-of-care approach in managing ARDS beyond lung-protective ventilation remains elusive, contributing to significant variability in clinical practice. Although the optimal therapeutic strategy for managing moderate to severe ARDS remains extremely controversial, therapies supported with more robust clinical evidence should be considered first. The purpose of this narrative review is to discuss the published clinical evidence for both pharmacologic and nonpharmacologic management strategies in adult patients with moderate to severe ARDS as well as to discuss practical considerations for implementation.

#### Annals of the American Thoracic Society

**Prone Position for Acute Respiratory Distress Syndrome. A Systematic Review and Meta-Analysis.** (2017)

Munshi Laveena, Del Sorbo Lorenzo, Adhikari Neill K. J, Hodgson Carol L., Wunsch Hannah, Meade Maureen O., Uleryk Elizabeth, Mancebo Jordi, Pesenti Antonio, Ranieri V. Marco, Fan Eddy

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=2aecbdc3b723496aec54b7565642531a)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=f736cd04e8a6fb12addfd415df1444ba)

RATIONALEThe application of prone positioning for acute respiratory distress syndrome (ARDS) has evolved, with recent trials focusing on patients with more severe ARDS, and applying prone ventilation for more prolonged periods.OBJECTIVESThis review evaluates the effect of prone positioning on 28-day mortality (primary outcome) compared with conventional mechanical ventilation in the supine position for adults with ARDS.METHODSWe updated the literature search from a systematic review published in 2010, searching MEDLINE, EMBASE, and CENTRAL (through to August 2016). We included randomized, controlled trials (RCTs) comparing prone to supine positioning in mechanically ventilated adults with ARDS, and conducted sensitivity analyses to explore the effects of duration of prone ventilation, concurrent lung-protective ventilation and ARDS severity. Secondary outcomes included PaO2/FiO2 ratio on Day 4 and an evaluation of adverse events. Meta-analyses used random effects models. Methodologic quality of the RCTs was evaluated using the Cochrane risk of bias instrument, and methodologic quality of the overall body of evidence was evaluated using the GRADE (Grading of Recommendations Assessment, Development, and Evaluation) guidelines.RESULTSEight RCTs fulfilled entry criteria, and included 2,129 patients (1,093 [51%] proned). Meta-analysis revealed no difference in mortality (risk ratio [RR], 0.84; 95% confidence interval [CI], 0.68-1.04), but subgroup analyses found lower mortality with 12 hours or greater duration prone (five trials; RR, 0.74; 95% CI, 0.56-0.99) and for patients with moderate to severe ARDS (five trials; RR, 0.74; 95% CI, 0.56-0.99). PaO2/FiO2 ratio on Day 4 for all patients was significantly higher in the prone positioning group (mean difference, 23.5; 95% CI, 12.4-34.5). Prone positioning was associated with higher rates of endotracheal tube obstruction and pressure sores. Risk of bias was low across the trials.CONCLUSIONSProne positioning is likely to reduce mortality among patients with severe ARDS when applied for at least 12 hours daily.

#### The Cochrane database of systematic reviews

**Lateral positioning for critically ill adult patients.** (2016)

Hewitt Nicky, Bucknall Tracey, Faraone Nardene M.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=39a3028ca2857a64fb49da102f1a12b3)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=e5c683aebeda81f0ce153107bb9307af)

BACKGROUNDCritically ill patients require regular body position changes to minimize the adverse effects of bed rest, inactivity and immobilization. However, uncertainty surrounds the effectiveness of lateral positioning for improving pulmonary gas exchange, aiding drainage of tracheobronchial secretions and preventing morbidity. In addition, it is unclear whether the perceived risk levied by respiratory and haemodynamic instability upon turning critically ill patients outweighs the respiratory benefits of side-to-side rotation. Thus, lack of certainty may contribute to variation in positioning practice and equivocal patient outcomes.OBJECTIVESTo evaluate effects of the lateral position compared with other body positions on patient outcomes (mortality, morbidity and clinical adverse events) in critically ill adult patients. (Clinical adverse events include hypoxaemia, hypotension, low oxygen delivery and global indicators of impaired tissue oxygenation.) We examined single use of the lateral position (i.e. on the right or left side) and repeat use of the lateral position (i.e. lateral positioning) within a positioning schedule.SEARCH METHODSWe searched the Cochrane Central Register of Controlled Trials (CENTRAL; 2015, Issue 5), MEDLINE (1950 to 23 May 2015), the Cumulative Index to Nursing and Allied Health Literature (CINAHL) (1937 to 23 May 2015), the Allied and Complementary Medicine Database (AMED) (1984 to 23 May 2015), Latin American Caribbean Health Sciences Literature (LILACS) (1901 to 23 May 2015), Web of Science (1945 to 23 May 2015), Index to Theses in Great Britain and Ireland (1950 to 23 May 2015), Trove (2009 to 23 May 2015; previously Australasian Digital Theses Program (1997 to December 2008)) and Proquest Dissertations and Theses (2009 to 23 May 2015; previously Proquest Digital Dissertations (1980 to 23 May 2015)). We handsearched the reference lists of potentially relevant reports and two nursing journals.SELECTION CRITERIAWe included randomized and quasi-randomized trials examining effects of lateral positioning in critically ill adults. We included manual or automated turns but limited eligibility to studies that included duration of body position of 10 minutes or longer. We examined each lateral position versus at least one comparator (opposite lateral position and/or another body position) for single therapy effects, and the lateral positioning schedule (repeated lateral turning) versus other positioning schedules for repetitive therapy effects.DATA COLLECTION AND ANALYSISWe pre-specified methods to be used for data collection, risk of bias assessment and analysis. Two independent review authors carried out each stage of selection and data extraction and settled differences in opinion by consensus, or by third party adjudication when disagreements remained unresolved. We planned analysis of pair-wise comparisons under composite time intervals with the aim of considering recommendations based on meta-analyses of studies with low risk of bias.MAIN RESULTSWe included 24 studies of critically ill adults. No study reported mortality as an outcome of interest. Two randomized controlled trials (RCTs) examined lateral positioning for pulmonary morbidity outcomes but provided insufficient information for meta-analysis. A total of 22 randomized trials examined effects of lateral positioning (four parallel-group and 18 cross-over designs) by measuring various continuous data outcomes commonly used to detect adverse cardiopulmonary events within critical care areas. However, parallel-group studies were not comparable, and cross-over studies provided limited data as the result of unit of analysis errors. Eight studies provided some data; most of these were single studies with small effects that were imprecise. We pooled partial pressure of arterial oxygen (PaO2) as a measure to detect hypoxaemia from two small studies of participants with unilateral lung disease (n = 19). The mean difference (MD) between lateral positions (bad lung down versus good lung down) was approximately 50 mmHg (MD -49.26 mmHg, 95% confidence interval (CI) -67.33 to -31.18; P value < 0.00001). Despite a lower mean PaO2 for bad lung down, hypoxaemia (mean PaO2 < 60 mmHg) was not consistently reported. Furthermore, pooled data had methodological shortcomings with unclear risk of bias. We had similar doubts regarding internal validity for other studies included in the review.AUTHORS' CONCLUSIONSReview authors could provide no clinical practice recommendations based on the findings of included studies. Available research could not eliminate the uncertainty surrounding benefits and/or risks associated with lateral positioning of critically ill adult patients. Research gaps include the effectiveness of lateral positioning compared with semi recumbent positioning for mechanically ventilated patients, lateral positioning compared with prone positioning for acute respiratory distress syndrome (ARDS) and less frequent changes in body position. We recommend that future research be undertaken to address whether the routine practice of repositioning patients on their side benefits all, some or few critically ill patients.

#### Chest

**Use of rescue therapies during the H1N1 pandemic: A systematic review exploring global differences in the management of severe acute respiratory distress syndrome** (2015)

Gadre S., Duggal A.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=174f11cc231ebce703679ee3a12831c9)

Purpose: The 2009-2010 Influenza A (H1N1) outbreak was declared the first pandemic of this century after early reports of high morbidity and mortality. The H1N1 pandemic was the first instance of a pandemic that was globally reported over different geographical and socioeconomic strata. There are significant differences in the utilization of resources for Acute Respiratory Distress Syndrome (ARDS) management in different geographical settings. Our goal was to better understand global differences in the management of severe ARDS with a focus on the utilization of non-conventional modalities. <br/>Method(s): We performed a systematic review of all studies published between 3/2009 and 6/2013 describing patients with ARDS during the 2009-2010 Influenza A (H1N1) outbreak. <br/>Result(s): We identified 121 studies from 41 countries that described ARDS in the setting of H1N1 influenza A. Only 39 (32.23%) studies from 20 countries reported exclusively on adult patients with ARDS. The mean age ranged from 31.2-48.3 years. The mean APACHE II score ranged from 11.4-66. The mean PaO2 to FiO2 ratio ranged from 52.9-196 mmHg. Studies from Europe and North America utilized rescue interventions like prone position ventilation (13-32% patients), inhaled vasodilators (13-27% patients) and ECMO (11-86% patients) much more than in countries with limited critical care capacity. At a global level, the inhaled vasodilators (n=231, 16.92%), prone position ventilation (n=206, 15.09%) and extra corporeal membrane oxygenation (ECMO) (n=461, 33.77%) were the most common rescue interventions for severe ARDS. Globally, the use of neuromuscular blockade (n=7, 0.51%), airway pressure release ventilation (APRV) (n=11, 0.8%) and high frequency oscillatory ventilation (HFOV) (n=14, 1.02%) was infrequent. The short-term mortality for patients in developed countries was 23-43% compared to 20-77% in developing countries. <br/>Conclusion(s): The 2009 pandemic resulted in a sudden increase in the incidence of severe respiratory failure due to a reversible infectious etiology in a relatively young population. In developed countries, prone position ventilation and inhaled vasodilators were used often. ECMO was a commonly used rescue strategy with favorable short-term mortality. In developing countries, rescue treatments for refractory hypoxemia were infrequently used and a higher short-term mortality was noted. Clinical Implications: The systematic review describes the utilization of rescue strategies for ARDS, which could direct therapy in the event of a future pandemic.

#### Medicina intensiva

**The effects of prone position ventilation in patients with acute respiratory distress syndrome. A systematic review and metaanalysis.** (2015)

Mora-Arteaga J. A, Bernal-Ramírez O. J, Rodríguez S. J

INTRODUCTIONProne position ventilation has been shown to improve oxygenation and ventilatory mechanics in patients with acute respiratory distress syndrome. We evaluated whether prone ventilation reduces the risk of mortality in adult patients with acute respiratory distress syndrome versus supine ventilation.METHODOLOGYA metaanalysis of randomized controlled trials comparing patients in supine versus prone position was performed. A search was conducted of the Pubmed, Embase, Cochrane Library, and LILACS databases. Mortality, hospital length of stay, days of mechanical ventilation and adverse effects were evaluated.RESULTSSeven randomized controlled trials (2,119 patients) were included in the analysis. The prone position showed a nonsignificant tendency to reduce mortality (OR: 0.76; 95%CI: 0.54 to 1.06; P=.11, I(2) 63%). When stratified by subgroups, a significant decrease was seen in the risk of mortality in patients ventilated with low tidal volume (OR: 0.58; 95%CI: 0.38 to 0.87; P=.009, I(2) 33%), prolonged pronation (OR: 0.6; 95%CI: 0.43 to 0.83; p=.002, I(2) 27%), start within the first 48hours of disease evolution (OR 0.49; 95%CI 0.35 to 0.68; P=.0001, I(2) 0%) and severe hypoxemia (OR: 0.51: 95%CI: 0.36 to 1.25; P=.0001, I(2) 0%). Adverse effects associated with pronation were the development of pressure ulcers and endotracheal tube obstruction.CONCLUSIONSProne position ventilation is a safe strategy and reduces mortality in patients with severely impaired oxygenation. It should be started early, for prolonged periods, and should be associated to a protective ventilation strategy.

#### The Cochrane database of systematic reviews

**Prone position for acute respiratory failure in adults.** (2015)

Bloomfield Roxanna, Noble David W., Sudlow Alexis

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=3482151bca2c2a44e8c2420d37f5e2a7)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=97b9ef5a10bd7e817a07150aa37a6f67)

BACKGROUNDAcute hypoxaemia de novo or on a background of chronic hypoxaemia is a common reason for admission to intensive care and for provision of mechanical ventilation. Various refinements of mechanical ventilation or adjuncts are employed to improve patient outcomes. Mortality from acute respiratory distress syndrome, one of the main contributors to the need for mechanical ventilation for hypoxaemia, remains approximately 40%. Ventilation in the prone position may improve lung mechanics and gas exchange and could improve outcomes.OBJECTIVESThe objectives of this review are (1) to ascertain whether prone ventilation offers a mortality advantage when compared with traditional supine or semi recumbent ventilation in patients with severe acute respiratory failure requiring conventional invasive artificial ventilation, and (2) to supplement previous systematic reviews on prone ventilation for hypoxaemic respiratory failure in an adult population.SEARCH METHODSWe searched the Cochrane Central Register of Controlled Trials (CENTRAL; 2014, Issue 1), Ovid MEDLINE (1950 to 31 January 2014), EMBASE (1980 to 31 January 2014), the Cumulative Index to Nursing and Allied Health Literature (CINAHL) (1982 to 31 January 2014) and Latin American Caribbean Health Sciences Literature (LILACS) (1992 to 31 January 2014) in Ovid MEDLINE for eligible randomized controlled trials. We also searched for studies by handsearching reference lists of relevant articles, by contacting colleagues and by handsearching published proceedings of relevant journals. We applied no language constraints, and we reran the searches in CENTRAL, MEDLINE, EMBASE, CINAHL and LILACS in June 2015. We added five new studies of potential interest to the list of "Studies awaiting classification" and will incorporate them into formal review findings during the review update.SELECTION CRITERIAWe included randomized controlled trials (RCTs) that examined the effects of prone position versus supine/semi recumbent position during conventional mechanical ventilation in adult participants with acute hypoxaemia.DATA COLLECTION AND ANALYSISTwo review authors independently reviewed all trials identified by the search and assessed them for suitability, methods and quality. Two review authors extracted data, and three review authors reviewed the data extracted. We analysed data using Review Manager software and pooled included studies to determine the risk ratio (RR) for mortality and the risk ratio or mean difference (MD) for secondary outcomes; we also performed subgroup analyses and sensitivity analyses.MAIN RESULTSWe identified nine relevant RCTs, which enrolled a total of 2165 participants (10 publications). All recruited participants suffered from disorders of lung function causing moderate to severe hypoxaemia and requiring mechanical ventilation, so they were fairly comparable, given the heterogeneity of specific disease diagnoses in intensive care. Risk of bias, although acceptable in the view of the review authors, was inevitable: Blinding of participants and carers to treatment allocation was not possible (face-up vs face-down).Primary analyses of short- and longer-term mortality pooled from six trials demonstrated an RR of 0.84 to 0.86 in favour of the prone position (PP), but findings were not statistically significant: In the short term, mortality for those ventilated prone was 33.4% (363/1086) and supine 38.3% (395/1031). This resulted in an RR of 0.84 (95% confidence interval (CI) 0.69 to 1.02) marginally in favour of PP. For longer-term mortality, results showed 41.7% (462/1107) for prone and 47.1% (490/1041) for supine positions, with an RR of 0.86 (95% CI 0.72 to 1.03). The quality of the evidence for both outcomes was rated as low as a result of important potential bias and serious inconsistency.Subgroup analyses for mortality identified three groups consistently favouring PP: those recruited within 48 hours of meeting entry criteria (five trials; 1024 participants showed an RR of 0.75 (95% CI 0.59 to 94)); those treated in the PP for 16 or more hours per day (five trials; 1005 participants showed an RR of 0.77 (95% CI 0.61 to 0.99)); and participants with more severe hypoxaemia at trial entry (six trials; 1108 participants showed an RR of 0.77 (95% CI 0.65 to 0.92)). The quality of the evidence for these outcomes was rated as moderate as a result of potentially important bias.Prone positioning appeared to influence adverse effects: Pressure sores (three trials; 366 participants) with an RR of 1.37 (95% CI 1.05 to 1.79) and tracheal tube obstruction with an RR of 1.78 (95% CI 1.22 to 2.60) were increased with prone ventilation. Reporting of arrhythmias was reduced with PP, with an RR of 0.64 (95% CI 0.47 to 0.87).AUTHORS' CONCLUSIONSWe found no convincing evidence of benefit nor harm from universal application of PP in adults with hypoxaemia mechanically ventilated in intensive care units (ICUs). Three subgroups (early implementation of PP, prolonged adoption of PP and severe hypoxaemia at study entry) suggested that prone positioning may confer a statistically significant mortality advantage. Additional adequately powered studies would be required to confirm or refute these possibilities of subgroup benefit but are unlikely, given results of the most recent study and recommendations derived from several published subgroup analyses. Meta-analysis of individual patient data could be useful for further data exploration in this regard. Complications such as tracheal obstruction are increased with use of prone ventilation. Long-term mortality data (12 months and beyond), as well as functional, neuro-psychological and quality of life data, are required if future studies are to better inform the role of PP in the management of hypoxaemic respiratory failure in the ICU.

#### Journal of Critical Care

**Impact of patient position on the incidence of ventilator-associated pneumonia: A meta-analysis of randomized controlled trials** (2009)

Alexiou Vangelis G., Ierodiakonou Vrettos, Dimopoulos George, Falagas Matthew E.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=af8d2d8bc090c2ea50a7630ed6973281)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=005fddaf98f30f28704bdc83c1cdc1e6)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=ebe6dc45d1e196700f601c2f5836cf5a)

  The aim of this study is to summarize the effect of position (prone and semirecumbent 45°) of mechanically ventilated patients on the incidence of ventilator-associated pneumonia (VAP) and other outcomes. A systematic search for randomized control trials (RCTs) was done. We estimated pooled odds ratios (ORs) and 95% confidence intervals (CIs) using fixed effects model or random effects model, where appropriate. For continuous variables, we calculated the estimation of weighted mean differences. We analyzed data extracted from 3 RCTs studying the semirecumbent 45° and 4 RCTs studying the prone position with a total of 337 and 1018 patients, respectively. The odds of developing clinically diagnosed VAP were significantly lower among patients in the semirecumbent 45° position compared to patients in the supine position (OR = 0.47; 95% CI, 0.27-0.82; 337 patients). The comparison of prone vs supine position group showed a moderate trend toward better outcomes regarding the incidence of clinically diagnosed VAP among patients in the prone position (OR = 0.80; 95% CI, 0.60-1.08; 1018 patients). The subanalysis regarding the incidence of microbiologically documented VAP, the length of intensive care unit stay, and the duration of mechanical ventilation showed that patients in the semirecumbent 45° position have a moderate trend toward better clinical outcomes. This meta-analysis provides additional evidence that the usual practice of back-rest elevation of 15° to 30° is not sufficient to prevent VAP in mechanically ventilated patients. Patients positioned semirecumbently 45° have significantly lower incidence of clinically diagnosed VAP compared to patients positioned supinely. On the other hand, the incidence of clinically diagnosed VAP among patients positioned pronely does not differ significantly from the incidence of clinically diagnosed VAP among patients positioned supinely.   The aim of this study is to summarize the effect of position (prone and semirecumbent 45 degrees ) of mechanically ventilated patients on the incidence of ventilator-associated pneumonia (VAP) and other outcomes. A systematic search for randomized control trials (RCTs) was done. We estimated pooled odds ratios (ORs) and 95% confidence intervals (CIs) using fixed effects model or random effects model, where appropriate. For continuous variables, we calculated the estimation of weighted mean differences. We analyzed data extracted from 3 RCTs studying the semirecumbent 45 degrees and 4 RCTs studying the prone position with a total of 337 and 1018 patients, respectively. The odds of developing clinically diagnosed VAP were significantly lower among patients in the semirecumbent 45 degrees position compared to patients in the supine position (OR = 0.47; 95% CI, 0.27-0.82; 337 patients). The comparison of prone vs supine position group showed a moderate trend toward better outcomes regarding the incidence of clinically diagnosed VAP among patients in the prone position (OR = 0.80; 95% CI, 0.60-1.08; 1018 patients). The subanalysis regarding the incidence of microbiologically documented VAP, the length of intensive care unit stay, and the duration of mechanical ventilation showed that patients in the semirecumbent 45 degrees position have a moderate trend toward better clinical outcomes. This meta-analysis provides additional evidence that the usual practice of back-rest elevation of 15 degrees to 30 degrees is not sufficient to prevent VAP in mechanically ventilated patients. Patients positioned semirecumbently 45 degrees have significantly lower incidence of clinically diagnosed VAP compared to patients positioned supinely. On the other hand, the incidence of clinically diagnosed VAP among patients positioned pronely does not differ significantly from the incidence of clinically diagnosed VAP among patients positioned supinely.

#### Journal of critical care

**Prone positioning in hypoxemic respiratory failure: meta-analysis of randomized controlled trials.** (2009)

Kopterides Petros, Siempos Ilias I., Armaganidis Apostolos

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=b63a3970fd562241411b77f2d132c8c1)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=3b9ec453edaaf01692f4425cb5f635fc)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=ebe6dc45d1e196700f601c2f5836cf5a)

PURPOSEProne positioning is used to improve oxygenation in patients with hypoxemic respiratory failure (HRF). However, its role in clinical practice is not yet clearly defined. The aim of this meta-analysis was to assess the effect of prone positioning on relevant clinical outcomes, such as intensive care unit (ICU) and hospital mortality, days of mechanical ventilation, length of stay, incidence of ventilator-associated pneumonia (VAP) and pneumothorax, and associated complications.METHODSWe used literature search of MEDLINE, Current Contents, and Cochrane Central Register of Controlled Trials. We focused only on randomized controlled trials reporting clinical outcomes in adult patients with HRF. Four trials met our inclusion criteria, including 662 patients randomized to prone ventilation and 609 patients to supine ventilation.RESULTSThe pooled odds ratio (OR) for the ICU mortality in the intention-to-treat analysis was 0.97 (95% confidence interval [CI], 0.77-1.22), for the comparison between prone and supine ventilated patients. Interestingly, the pooled OR for the ICU mortality in the selected group of the more severely ill patients favored prone positioning (OR, 0.34; 95% CI, 0.18-0.66). The duration of mechanical ventilation and the incidence of pneumothorax were not different between the 2 groups. The incidence of VAP was lower but not statistically significant in patients treated with prone positioning (OR, 0.81; 95% CI, 0.61-1.10). However, prone positioning was associated with a higher risk of pressure sores (OR, 1.49; 95% CI, 1.17-1.89) and a trend for more complications related to the endotracheal tube (OR, 1.30; 95% CI, 0.94-1.80).CONCLUSIONSDespite the inherent limitations of the meta-analytic approach, it seems that prone positioning has no discernible effect on mortality in patients with HRF. It may decrease the incidence of VAP at the expense of more pressure sores and complications related to the endotracheal tube. However, a subgroup of the most severely ill patients may benefit most from this intervention.

#### American journal of health-system pharmacy : AJHP : official journal of the American Society of Health-System Pharmacists

**Recent developments in the management of acute respiratory distress syndrome in adults.** (2008)

Bream-Rouwenhorst Heather R., Beltz Elizabeth A., Ross Mary B., Moores Kevin G.

PURPOSERecent developments in the management of acute respiratory distress syndrome (ARDS) in adults are reviewed.SUMMARYCorticosteroids have been extensively studied in ARDS; however, they have not demonstrated clear benefit in patients with ARDS. Some trials have found increased complications and mortality related to corticosteroid use. The use of conservative fluid management has been associated with significant reductions in morbidity, highlighting the need to avoid fluid over-administration in patients with ARDS. A number of ventilatory strategies have also been studied. Studies have found that higher positive end-expiratory pressure settings do not appear to be harmful in patients with ARDS. In an effort to prevent alveolar overdistention, low tidal volume and plateau pressure ventilation is increasingly being used in patients with acute lung injury (ALI). Given the increasing evidence supporting the use of lower tidal volume ventilation, this strategy has become the new standard of care in patients with suspected ALI and ARDS. No clear benefit has been shown in the treatment of ARDS with nitric oxide and surfactant. Prostaglandins and acetylcysteine are not considered useful in the treatment of ARDS, while no conclusions can be drawn regarding the benefits of albuterol on mortality in patients with ARDS. The use of prone positioning should be discouraged in the treatment of ARDS based on its associated risks.CONCLUSIONEarly administration of moderate-dosage corticosteroids likely helps decrease the time of ventilator dependence and duration of intensive care unit stay. Conservative fluid management and low tidal volume ventilation are becoming increasingly widespread in the management of patients with ARDS. Nitric oxide, surfactant, prostaglandins, albuterol, acetylcysteine, and prone positioning have not been shown to be beneficial in the treatment of ARDS.

#### Health SA Gesondheid

**Evidence-based nursing interventions and guidelines for prone positioning of adult, ventilated patients: a systematic review.** (2008)

Nortje S., Nel E., Nolte A.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=f17e867d4f8f9a6be32e2be91995c555)

Although the prone positioning of a critically ill patient poses a challenge to nursing interventions, it remains the responsibility of nurses to develop a way to provide the same basic and intensive care to those patients lying prone as to those lying supine. The purpose of this study was firstly to conduct a systematic review of the literature as exploration and description ofthe evidence in support of the beneficial nursing interventions during prone positioning of ventilated patients, and secondly to develop evidence-based nursing guidelines for the nursing process. This exploratory, descriptive and retrospective systematic review includes data from 45 clinical trials, with a total population of 2 148 patients. Data was extracted onto data abstraction forms, assessed for methodological quality and finally summarised in evidence tables. All statistical calculations for the meta-analysis were performed by the RevMan 4.2.8 program. Prone positioning showed significant (p < 0.0001) increases in the partial pressure of oxygen in arterial blood (PaO2) weighted mean difference (WMD =11.43) and the partial pressure of oxygen in arterial blood/fraction of inspired oxygen (PaO2/FiO2) ratio (WMD = 21.58, 95% CI = 11.36; 31.8). The effects of complications, oxygenation and haemodynamic outcomes compared with the different prone-positioning protocols produced inconclusive results. Nursing guidelines for prone positioning were developed based on the best available evidence. The lack of related articles on nursing care of prone positioning was a drawback. Based on these results, recommendations are made towards further study on the nursing care of prone-positioned patients.

#### Critical Care Medicine

**Mechanical ventilation in sepsis-induced acute lung injury/acute respiratory distress syndrome: An evidence-based review** (2004)

Sevransky J.E., Levy M.M., Marini J.J.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=4010ea10a53744c031b70f1ea9d149e2)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=4010ea10a53744c031b70f1ea9d149e2)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=128aa715eaf2274748374ffcee28f6d3)

Objective: In 2003, critical care and infectious disease experts representing 11 international organizations developed management guidelines for mechanical ventilation in sepsis-induced acute lung injury/acute respiratory distress syndrome (ARDS) that would be of practical use for the bedside clinician, under the auspices of the Surviving Sepsis Campaign, an international effort to increase awareness and improve outcome in severe sepsis. <br/>Design(s): The process included a modified Delphi method, a consensus conference, several subsequent smaller meetings of subgroups and key individuals, teleconferences, and electronic-based discussion among subgroups and among the entire committee. <br/>Method(s): The modified Delphi methodology used for grading recommendations built on a 2001 publication sponsored by the International Sepsis Forum. We undertook a systematic review of the literature graded along five levels to create recommendation grades from A to E, with A being the highest grade. Pediatric considerations to contrast adult and pediatric management are in the article by Parker et al. on p. S591. <br/>Conclusion(s): A minimum amount of positive end-expiratory pressure should be set to prevent lung collapse at end expiration in ARDS. Setting the level of positive end-expiratory pressure may be guided by FIO<sub>2</sub> requirement or measurement of thoracopulmonary compliance. Role of noninvasive positive-pressure ventilation in acute lung injury/ARDS is undefined. Small tidal volume ventilation and limitation of end-inspiratory plateau pressure is important in the management of ARDS and may be facilitated by permissive hypercapnia. Prone positioning should be considered in the severest of ARDS patients. The ideal fluid management strategy in ARDS is unknown. Weaning protocols should be in place that include spontaneous breathing trials and criteria for initiating such trials. The role of high-frequency oscillatory ventilation and airway pressure release ventilation in ARDS is uncertain.

## D. Original Research

1. **"How I Do It: High Flow, Non-invasive ventilation and Awake (non-intubation) Proning in Covid-19 Patients with Respiratory Failure"**  
   Raoof S. Chest 2020;:No page numbers.

The Covid 19 pandemic will be remembered for the rapidity with which it spread, the morbidity and mortality associated with it and the paucity of evidence-based management guidelines. One of the major concerns of hospitals was to limit spread of infection to health care workers. Since the virus is spread mainly by respiratory droplets and aerosolized particles, procedures which may potentially disperse viral particles, the so called "aerosol-generating procedures" or AGPs were avoided whenever possible. Included in this category were non-invasive ventilation (NIV), high flow nasal cannula (HFNC) and awake (non-intubated) proning. Accordingly, at many health care facilities, patients who had increasing oxygen requirements were emergently intubated and mechanically ventilated to avoid exposure to AGPs. With experience, clinicians realized that mortality of invasively ventilated patients was high and it was not easy to extubate many of these patients. This raised the concern that HFNC and NIV were being underutilized to avoid intubation and to facilitate extubation. In this article, we attempt to separate fact from fiction and perception from reality pertaining to the aerosol dispersion with NIV, HFNC and AP. We describe precautions that hospitals and health care providers must take to mitigate risks with these devices. Finally, we take a practical approach in describing how we use the three techniques, including the common indications, contraindications and practical aspects of application.<br/>Copyright &#xa9; 2020. Published by Elsevier Inc.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=a7bff0adca7e4663ca041661864bcfa0)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=fa665322cfed97da1c3ba4a227128b8b)

1. **Awake prone positioning for non-intubated oxygen dependent COVID-19 pneumonia patients.**  
   Ng Ziqin The European respiratory journal 2020;56(1):No page numbers.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=c44df2d32acfadbca0096ee7163ec3fc)

1. **Benefits of conscious proning of patients with Covid-19.**  
   Burke World of Irish Nursing & Midwifery 2020;28(5):52-53.

1. **Early application of prone position for management of Covid-19 patients.**  
   Golestani-Eraghi Majid Journal of clinical anesthesia 2020;66:109917.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=0a4fa4446ad8512b2d7fcc1b669c660d)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=bbb66c84cada5c4fc71a084df18554f5)

1. **Early Self-Proning in Awake, Non-intubated Patients in the Emergency Department: A Single ED's Experience During the COVID-19 Pandemic**  
   Caputo N.D. Academic Emergency Medicine 2020;27(5):375-378.

Objective: Prolonged and unaddressed hypoxia can lead to poor patient outcomes. Proning has become a standard treatment in the management of patients with ARDS who have difficulty achieving adequate oxygen saturation. The purpose of this study was to describe the use of early proning of awake, non-intubated patients in the emergency department (ED) during the COVID-19 pandemic. <br/>Method(s): This pilot study was carried out in a single urban ED in New York City. We included patients suspected of having COVID-19 with hypoxia on arrival. A standard pulse oximeter was used to measure SpO<sub>2</sub>. SpO<sub>2</sub> measurements were recorded at triage and after 5 minutes of proning. Supplemental oxygenation methods included non-rebreather mask (NRB) and nasal cannula. We also characterized post-proning failure rates of intubation within the first 24 hours of arrival to the ED. <br/>Result(s): Fifty patients were included. Overall, the median SpO<sub>2</sub> at triage was 80% (IQR 69 to 85). After application of supplemental oxygen was given to patients on room air it was 84% (IQR 75 to 90). After 5 minutes of proning was added SpO<sub>2</sub> improved to 94% (IQR 90 to 95). Comparison of the pre- to post-median by the Wilcoxon Rank-sum test yielded P = 0.001. Thirteen patients (24%) failed to improve or maintain their oxygen saturations and required endotracheal intubation within 24 hours of arrival to the ED. <br/>Conclusion(s): Awake early self-proning in the emergency department demonstrated improved oxygen saturation in our COVID-19 positive patients. Further studies are needed to support causality and determine the effect of proning on disease severity and mortality.<br/>Copyright &#xa9; 2020 by the Society for Academic Emergency Medicine

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=93800b79007b0f58f86240aa90b21a00)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=92be4509e27b11b923c6350835bf10eb)

1. **Feasibility and physiological effects of prone positioning in non-intubated patients with acute respiratory failure due to COVID-19 (PRON-COVID): a prospective cohort study.**  
   Coppo Anna The Lancet. Respiratory medicine 2020;8(8):765-774.

BACKGROUNDThe COVID-19 pandemic is challenging advanced health systems, which are dealing with an overwhelming number of patients in need of intensive care for respiratory failure, often requiring intubation. Prone positioning in intubated patients is known to reduce mortality in moderate-to-severe acute respiratory distress syndrome. We aimed to investigate feasibility and effect on gas exchange of prone positioning in awake, non-intubated patients with COVID-19-related pneumonia.METHODSIn this prospective, feasibility, cohort study, patients aged 18-75 years with a confirmed diagnosis of COVID-19-related pneumonia receiving supplemental oxygen or non-invasive continuous positive airway pressure were recruited from San Gerardo Hospital, Monza, Italy. We collected baseline data on demographics, anthropometrics, arterial blood gas, and ventilation parameters. After baseline data collection, patients were helped into the prone position, which was maintained for a minimum duration of 3 h. Clinical data were re-collected 10 min after prone positioning and 1 h after returning to the supine position. The main study outcome was the variation in oxygenation (partial pressure of oxygen [PaO2]/fractional concentration of oxygen in inspired air [FiO2]) between baseline and resupination, as an index of pulmonary recruitment. This study is registered on ClinicalTrials.gov, NCT04365959, and is now complete.FINDINGSBetween March 20 and April 9, 2020, we enrolled 56 patients, of whom 44 (79%) were male; the mean age was 57·4 years (SD 7·4) and the mean BMI was 27·5 kg/m2 (3·7). Prone positioning was feasible (ie, maintained for at least 3 h) in 47 patients (83·9% [95% CI 71·7 to 92·4]). Oxygenation substantially improved from supine to prone positioning (PaO2/FiO2 ratio 180·5 mm Hg [SD 76·6] in supine position vs 285·5 mm Hg [112·9] in prone position; p<0·0001). After resupination, improved oxygenation was maintained in 23 patients (50·0% [95% CI 34·9-65·1]; ie, responders); however, this improvement was on average not significant compared with before prone positioning (PaO2/FiO2 ratio 192·9 mm Hg [100·9] 1 h after resupination; p=0·29). Patients who maintained increased oxygenation had increased levels of inflammatory markers (C-reactive protein: 12·7 mg/L [SD 6·9] in responders vs 8·4 mg/L [6·2] in non-responders; and platelets: 241·1 × 103/μL [101·9] vs 319·8 × 103/μL [120·6]) and shorter time between admission to hospital and prone positioning (2·7 days [SD 2·1] in responders vs 4·6 days [3·7] in non-responders) than did those for whom improved oxygenation was not maintained. 13 (28%) of 46 patients were eventually intubated, seven (30%) of 23 responders and six (26%) of 23 non-responders (p=0·74). Five patients died during follow-up due to underlying disease, unrelated to study procedure.INTERPRETATIONProne positioning was feasible and effective in rapidly ameliorating blood oxygenation in awake patients with COVID-19-related pneumonia requiring oxygen supplementation. The effect was maintained after resupination in half of the patients. Further studies are warranted to ascertain the potential benefit of this technique in improving final respiratory and global outcomes.FUNDINGUniversity of Milan-Bicocca.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=f0583ebc08287cff41faa84919fb159a)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=2068bdff5b1ce3d027e8fd71290fcc7d)

1. **Helmet continuous positive airway pressure and prone positioning: A proposal for an early management of COVID-19 patients**  
   Longhini F. Pulmonology 2020;26(4):186-191.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=8ae7ce60b275588ae97c93df9ba9efc4)

1. **Implementing Automated Prone Ventilation for Acute Respiratory Distress Syndrome via Simulation-Based Training**  
   Poor A.D. American journal of critical care : an official publication, American Association of Critical-Care Nurses 2020;29(3):No page numbers.

BACKGROUND: Prone position ventilation (PPV) is recommended for patients with severe acute respiratory distress syndrome, but it remains underused. Interprofessional simulation-based training for PPV has not been described. <br/>OBJECTIVE(S): To evaluate the impact of a novel interprofessional simulation-based training program on providers' perception of and comfort with PPV and the program's ability to help identify unrecognized safety issues ("latent safety threats") before implementation. <br/>METHOD(S): A prospective observational quality improvement study was done in the medical intensive care unit of an academic medical center. Registered nurses, physicians, and respiratory therapists were trained via a didactic session, simulations, and structured debriefings during which latent safety threats were identified. Participants completed anonymous surveys before and after training. <br/>RESULT(S): A total of 73 providers (37 nurses, 18 physicians, 18 respiratory therapists) underwent training and completed surveys. Before training, only 39% of nurses agreed that PPV would be beneficial to patients with severe acute respiratory distress syndrome, compared with 96% of physicians and 70% of respiratory therapists (P &lt; .001). Less than half of both nurses and physicians felt comfortable taking care of prone patients. After training, perceived benefit increased among all providers. Comfort taking care of proned patients and managing cardiac arrest increased significantly among nurses and physicians. Twenty novel latent safety threats were identified. <br/>CONCLUSION(S): Interprofessional simulation-based training may improve providers' perception of and comfort with PPV and can help identify latent safety threats before implementation.<br/>Copyright&#xa9; 2020 American Association of Critical-Care Nurses.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=d99917a52c63623d502b90476ab3bb04)

1. **Intubation and Ventilation amid the COVID-19 Outbreak: Wuhan's Experience**  
   Meng L. Anesthesiology 2020;:1317-1332.

The COVID-19 outbreak has led to 80,409 diagnosed cases and 3,012 deaths in mainland China based on the data released on March 4, 2020. Approximately 3.2% of patients with COVID-19 required intubation and invasive ventilation at some point in the disease course. Providing best practices regarding intubation and ventilation for an overwhelming number of patients with COVID-19 amid an enhanced risk of cross-infection is a daunting undertaking. The authors presented the experience of caring for the critically ill patients with COVID-19 in Wuhan. It is extremely important to follow strict self-protection precautions. Timely, but not premature, intubation is crucial to counter a progressively enlarging oxygen debt despite high-flow oxygen therapy and bilevel positive airway pressure ventilation. Thorough preparation, satisfactory preoxygenation, modified rapid sequence induction, and rapid intubation using a video laryngoscope are widely used intubation strategies in Wuhan. Lung-protective ventilation, prone position ventilation, and adequate sedation and analgesia are essential components of ventilation management.<br/>Copyright &#xa9; 2020, the American Society of Anesthesiologists, Inc.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=14c658df3917059532b94cdd1a539e6c)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=a1d76524a3ab9a096da601b8aee28978)

1. **Nursing management of severe COVID-19 patients undergoing extracorporeal membrane oxygenation combined with prone position ventilation**  
   Nie Q. Heart Surgery Forum 2020;23(4):No page numbers.

Acute respiratory distress syndrome (ARDS) is a serious lung injury in patients with severe coronavirus disease 2019 (COVID-19). This process often is difficult to reverse, eventually leading to the death of patients. Extracorporeal membrane oxygenation (ECMO) treatment can provide patients with cardiopulmonary function support and buy time for clinicians' treatment. However, some patients still suffer from poor oxygenation after ECMO treatment. At this time, nurses can change the patient's position to prone position to improve oxygenation level and promote sputum excretion. It is a great challenge for COVID-19 patients to change their postures while receiving ECMO treatment. This article provides suggestions for this process by reviewing our hospital's experience in treating severe COVID-19 patients.<br/>Copyright &#xa9; 2020 Forum Multimedia Publishing, LLC.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=8ee1973ad81e3e9bb1d931c3b0bbfde1)

1. **Optimising Ventilator Use during the COVID-19 Pandemic**  
   Sheikh S. Journal of the College of Physicians and Surgeons--Pakistan : JCPSP 2020;30(6):46-47.

Hypoxemia is the most common cause for hospitalization in COVID-19 patients. Acute hypoxemic respiratory failure or acute respiratory distress syndrome (ARDS) is the most common complication in COVID-19 patients. Close monitoring of respiratory decompensation is essential. Supplemental oxygen, high flow nasal canula, non-invasive ventilation and endotracheal intubation are the most commonly suggested methods to improve oxygenation. Early intubation with pre-oxygenation, modified rapid sequence intubation and intubation using a video laryngoscope has been advised as a strategy including lung protective ventilation, prone position ventilation, adequate sedation and extracorporeal membrane oxygenation. Strict personal precautions and challenges related to airway management has been currently studied. The authors summarize here the issues of mechanical ventilation and some strategies to resolve them. Key Words: Mechanical ventilation, COVID-19, Hypoxemia.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=2abb9fa6c554dcbeb6a3e83f350e0616)

1. **Planning for a COVID-19 crisis**  
   Sutton-Smith Lynsey Kai Tiaki : Nursing New Zealand 2020;26(4):26.

[...]we were told to plan for a catastrophe.Colleagues from China and Italy reported unprecedented admissions, bulging hospitals with sick, vulnerable patients ventilated in car parks, corridors, or in purposebuilt hospitals, of nursing teams proning patients en masse and running out of ventilators and personal protection equipment (PPE).By the end of March we had multiple policies and guidelines signed off on family visitation, end-of-life care, a poster on how to care for a COVID-19 patient, a COVID-19 manual, resuscitation and intubation guidelines, proning guides, wellbeing resources, and cleaning and infection control.By early April, information technology delivered six Zoom-enabled cell phones and we created guidelines and policies on virtual family meetings.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=e0bc7dbaefed570e37fc9f6853822b35)

1. **Prevention of pressure ulcers among individuals cared for in the prone position: lessons for the COVID-19 emergency.**  
   Moore Zena Journal of wound care 2020;29(6):312-320.

OBJECTIVEPressure ulcers (PUs) involve the destruction of skin and underlying tissue due to prolonged pressure and shear forces. These ulcers are painful and significantly reduce a person's quality of life. PUs are also expensive to manage and impact negatively on the achievement of cost-effective, efficient care delivery.METHODProne positioning is a postural therapy that aims to enhance respiratory function through increasing oxygenation levels. In contemporary clinical practice, ventilation in the prone position is indicated for patients with severe acute respiratory distress syndrome. However, despite its advantages in terms of respiratory function, several studies have examined complications of prone position ventilation and have identified PUs (facial PUs as well as PUs on other weight-bearing areas of the body) as a frequent complication in patients who are already in a precarious medical situation. International data suggest that up to 57% of patients nursed in the prone position develop a PU. The aim of this clinical review is to identify and review evidence-based recommendations developed to facilitate the selection and application of preventive interventions aimed at reducing PU development in patients ventilated in the prone position. Given the current COVID-19 crisis, this review is timely as intensive care unit (ICU) patients with COVID-19 require ventilation in the prone position at a level that is disproportionate to the general intensive care population. Up to 28% of patients admitted to the ICU with confirmed infection due to severe COVID-19 are cared for in the prone position. The scope of this review is limited to adult individuals only.RESULTSThe skin assessment should be undertaken before proning and following positioning the patient back into the supine position. Although it is essential to keep the skin clean and moisturised, using pH-balanced cleansers, there is inconsistency in terms of the evidence to support the type of moisturiser. Use of positioning devices in addition to repositioning is recommended to offload pressure points on the face and body. Further, using dressings such as hydrocolloids, transparent film and silicone may be of benefit in decreasing facial skin breakdown.CONCLUSIONGiven the importance of PU prevention in this cohort of patients, adopting a focused prevention strategy, including skin assessment and care, offloading and pressure redistribution, and dressings for prevention may contribute to a reduction in the incidence and prevalence of these largely preventable wounds.

1. **Prone Position and Lung Ventilation and Perfusion Matching in Acute Respiratory Failure due to COVID-19**  
   Zarantonello F. American journal of respiratory and critical care medicine 2020;202(2):278-279.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=e4a20dcd848db384ef5020072eea4d4e)

1. **Prone Position in Acute Respiratory Distress Syndrome Patients: A Retrospective Analysis of Complications**  
   Lucchini Dimensions of Critical Care Nursing 2020;39(1):39-46.

Early application of prolonged prone positioning has been shown to improve patient survival in moderate to severe adult respiratory distress syndrome (ARDS) patients. Prone position is a key component of lung protective mechanical ventilation in association with low tidal volume and neuromuscular blocking agents in patients with severe ARDS. Pressure sores are the major prone position complication. The rate of complication is lowering with the increase in center expertise...

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=6477c18d0d9576ce2418f4e1c8ae8262)

1. **Prone Positioning in Awake, Nonintubated Patients With COVID-19 Hypoxemic Respiratory Failure.**  
   Thompson Alison E. JAMA internal medicine 2020;:No page numbers.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=16191507ca4371360ada794fc059a871)

1. **Prone positioning monitored by electrical impedance tomography in patients with severe acute respiratory distress syndrome on veno-venous ECMO**  
   Franchineau G. Annals of Intensive Care 2020;10(1):No page numbers.

Background: Prone positioning (PP) during veno-venous ECMO is feasible, but its physiological effects have never been thoroughly evaluated. Our objectives were to describe, through electrical impedance tomography (EIT), the impact of PP on global and regional ventilation, and optimal PEEP level. <br/>Method(s): A monocentric study conducted on ECMO-supported severe ARDS patients, ventilated in pressure-controlled mode, with 14-cmH<sub>2</sub>O driving pressure and EIT-based "optimal PEEP". Before, during and after a 16-h PP session, EIT-based distribution and variation of tidal impedance, VT<sub>dorsal</sub>/VT<sub>global</sub> ratio, end-expiratory lung impedance (EELI) and static compliance were collected. Subgroup analyses were performed in patients who increased their static compliance by &gt;= 3 mL/cmH<sub>2</sub>O after 16 h of PP. <br/>Result(s): For all patients (n = 21), tidal volume and EELI were redistributed from ventral to dorsal regions during PP. EIT-based optimal PEEP was significantly lower in PP than in supine position. Median (IQR) optimal PEEP decreased from 14 (12-16) to 10 (8-14) cmH<sub>2</sub>O. Thirteen (62%) patients increased their static compliance by &gt;= 3 mL/cmH<sub>2</sub>O after PP on ECMO. This subgroup had higher body mass index, more frequent viral pneumonia, shorter ECMO duration, and lower baseline VT<sub>dorsal</sub>/VT<sub>global</sub> ratio than patients with compliance &lt;= 3 mL/cmH<sub>2</sub>O (P &lt; 0.01). <br/>Conclusion(s): Although baseline tidal volume distribution on EIT may predict static compliance improvement after PP on ECMO, our results support physiological benefits of PP in all ECMO patients, by modifying lung mechanics and potentially reducing VILI. Further studies, including a randomized-controlled trial, are now warranted to confirm potential PP benefits during ECMO.<br/>Copyright &#xa9; 2020, The Author(s).

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=35c8210802837fc90cb5fbf6449077ce)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=b5b9b2666bc59f2e619844ff8dde69ba)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=83129e5e00200277b9dbfa8bb776a0f7)

1. **Prone positioning to improve oxygenation and relieve respiratory symptoms in awake, spontaneously breathing non-intubated patients with COVID-19 pneumonia**  
   Sztajnbok J. Respiratory Medicine Case Reports 2020;30:No page numbers.

Emergency departments are facing an unprecedented challenge in dealing with patients who have coronavirus disease 2019 (COVID-19). The massive number of cases evolving to respiratory failure are leading to a rapid depletion of medical resources such as respiratory support equipment, which is more critical in low- and middle-income countries. In this context, any therapeutic and oxygenation support strategy that conserves medical resources should be welcomed. Prone positioning is a well-known ventilatory support strategy to improve oxygenation levels. Self-proning can be used in the management of selected patients with COVID-19 pneumonia. Here, we describe our experience with two COVID-19-positive patients who were admitted with respiratory failure. The patients were successfully managed with self-proning and noninvasive oxygenation without the need for intubation.<br/>Copyright &#xa9; 2020

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=3a2e88f8f9df2a645061c963e58df6f7)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=59054a5a3ad0ac38b668112321ce494a)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=af62cbda53bc6a654f676a3a1be6f522)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=ec55714bf951eaf0fee9deafa463f7f7)

1. **Prone ventilation in a 27 week pregnant woman with COVID-19 severe ards**  
   Barile L. Signa Vitae 2020;16(1):199-202.

Pregnant women are more sensitive to respiratory pathogens due to the physiological changes related to pregnancy with an increase in morbidity and mortality. Pregnancy and childbirth do not seem to aggravate the course of symptoms of COVID-19 pneumonia. However, reports on optimal management of severe COVID-19-related ARDS during pregnancy are still lacking. To our knowledge only two case reports describe prone ventilation in pregnant women with severe ARDS, no one related to COVID-19. We report the case of a COVID-19 related severe ARDS in a 48-year-old woman in the last trimester of pregnancy. The patient required intensive care hospitalization for 20 days and invasive mechanical ventilation for 15 days. Pronation maneuver during mechanical ventilation relieved hypoxia and prevented mother and fetus damages, thus avoiding an urgent cesarean section and a premature birth. The patient was successfully discharged from the hospital without maternal and fetal sequelae. In our experience prone ventilation can be safely used to improve respiratory gas exchanges in the last trimester of pregnancy in case of severe ARDS.<br/>Copyright &#xa9; 2020 The Authors.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=d5693603de9e2b446ff36ed330a7495f)

1. **Proning reduces ventilation heterogeneity in patients with elevated BMI: Implications for COVID-19 pneumonia management?**  
   Foy B.H. ERJ Open Research 2020;6(2):1-4.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=8baa0cf77b5571c37c81fe2a1ff4b397)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=32f66f7017f3a38e841631e58ce04db4)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=71b34fd5e984861399b3e3e388d8a4b4)

1. **Rationale and significance of patient selection in awake prone positioning for COVID-19 pneumonia**  
   Huang C.F. The European respiratory journal 2020;:No page numbers.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=6cd3d24ab2293a7f36d2608c80916770)

1. **The care of patients through the lens of the fundamentals into times of the COVID-19 outbreak**  
   Danielis Matteo Intensive & Critical Care Nursing 2020;60:No page numbers.

Alongside these needs, other concerns regarding surveillance are emerging, as in the case of pressure ulcer risk in patients in the prone position or with a prolonged use of non-invasive ventilation devices.[...]some medical treatments, such as administration of continuous positive airway pressure, may hinder patients’ needs such as eating and drinking or patient comfort, as the nurse may not be immediately available to provide for these needs.Nurses must protect themselves from the airborne pathogen, requiring masks, goggles and/or face shields (Jansson et al., 2020); this prevents the nurse from speaking normally and being close to the patients for a long time.[...]personal protective equipment creates additional barriers to communication and reduces the opportunity to identify and discern the health professionals’ role.[...]emotional and social support has to be considered among both the short and the long-term goals to improve psychological resilience during the COVID-19 epidemic, especially among older people.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=6a4db44f02ab6fb45e96040ebe416676)

1. **The use of exoskeletons to help with prone positioning in the intensive care unit during COVID-19.**  
   Settembre Nicla Annals of physical and rehabilitation medicine 2020;63(4):379-382.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=03d69389976103fd37024d0b3e088a73)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=c9df0288d9aa6fd9a1d3a593bcecc53d)

1. **Use of awake proning to avoid invasive ventilation in a patient with severe COVID-19 pneumonitis**  
   Whittemore P. BMJ case reports 2020;13(8):No page numbers.

A 60-year-old man with swab-positive COVID-19 and extensive ground-glass change seen on CT imaging was successfully managed on our COVID-19 high-dependency unit with only low-flow oxygen and strict awake proning instructions. He was successfully weaned off oxygen entirely without any requirement for non-invasive or invasive ventilation and made a recovery to be discharged home after an 18-day hospital stay.<br/>Copyright &#xa9; BMJ Publishing Group Limited 2020. No commercial re-use. See rights and permissions. Published by BMJ.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=8e1025ae8df8fc1cc992087de39a04a9)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=80e40efd4ada75370c2f3dc95fd4cc4b)

1. **A novel application of healthcare simulation: Developing and implementing a prone ventilation protocol for severe acute respiratory distress syndrome (ARDS)**  
   Mourad B. American Journal of Respiratory and Critical Care Medicine 2019;199(9):No page numbers.

Hypothesis:ARDS is an acute inflammatory lung injury that carries an overall mortality of 40%. Prone positioning during mechanical ventilation can decrease mortality to as low as 16%. Despite awareness of this evidence, clinicians rarely employ this maneuver due to lack of experience in manual prone positioning, as well as confidence and competency. Use of simulation for prone ventilation has not been described in the literature. We used simulation to develop a step-by-step protocol for manual proning and then piloted an in-situ interprofessional simulation. We hypothesized that simulation training would improve comfort and competence in instituting prone positioning and managing potential complications. <br/>Method(s):This was a quality improvement initiative encompassing critical care nurses, respiratory therapists and physicians. An interprofessional work group developed detailed instructions required for patient preparation, prone and supine maneuvering. A standardized patient (SP) was used to evaluate feasibility. Three in-situ sessions using SPs were performed to refine the protocol. An education video demonstrating all steps was created. Subsequently, training was accomplished in three phases: Phase 1: Participants watched the educational video. Pre-course survey assessing confidence and medical knowledge was completed after. Phase 2: Participants were trained in the steps of preparation and prone positioning of a simulated patient in an ICU room, using a high-fidelity SimMan3Gmanikin. Phase 3: Participants were provided with a scenario to prone a patient, and then return to supine during a simulated emergency. Timing of pre-identified critical actions were measured. A post-course survey was administered after. <br/>Result(s):Eighty critical care interprofessional staff members participated. They self-reported confidence in managing ARDS, but a lack of confidence in prone positioning. Wilcoxon rank sum test was used to compare means between pre-training and post-training groups. Participants were de-identified and unmatched. A significant increase in comfort in prone positioning (p&lt;.0001) and in confidence levels in managing patients (p&lt;.0010) was found. No significant changes in knowledge were found. The learners were able to rapidly perform critical actions. Average time to return a patient supine to start CPR was 63 seconds (Table 1). <br/>Conclusion(s):Unique application of simulation allowed for rapid progression and refinement of the protocol and checklist before "go-live". Implementation of an in-situ prone simulation program improved confidence and skill of critical care staff in initiation of prone ventilation and ongoing management, however it did not change medical knowledge. Simulation training led to prompt recognition and performance of critical actions during a simulated medical emergency during prone ventilation. (Figure Presented).

1. **Effect of Prone Positioning on Intraocular Pressure in Patients With Acute Respiratory Distress Syndrome.**  
   Saran Sai Critical care medicine 2019;47(9):e761.

OBJECTIVESTo evaluate the effect of prolonged duration of prone position (with head laterally rotated) on intraocular pressure in acute respiratory distress syndrome patients.DESIGNProspective observational study.SETTINGUniversity hospital ICU.PATIENTSTwenty-five acute respiratory distress syndrome patients, age 60 years (51-67 yr), Sequential Organ Failure Assessment score 10 (10-12), PaO2/FIO2 ratio of 90 (65-120), and all in septic shock.INTERVENTIONSNone.MEASUREMENTS AND MAIN RESULTSIntraocular pressure (in mm Hg) measured by hand-held applanation tonometer, at different time points. Before prone (in both eyes): at 30-45° head-end elevation position (THE pre-prone), in supine position just before turning prone (Tsupine pre-prone); during prone (in nondependent eye): at 10 minutes (T10 prone), 30 minutes (T30 prone), and at just before end of prone session (Tend-prone). After end of prone session (both eyes): at 5 minutes (T5 supine post-prone), 10 minutes (T10 HE post-prone), 15 minutes (T15 HE post-prone), and 30 minutes (T30 HE post-prone). Median duration of prone position was 14 hours (12-18 hr). Median intraocular pressure increased significantly (p ≤ 0.001) in both eyes. In dependent eye, from 15 (12-19) at THE pre-prone to 24, 21, 19, and 16 at T5 supine post-prone, T10 HE post-prone, T15 HE post-prone, and T30 HE post-prone respectively, whereas in nondependent eye from 14 (12-18.5) at THE pre-prone to 23, 25, 32, 25, 22, 20, and 17 at T10 prone, T30 prone, Tend-prone, T5 supine post-prone, T10 HE post-prone, T15 HE post-prone, and T30 HE post-prone respectively. Bland-Altman plot analysis showed significant linear relationship (r = 0.789; p ≤ 0.001) with good agreement between rise in mean intraocular pressure of the both eyes (dependent eye and nondependent eye) with their paired differences after the end of different duration of prone session (T5 supine post-prone).CONCLUSIONSThere is significant increase in intraocular pressure due to prone positioning among acute respiratory distress syndrome patients. Intraocular pressure increases as early as 10 minutes after proning, with increasing trend during prone position, which persisted even at 30 minutes after the end of post prone session although with decreasing trend.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=9521c6fbf43b9efaeb4fb9e5cadbf72e)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=9521c6fbf43b9efaeb4fb9e5cadbf72e)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=912af2e39921cc9ddeabe6d8db0f4a39)

1. **Impact of interprofessional simulation training on barriers to implementation of prone position ventilation for ARDS**  
   Poor A. American Journal of Respiratory and Critical Care Medicine 2019;199(9):No page numbers.

Rationale: Prone position ventilation (PPV) is recommended by major guidelines for patients with severe ARDS, but it remains underutilized. Previously identified barriers, including patient safety, complications, and lack of perceived benefit, may limit implementation. No literature exists on interprofessional training for PPV. We aimed to evaluate the impact of a novel interprofessional simulation-based training program on provider perception and comfort with performing PPV. <br/>METHOD(S): This prospective observational study was conducted in the medical ICU of a tertiary academic medical center with no experience in prone position ventilation. Registered nurses (RNs), respiratory therapists (RTs) and physicians (MDs) underwent a 2-hour interprofessional training session consisting of a didactic session, simulated placement of volunteers in prone position, simulated emergency scenarios, and a structured debrief. Before and after training, participants completed anonymous surveys assessing perception and comfort with PPV using a 5-item Likert scale. Descriptive statistical analyses were used to compare provider experience, perception and comfort with PPV before and after interprofessional simulation training. <br/>RESULT(S): 73 providers completed training (37 RN, 18 MD, 18 RT). Providers had minimal prior PPV experience (94% RN, 80% RT, 86% MD had proned &lt; 5 patients). Before training, a minority of RNs believed that PPV is beneficial to their patients with severe ARDS, compared to MDs and RTs (39% vs 96% and 70% respectively, p&lt;0.001). A minority of RNs and MDs felt comfortable taking care of prone patients, and were less comfortable than RTs (RN 35%, MD 27%, RT 70%, p=0.035); a minority of all providers were comfortable managing cardiac arrest in prone patients (RN 29%, MD 24%, RT 22%, p=0.434). After training, perceived benefit increased in all providers (Fig. 1A), with the largest increase occurring in RNs (DELTA50%, pre vs post training p&lt;0.001), compared to RTs (DELTA30%, p=0.008) and MDs (DELTA4%, p=0.046). Comfort in both taking care of and managing cardiac arrest increased in RNs and MDs, with greatest improvement in MDs (DELTA51%, pre vs post training p = 0.005; DELTA70%, p&lt;0.001, respectively) as compared to RNs (DELTA28%,p=0.002; DELTA30%, p&lt;0.015) and RTs (DELTA19%, p=0.477; DELTA61% p=0.01) (Fig 1B,1C). <br/>CONCLUSION(S): In a medical center with no PPV experience, an interprofessional simulation-based training program improved perception of benefit and comfort levels with providing PPV. By enhancing communication and collaboration among different providers, as well as allowing real time practice of the procedure, interprofessional simulation-based training may assist in the implementation of new complex.

1. **Not prone to prone? A review of patient characteristics to understand current use of prone position therapy in moderate to severe acute respiratory distress syndrome**  
   Giovanni S. American Journal of Respiratory and Critical Care Medicine 2019;199(9):No page numbers.

Rationale:The use of prone position therapy in acute respiratory distress syndrome (ARDS) improves 30 and 90 day mortality. Recent studies evaluating the epidemiology and outcomes of ARDS in intensive care units reported that prone position therapy ("proning") was only implemented in 7- 32% of patients with moderate- severe ARDS. The purpose of this study is to describe the characteristics of patients with ARDS who met criteria for proning. <br/>METHOD(S): We used a retrospective cohort of all mechanically ventilated patients who met Berlin criteria for moderate- severe ARDS with a PaO2/FiO2 ratio &lt;150 at two academic hospitals between October 2016 and April 2017. Electronic health records were reviewed to determine indication of proning and PaO2/FiO2 ratio at 24 hours. The cohort was further narrowed by selecting for those who met PROSEVA criteria at 24 hours (PaO2/FiO2 &lt;150 and FiO2 &gt;60%) or who underwent proning. We then compared ventilator settings, ARDS risk factors and provider documentation of ARDS among those who were proned and not proned, and performed a narrative review to identify potential barriers and facilitators of proning. <br/>RESULT(S): Most of the 98 patients with moderate-severe ARDS had significant improvement in oxygenation over the first 24 hours of mechanical ventilation (63%). Of the 36 remaining patients with persistent hypoxemia who met PROSEVA criteria at 24 hours, only 10 underwent proning (28%). Compared to those who were not proned, patients who underwent proning were more likely to have pneumonia as a risk factor (90% vs. 54%), and have lower PaO2/FiO2 ratios (87.5 vs. 109.5). Severity of illness was high; 50% of non-proned patients had early withdrawal of life sustaining therapies in the setting of multiorgan failure, hemodynamic instability, and cardiac arrest. One patient had massive hemoptysis; another patient was managed with extracorporeal life support in the first 24 hours. A quarter of the non-proned patients lacked documentation of ARDS in the medical record and consideration of proning was only mentioned for 3 of the non-proned patients. <br/>CONCLUSION(S): Many patients with moderate to severe ARDS improve rapidly and do not meet PROSEVA criteria for proning at 24 hours. However, proning is uncommon even among those with persistent moderate-severe hypoxemia. Lack of recognition and documentation of ARDS, hemodynamic instability, and poor prognosis may be important barriers to the use of prone positioning. Further study is warranted to understand barriers to proning and facilitators of more widespread implementation.

1. **Pressure ulcers following prone positioning in ARDS patients undergoing ECMO treatment**  
   Binda F. Intensive Care Medicine Experimental 2019;7:No page numbers.

INTRODUCTION. The application of prone positioning (PP) during veno-venous extracorporeal membrane oxygenation (VV-ECMO) has shown to be a safe and reliable technique when performed in a recognized ECMO center with the appropriately trained staff and standard procedures. [1] Several clinical studies evaluated the safety and efficacy of PP in mechanically ventilated patients, however a higher frequency of pressure ulcers has been reported. [2] OBJECTIVES. To detect the incidence and the characteristics of pressure ulcers in PP patients with severe acute respiratory distress syndrome undergoing ECMO treatment. METHODS. Observational retrospective analysis of all the patients admitted to our intensive care unit (ICU) of a tertiary level hospital from January 2013 to December 2017. Only the patients undergoing PP for at least 12 hours were included. The Braden scale was used to assess the patients' risk of developing a pressure ulcer at ICU admission while the pressure ulcers were staged according to the NPUAP staging system (National Pressure Ulcer Advisory Panel). Age, sex, BMI, ICU length of stay, SAPS and SOFA score and mortality were recorded. RESULTS. A total of 50 PP patients undergoing ECMO were identified in the medical records. The pressure ulcers incidence was 46% and the main part of the body with skin lesions were: face (51.3%), rib cage (15.4%), hip bones (7.7%) knees (5.1%) and others (20.5%). Fourteen patients (28%) report 3 pressure ulcers present simultaneously in different anatomical sites. During all PP maneuvers, no adverse events, like ECMO cannula dislocation, were recorded. The other results are summarized in table 1. CONCLUSION. In this sample, PP is a safe procedure but it is associated with a high risk of pressure ulcers on the face. For this reason, further preventive measures to protect the skin should be implemented.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=9aaed110468010c55cc69f5341e04319)

[3&spage=55 this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=0f5dc540336d2f166210140512198ee1)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=e107ed641ff9ece29fd7dc9c49c17e2d)

1. **Prone positioning and extracorporeal membrane oxygenation for severe acute respiratory distress syndrome: time for a randomized trial?**  
   Guervilly Christophe Intensive care medicine 2019;45(7):1040-1042.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=e94b6c349e325a62579fe80adcba3214)

1. **Prone positioning before extracorporeal membrane oxygenation for severe acute respiratory distress syndrome: A retrospective multicenter study.**  
   Kim W.-Y Medicina intensiva 2019;43(7):402-409.

OBJECTIVETo evaluate the clinical outcomes of patients with severe acute respiratory distress syndrome (ARDS) subjected to prone positioning before extracorporeal membrane oxygenation (ECMO).DESIGNA retrospective analysis of a multicenter cohort was carried out.SETTINGPatients admitted to the Intensive Care Units of 11 hospitals in Korea.PATIENTSPatients were divided into those who underwent prone positioning before ECMO (n=28) and those who did not (n=34).INTERVENTIONSNone.VARIABLES OF INTERESTThirty-day mortality, ECMO weaning failure rate, mechanical ventilation weaning success rate, mechanical ventilation-free days at day 60.RESULTSThe prone group had lower median peak inspiratory pressure and lower median dynamic driving pressure before ECMO. Thirty-day mortality was 21% in the prone group and 41% in the non-prone group (p=0.098). The prone group also showed a lower ECMO weaning failure rate, and a higher mechanical ventilation weaning success rate and more mechanical ventilation-free days at day 60. In the non-prone group, median dynamic compliance marginally decreased shortly after ECMO, but no significant change was observed in the prone group.CONCLUSIONSProne positioning before ECMO was not associated to increased mortality and tended to exert a protective effect.

1. **Routine prone position mechanical ventilation for severe acute respiratory distress syndrome. 10 year outcomes**  
   Douglas I.S. American Journal of Respiratory and Critical Care Medicine 2019;199(9):No page numbers.

Rationale Acute Respiratory Distress Syndrome (ARDS) mortality remains high (~25-35%) despite wide implementation of lung protective ventilation (LPV, e.g. lower tidal volumes). Ancillary therapies including prone position ventilation (PPV) may augment LPV and enhance survival. However the adoption of PPV remains remarkably low despite compelling evidence. In the ProSEVA RCT (Guerin et al. NEJM 2013) 28d mortality amongst 229 severe ARDS patients managed supine was 32.8% vs. 16% for 237 patients randomized to PPV for at least 17 h/day; OR 0.42 (0.26-0.66) OBJECTIVES Determine the clinical effectiveness of a universal ARDS LPV protocol that includes a mandatory trial of PPV for patient requiring PF&lt;100 with FiO2&gt; 0.6 and PEEP &gt;10 for &gt;2 hours in a community academic medical center. METHODS Retrospective analysis of an integrated mechanical ventilation (MV) database (2008-2018). Patients were prospectively identified as receiving PPV. Additional data and therapeutic co-interventions were extracted from an EMR (Epic and Lifetime clinical record, OnBase). Statistical analyses were performed in MS Excel and SAS JMP v11.1. RESULTS 5427 patients received MV (2008-2018). 344 ARDS patients were managed with PPV for &gt;1 hour during their ICU course. Average (SD) age was 50.9 (15.1), 42% were female, average height and actual weight were 66.3+/-4.3 inches and 79.7+/-24 kg. ARDS was of a pulmonary source in 42.4% and extrapulmonary in 57%. Initial ventilator settings were: V<sub>T</sub> 6.7-7mL/kg PBW, FiO2 85 8% PEEP 10cmH2O. Highest Pplat was 30.3+/-7.1 cmH<sub>2</sub>O. Average length of ICU stay was 24.9+/-39.5 days. ICU LOS amongst 167 survivors who discharged home (43.8%) was 24.2+/-20.4 days compared with 36.6+/-38.5 for 110 survivors (28.9%) who transferred to an LTAC or other ICU (p&lt;0.05). PPV time was similar amongst survivors (39+/-2.8 hr) and non-survivors (38+/-4.5hr). Hospital Mortality was 27.3%. In comparison, mortality in the ProSEVA PPV group was 16% vs. 32.8% for patients managed with SPV. Mortality was higher for female PPV patients 32.9% than males 27.1%, P&lt;0.05. CONCLUSION In this largest reported cohort of patients managed with protocolized LPV including routine and prolonged PPV, mortality was higher than reported for patients in the PPV arm of ProSEVA especially amongst females, despite PPV having been administered for longer periods and initiated at lower P/F ratios. PPV facilitated LPV by limiting highest pPlat. ARDS survival despite PPV was associated with significant post-hospital disease burden requiring LTAC, SNF or rehab in 38.5%. PPV to reduce ARDS mortality requires additional prospective study to evaluate efficacy in non-European ICUs.

1. **The Cost-Effectiveness of Interventions to Increase Utilization of Prone Positioning for Severe Acute Respiratory Distress Syndrome.**  
   Baston Cameron M. Critical care medicine 2019;47(3):e198.

OBJECTIVESDespite strong evidence supporting proning in acute respiratory distress syndrome, few eligible patients receive it. This study determines the cost-effectiveness of interventions to increase utilization of proning for severe acute respiratory distress syndrome.DESIGNWe created decision trees to model severe acute respiratory distress syndrome from ICU admission through death (societal perspective) and hospital discharge (hospital perspective). We assumed patients received low tidal volume ventilation. We used short-term outcome estimates from the PROSEVA trial and longitudinal cost and benefit data from cohort studies. In probabilistic sensitivity analyses, we used distributions for each input that included the fifth to 95th percentile of its CI.SETTINGICUs that care for patients with acute respiratory distress syndrome.SUBJECTSPatients with moderate to severe acute respiratory distress syndrome.INTERVENTIONSThe implementation of a hypothetical intervention to increase the appropriate utilization of prone positioning.MEASUREMENTS AND MAIN RESULTSIn the societal perspective model, an intervention that increased proning utilization from 16% to 65% yielded an additional 0.779 (95% CI, 0.088-1.714) quality-adjusted life years at an additional long-term cost of $31,156 (95% CI, -$158 to $92,179) (incremental cost-effectiveness ratio = $38,648 per quality-adjusted life year [95% CI, $1,695-$98,522]). If society was willing to pay $100,000 per quality-adjusted life year, any intervention costing less than $51,328 per patient with moderate to severe acute respiratory distress syndrome would represent good value. From a hospital perspective, the intervention yielded 0.072 (95% CI, 0.008-0.147) more survivals-to-discharge at a cost of $5,242 (95% CI, -$19,035 to $41,019) (incremental cost-effectiveness ratio = $44,615 per extra survival [95% CI, -$250,912 to $558,222]). If hospitals were willing to pay $100,000 per survival-to-discharge, any intervention costing less than $5,140 per patient would represent good value.CONCLUSIONSInterventions that increase utilization of proning would be cost-effective from both societal and hospital perspectives under many plausible cost and benefit assumptions.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=382538575df11c408ad8c8a737869014)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=382538575df11c408ad8c8a737869014)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=4bb751f0756a3e7e391abfe862b212a0)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=16e2d4fd7c787fbfab5111ffd7a83bd1)

1. **What comes out on top: Prone positioning versus extracorporeal membrane oxygenation for severe acute respiratory distress syndrome at large quaternary regional center**  
   Baltaji S. American Journal of Respiratory and Critical Care Medicine 2019;199(9):No page numbers.

Introduction: Acute respiratory distress syndrome (ARDS) is associated with high mortality and has changed little in the last two decades. Strategies involved in rescue therapy in severe ARDS include prone positioning with accumulating evidence suggests a survival benefit of prone positioning in severe ARDS. Alternative strategy is Extracorporeal membrane oxygenation (ECMO) which has been utilized increasingly for the management of these patients. Several studies have been conducted to determine the superiority of one rescue strategy over another with no clear winner.1,2,3 The aim of this study is to compare the outcomes using ECMO versus prone positioning in patient with severe ARDS at a large single center institute. <br/>Method(s): A retrospective study utilizing data derived from patients treated for severe ARDS managed with either rotoprone position or ECMO at Allegheny General Hospital over two years period. Demographics, comorbidities, sequential organ failure assessment score (SOFA) were abstracted from medical charts along with outcomes of sixty day mortality, Mechanical ventilator weaning failure rate, ICU length of stay (LOS), hospital LOS, mortality, need for tracheostomy, need for renal replacement therapy (RRT) and need for transfusion. A T-test was used for continuous variables and chi-square or Fishers exact was used, as appropriate, for categorical variables to compare outcomes. <br/>Result(s): 110 patients were treated for severe ARDS. 38 patients and 48 patients underwent prone positioning vs ECMO respectively. 24 were excluded due to unexpected death, prone positioning being used prior to ECMO, improvement prior to rescue strategy initiation. Sixty Day Mortality was 39.5%(n=15) in the prone group and 43.8% (n=21) in the ECMO group (P=0.69). Mechanical ventilator weaning failure rate was higher in ECMO group (43.8%) vs 31.6% in the prone positioning(p=0.249). Mean ICU LOS was 19.4 days in the prone group and 27.9 days in the ECMO group (P=0.017). Need for RRT was 10.8% in the prone group and 34% in the ECMO group (P=0.011). Need for blood transfusions was 65.8% in the prone group and 98% in the ECMO group (P=0.001). The hospital LOS, need for intermittent Hemodialysis and hospital discharge disposition among survivors did not differ significantly between groups. <br/>Conclusion(s): Our study showed no significant difference in overall mortality with a significant need to RRT and longer ICU LOS in the ECMO group. Our study supports the existing evidence to use prone position as a rescue therapy for severe ARDS. Future trials are needed to demonstrate reduced mortality with ECMO in ARDS patients. (Figure Presented).

1. **Why Prone? Why Now? Improving Outcomes for ARDS Patients.**  
   Anon. Critical care nurse 2019;39(5):84.

1. **A retrospective observational study of prone positioning practices in the management of acute respiratory distress syndrome (ARDS) over a 2 year period in a single adult district general hospital (DGH) intensive care unit (ICU)**  
   Nwamarah A.F. Intensive Care Medicine Experimental 2018;6:No page numbers.

INTRODUCTION. Mechanical ventilation in ARDS may contribute to further lung damage due to high ventilatory pressures/volume delivered to a poorly compliant lung. Although various strategies for improving outcomes in ARDS have been tried, the only technique with good supporting evidence is prone positioning [1]. However, it is labour intensive, requires staff training and has potential complications. OBJECTIVES. To review prone positioning practices within one DGH ICU in terms of demographics, reasons for initiation and outcomes. METHODS. The electronic patient record database for a single ICU was interrogated for the keywords 'prone', 'proned', 'proning' and 'ECMO' for the period 03/2016 to 03/2018. Cases were reviewed to find the PaO2/FiO2 (PF) ratio and ventilation modes at instigation of prone positioning. Outcomes were recorded in terms of in-hospital and ICU mortality, and whether extra corporeal membrane oxygen-ation (ECMO) was required. Demographics and Clinical Frailty Scores (CFS) were recorded. RESULTS. Of the 14 patients placed in prone position, 64.3% met the classification for severe ARDS with a PF ratio of &lt; 13.3 kPa. The mean age was 61 years (SD 19.3 years), 4 males and 10 females. We observed 50% survival. A higher CFS was associated with a worse outcome. Although 6 patients were referred to an ECMO centre, only 2 were transferred and none received ECMO. 2 of the patients referred for ECMO were not deemed candidates due to increased bleeding risks. The median number of proning episodes was 2 (IQR 1-2.25) with a mean duration of 14hr10mins (SD 4hrs10mins). There appears to be no correlation between the number of proning episodes and PF ratios. Patients with a lower CFS were found to tolerate a lower PF ratio in comparison to those with a higher CFS. 28.6% deemed CFS 1, were all classified as severe ARDS. 57.1% of patients received a trial of airway pressure release ventilation (APRV) prior to proning; and had a better outcome with 75% survival. 2 patients had documented complications secondary to proning: re-intubation; and facial oedema. <br/>CONCLUSION(S): In this small group, reduced frailty and a trial of APRV, may both be associated with better outcomes in prone positioning for ARDS. Further work should be done to investigate the relationship between CFS and PF ratios, in terms of impact upon survival with proning. It is likely that, during this 2 year study period, other patients with ARDS may have benefited from prone positioning. The duration of proning was intended to be 16 hrs, but there was considerable variation. Introduction of an evidence based protocol for the initiation of prone positioning in ARDS may lead to more frequent instigation of proning in ICU.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=ead8d94ba871c2c366e1f349effda5e5)

[2&spage=40 this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=905976245ff176d0ca494bb84170f055)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=cf2ef8e08d8dfd7dd029e00ba702cc4d)

1. **Acute Respiratory Distress Syndrome and Prone Positioning.**  
   Mitchell Dannette A. AACN advanced critical care 2018;29(4):415-425.

Acute respiratory distress syndrome continues to have high morbidity and mortality despite more than 50 years of research. The Berlin definition in 2012 established risk stratification based on degree of hypoxemia and the use of positive end-expiratory pressure. The use of prone positioning as a treatment modality has been studied for more than 40 years, with recent studies showing an improvement in oxygenation and decreased mortality. The studies also provide evidence to support the methodology and length of treatment time. Recent guidelines include several ventilator strategies for acute respiratory distress syndrome, including prone positioning. Protocols and procedures discussed in this article ensure successful prone repositioning and prevention of complications related to the procedure itself.

1. **Acute respiratory distress syndrome diagnosis and management: Assessment of current practice in a tertiary care center intensive care unit**  
   Mikhaeil M. Intensive Care Medicine Experimental 2018;6:No page numbers.

INTRODUCTION. Although the Acute Respiratory Distress Syndrome (ARDS) is common in medical-surgical intensive care units (MSICU) and is associated with significant morbidity and mortality, it is frequently unrecognized, especially in its mild forms, resulting in sub-optimal management. OBJECTIVES. We sought to assess how well ARDS was being diagnosed, based on the Berlin definition, and whether an evidence-based algorithm for the management of ARDS was being followed in our tertiary care MSICU. METHODS. Over a 28-day period in the ICU, we assessed all admitted patients daily for the diagnosis of ARDS, using the Berlin criteria. Paper and electronic charts of those fulfilling criteria were audited for the documentation of the ARDS diagnosis. Various aspects of the management of ARDS were assessed. RESULTS. Over a 28-day period, 90 patients were screened and 13 (14.4%) met Berlin criteria for ARDS. A total of 101 patient-days of ARDS management were assessed. Documentation of the diagnosis did not differ significantly between mild, moderate, or severe ARDS (p=0.217), but none of the diagnoses were missed on the 9 patient-days of severe ARDS. While ARDS was documented in physician charting in 77% of patient-days, a lung-protective ventilation strategy was utilized during only 33% of patient-days. Targets for low tidal volumes and high PEEP were met 17% and 55% of patient-days, re-spectively. During over half (53%) of patient days, patients were in an undesirable positive 24-hour fluid balance. Appropriate sedation targets were achieved 59% of the time. While NMB was initiated at 5 of the 7 times (71%) when it was warranted, there were a total of 11 patient-days (11%) of inappropriate use of NMB. Appropriate use of NMB did not differ based on the severity of ARDS (p=0.416), but during the 9 patient-days of severe ARDS, 8 had appropriate use of NMB. While no patients were proned inappropriately, there were 23 patient-days (23%) when proning should have been initiated, but wasn't. Appropriate use of proning was significantly different between the mild, moderate, and severe ARDS groups (p=0.004). The local spontaneous breathing trial protocol at our center was followed during only 44% of appropriate patient-days. CONCLUSIONS. At a tertiary care MSICU, recognition of ARDS seems to be improving as compared to previously published rates, however many evidence-based elements of ARDS management were still not adhered to at acceptable rates.<sup>1</sup> Further research is required to look into the factors involved in decreased adherence to ARDS management practices. Results from this medical audit of clinical practice will be used to guide future quality improvement initiatives in the diag-nosis and management of ARDS.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=ead8d94ba871c2c366e1f349effda5e5)

[2&spage=40 this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=905976245ff176d0ca494bb84170f055)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=cf2ef8e08d8dfd7dd029e00ba702cc4d)

1. **Acute Respiratory Distress Syndrome: Advances in Diagnosis and Treatment.**  
   Fan Eddy JAMA 2018;319(7):698-710.

ImportanceAcute respiratory distress syndrome (ARDS) is a life-threatening form of respiratory failure that affects approximately 200 000 patients each year in the United States, resulting in nearly 75 000 deaths annually. Globally, ARDS accounts for 10% of intensive care unit admissions, representing more than 3 million patients with ARDS annually.ObjectiveTo review advances in diagnosis and treatment of ARDS over the last 5 years.Evidence ReviewWe searched MEDLINE, EMBASE, and the Cochrane Database of Systematic Reviews from 2012 to 2017 focusing on randomized clinical trials, meta-analyses, systematic reviews, and clinical practice guidelines. Articles were identified for full text review with manual review of bibliographies generating additional references.FindingsAfter screening 1662 citations, 31 articles detailing major advances in the diagnosis or treatment of ARDS were selected. The Berlin definition proposed 3 categories of ARDS based on the severity of hypoxemia: mild (200 mm Hg<Pao2/Fio2≤300 mm Hg), moderate (100 mm Hg<Pao2/Fio2≤200 mm Hg), and severe (Pao2/Fio2 ≤100 mm Hg), along with explicit criteria related to timing of the syndrome's onset, origin of edema, and the chest radiograph findings. The Berlin definition has significantly greater predictive validity for mortality than the prior American-European Consensus Conference definition. Clinician interpretation of the origin of edema and chest radiograph criteria may be less reliable in making a diagnosis of ARDS. The cornerstone of management remains mechanical ventilation, with a goal to minimize ventilator-induced lung injury (VILI). Aspirin was not effective in preventing ARDS in patients at high-risk for the syndrome. Adjunctive interventions to further minimize VILI, such as prone positioning in patients with a Pao2/Fio2 ratio less than 150 mm Hg, were associated with a significant mortality benefit whereas others (eg, extracorporeal carbon dioxide removal) remain experimental. Pharmacologic therapies such as β2 agonists, statins, and keratinocyte growth factor, which targeted pathophysiologic alterations in ARDS, were not beneficial and demonstrated possible harm. Recent guidelines on mechanical ventilation in ARDS provide evidence-based recommendations related to 6 interventions, including low tidal volume and inspiratory pressure ventilation, prone positioning, high-frequency oscillatory ventilation, higher vs lower positive end-expiratory pressure, lung recruitment maneuvers, and extracorporeal membrane oxygenation.Conclusions and RelevanceThe Berlin definition of acute respiratory distress syndrome addressed limitations of the American-European Consensus Conference definition, but poor reliability of some criteria may contribute to underrecognition by clinicians. No pharmacologic treatments aimed at the underlying pathology have been shown to be effective, and management remains supportive with lung-protective mechanical ventilation. Guidelines on mechanical ventilation in patients with acute respiratory distress syndrome can assist clinicians in delivering evidence-based interventions that may lead to improved outcomes.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=7c6bde9e0a1847e7292e689d3a135f5a)

1. **Application of prone position in hypoxaemic patients supported by veno-venous ECMO.**  
   Lucchini Alberto Intensive & critical care nursing 2018;48:61-68.

INTRODUCTIONVeno-Venous Extracorporeal Membrane Oxygenation (VV-ECMO) is an advanced respiratory care therapy allowing replacement of pulmonary gas exchange. Despite VV-ECMO support, some patients may remain hypoxaemic. A possible therapeutic procedure for these patients is the application of prone positioning.OBJECTIVEThe primary aim of the present study was to investigate modification of the PaO2/FiO2 ratio, in VV-ECMO patients with refractory hypoxaemia. The secondary aim was to evaluate the safety and feasibility of prone positioning for patients with severe Adult Respiratory Distress Syndrome supported by ECMO.METHODSWe retrospectively reviewed the electronic records and charts of all patients supported by VV-ECMO who experienced at least one pronation. Complications related with prone positioning were also recorded. First PaO2/FiO2 ratio was analysed during four different time steps: before pronation, one hour after pronation, at the end of pronation and one hour after returning to supine.RESULTSA total of 45 prone positioning manoeuvers were performed in 14 VV-ECMO patients from November 2009 to November 2014. The median duration of prone positioning cycles was 8 hours (IQR 6-10). No accidental dislodgement of intravascular lines, endotracheal tubes, chest tubes or a decrease in ECMO blood flow was observed. During the first prone positioning for each patient, the median PaO2/FiO2 ratio recorded was 123 (IQR 82-135), 152 (93-185), 149 (90-186) and 113 (74-182), during PRE-supine step, 1 h-prone positioning step, END-prone positioning step, and POST-supine step respectively.CONCLUSIONSThe application of prone positioning during VV-ECMO has shown to be a safe and reliable technique when performed in a recognised ECMO centre with the appropriately trained staff and standard procedures.

1. **Comparing Outcomes in Manual and Automatic Prone Positioning Therapy for Acute Respiratory Distress Syndrome...2018 National Teaching Institute Research Abstracts Presented at the AACN National Teaching Institute in Boston, Massachusetts, May 21-24, 2018.**  
   Morata Lauren American Journal of Critical Care 2018;27(3):No page numbers.

Purpose: Moderate to severe acute respiratory distress syndrome (ARDS) is a complex disease with a high mortality rate. Prone positioning therapy is an effective treatment option that helps reduce mortality among patients with ARDS. Nurses are responsible for safe and effective patient positioning by either manually placing patients prone or using an automatic proning bed to do so. The purpose of this study was to analyze various outcomes associated with manual versus automatic prone positioning therapy in patients with ARDS. Background/Significance: Prior research on prone positioning therapy in ARDS has focused on mortality benefit, yet, to our knowledge, no study has compared the outcomes between manual and automatic prone positioning therapy. The multidisciplinary team of an 849-bed tertiary referral center implemented an evidencebased prone positioning protocol to guide the use of manual and automatic prone positioning therapy. Comparison of outcomes between the 2 groups will assist other institutions to make decisions about methods of pronation and implement protocols to promote safe practice. Method: After approval was received from the institutional review board, a retrospective, descriptive comparative approach was used to analyze data from 37 adult patients whose condition met the Berlin definition of moderate to severe ARDS. All patients received either manual or automatic prone positioning therapy between November 1, 2014, and November 30, 2016. Data were part of a quality improvement database initiated at the start of protocol implementation. Statistical analysis included χ² test for complications and discharge disposition, and Mann-Whitney U test for time to initiating prone positioning from physician order and for intensive care unit (ICU) and hospital length of stay (LOS). A cost analysis was used to evaluate the cost associated with each therapy. Results: Manual and automatic prone positioning therapies were used for 16 and 21 patients, respectively. Time to initiation was similar between groups. Patients undergoing automatic prone positioning therapy were more likely to experience pressure injuries (P = .04), especially of the head (P = .003), thorax (P = .003), and lower extremities (P = .047). Other complications did not differ significantly between groups. Although the difference was not statistically significant, patients placed prone manually had shorter ICU and hospital LOS (7.1 and 6.5 days, respectively) compared with patients undergoing automatic prone positioning. In addition, patients undergoing manual prone positioning therapy were more likely to be discharged home than were patients who had automatic prone positioning therapy (43.8% vs 28.6%). Conclusion: Owing to the small sample size, additional research is needed to determine if manual or automatic prone positioning therapy is preferred. However, these results suggest that manual prone positioning therapy is safer, has lower complication rates, and may be more efficacious, as indicated by decreased LOS and discharge disposition. When automatic prone positioning therapy is required (eg, morbid obesity limiting safe manual pronation), nursing interventions are important to protect the patient's skin from pressure injuries.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=92d753f7eddd906e3662f9c78a4e821d)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=6248ab140fd9017d47e450f99779b169)

1. **Evaluation of effective emergency airway management for accidental extubation in a patient with head fixed in the prone position: A randomized crossover manikin study**  
   Koyama Y. Anesthesia and Analgesia 2018;126(4):12.

INTRODUCTION: It is very rare but challenging to perform emergency airway management for accidental extubation in a patient whose head and neck are xed in the prone position during neurosurgical operations. In the event of accidental extubation in the prone position, urgently turning the patient supine would be required for re-intubation. However, when intracranial or spinal cord surgery is in progress, turning a patient may compromise the sterility of the surgical eld and the stability of the cervical spine. In such a situation, supraglottic airway devices (SGAs) are probably most commonly used for airway rescue in the prone position1-4. However, there has been no comparison of the usefulness of SGAs with that of other techniques such as tracheal intubation using video laryngoscopes or berscopic guidance in this situation. Therefore, we sought to determine the most effective airway rescue technique for accidental extubation in the prone position in a manikin. <br/>METHOD(S): We compared the performance of the ProSeal laryngeal mask airway (PLMA) with that of tracheal intubation via the Pentax Airway Scope (AWS), McGRATH (McGRATH) and beroptic intubation through the LMA FASTRACH AIRWAY (FASTRACH) in a manikin in the prone position. The prone manikin was xed on the table, and the manikin's head was xed to a flat board. Twenty-one anesthesiologists performed airway management in the prone manikin with the four devices, and the time required for intubation/ventilation was measured. The success rates with the four study devices were also recorded. Failed intubation/ventilation was defined as an intubation/ventilation time &gt;90 s or esophageal intubation. The Kruskal-Wallis test followed by the Mann-Whitney U test with Bonferroni correction was used to compare the intubation/ventilation times between the four groups. The success rates between the four groups were compared by Chi-squared tests with Bonferroni correction. Data are expressed as median (range) in intubation/ventilation time and proportion in the success rate. <br/>RESULT(S): There was no significant difference in intubation/ ventilation time between the PLMA, 24.5 (13.5-89.5) s and the AWS, 29.9 (17.1-79.8) s. The AWS allowed significantly faster tracheal intubation than did the McGRATH, 46.7 (21.9-211.7) s and beroptic intubation via FASTRACH, 84.2 (48.7-271.5) s (P=0.006 and P&lt;0.001, respectively) (Figure 1). The success rates with the PLMA (100%) and AWS (100%) were significantly greater than those with the McGRATH (71.4%) and beroptic intubation via FASTRACH (57.1%). Taken together, airway management performance with the PLMA and AWS were comparable to each other and better than that of the McGRATH and beroptic intubation via FASTRACH in the prone position. <br/>CONCLUSION(S): Considering that tracheal intubation can provide a more secure airway and more stable ventilation than the PLMA, tracheal re-intubation with a channeled blade-type video laryngoscope such as the AWS may be a useful method of airway rescue for accidental extubation in the prone position when urgently turning the patient supine would be unsafe. (Figure Presented) .

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=4a1858e23efa0802bcbe9e278ff34755)

1. **Feasibility of prone ventilation in resource limited setting in rural based hospital in India: A pilot study**  
   Laux T. American Journal of Respiratory and Critical Care Medicine 2018;197:No page numbers.

RATIONALE: Early prone ventilation has been shown to decrease mortality in severe Acute Respiratory Distress Syndrome (ARDS). Prone ventilation is labor intensive and logistically difficult in low resource settings. We implemented prone positioning protocols appropriate for our High Dependency Unit (HDU) in rural India. <br/>METHOD(S): After training of residents and nursing staff, prone ventilation was implemented in severe ARDS in a seven bed HDU manned by three nursing staff, one resident doctor and one generalist. Between August and October 2017 we prone ventilated eligible patients daily until further prone ventilation was not indicated. We describe outcomes and feasibility associated with prone ventilation in a low resource setting. <br/>RESULT(S): We prone ventilated four eligible patients (Table 1). Without arterial blood gases, inability to maintain oxygen saturation more than 88% on 60% FiO2 or more with adequate PEEP was considered the indication for prone ventilation. Two of four patients survived. While the act of proning was not challenging, all patients required higher doses of sedatives to control agitation. Only one of four patients was paralyzed and this patient dramatically improved. However, the use of paralytics in our setting has not been fully realized due to issues with supply, controlling drip rates and sedation monitoring. Corrective measures were taken quickly for kinked tubing in one patient. There were no complications such as endotracheal tube or catheter dislodgement nor pressure sore development. Inability to perform adequate point of care ultrasound, central line placement and occasional cessation of enteral feeds were common challenges though did not affect overall management. One patient developed subcutaneous emphysema and another developed vasopressor induced peripheral ischemia leading to gangrene in unilateral limbs. 1 Table 1. Patients treated with prone ventilation <br/>CONCLUSION(S): Prone ventilation did not require additional staff at bedside to safely implement, but did redirect limited nursing staff away from other patients. Logistical issues - notably patient repositioning - were not an issue in our malnourished population. Higher doses of available sedatives were universally required. Prone ventilation proved to be an "appropriate technology" and a feasible intervention in our low resource setting. 2 (Table presented) .

1. **Mechanical Ventilation and Extracorporeal Membrane Oxygena tion in Acute Respiratory Insufficiency.**  
   Fichtner Falk Deutsches Arzteblatt international 2018;115(50):840-847.

BACKGROUNDMechanical ventilation is life-saving for patients with acute respiratory insufficiency. In a German prevalence study, 13.6% of patients in intensive care units received mechanical ventilation for more than 12 hours; 20% of these patients received mechanical ventilation as treatment for acute respiratory distress syndrome (ARDS). The new S3 guideline is the first to contain recommendations for the entire process of treatment in these groups of patients (indications, ventilation modes/parameters, ac- companying measures, treatments for refractory impairment of gas exchange, weaning, and follow-up care).METHODSThis guideline was developed according to the GRADE methods. Pertinent publications were identified by a systematic search of the literature, the quality of the evidence was evaluated, a risk/benefit assessment was conducted, and recommendations were issued by interdisciplinary consensus.RESULTSMechanical ventilation is recommended as primary treatment for patients with severe ARDS. In other patient groups, non-in- vasive ventilation can lower mortality. If mechanical ventilation is needed, ventilation modes allowing spontaneous breathing seem beneficial (quality of evidence [QoE]: very low). Protective ventilation (high positive end-expiratory pressure, low tidal volume, limited peak pressure) improve the survival of ARDS patients (QoE: high). If a severe impairment of gas exchange is present, prone posi- tioning lessens mortality (QoE: high). Veno-venous extracorporeal membrane oxygenation (vvECMO) has not unequivocally been shown to improve survival. Early mobilization and weaning protocols can shorten the duration of ventilation (QoE: moderate).CONCLUSIONRecommendations for patients undergoing mechanical ventilation include lung-protective ventilation, early sponta- neous breathing and mobilization, weaning protocols, and, for those with severe impairment of gas exchange, prone positioning. It is further recommended that patients with ARDS and refractory impairment of gas exchange should be transferred to an ARDS/ECMO center, where extracorporeal methods should be applied only after application of all other therapeutic options.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=5c768145e3160cd4d915b6469e91d93c)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=f99e904bba7b5beb6d50b10ca3b53227)

1. **Predictors of survival in patients with influenza pneumonia-related severe acute respiratory distress syndrome treated with prone positioning**  
   Kao K.-C. Annals of Intensive Care 2018;8(1):No page numbers.

Background: Patients with influenza complicated with pneumonia are at high risk of rapid progression to acute respiratory distress syndrome (ARDS). Prone positioning with longer duration and lung-protective strategies might reduce the mortality level in ARDS. The aim of this study is to investigate the survival predictors of prone positioning in patients with ARDS caused by influenza pneumonia. <br/>Method(s): This retrospective study was conducted by eight tertiary referral centers in Taiwan. From January 1 to March 31 in 2016, all of the patients in intensive care units with virology-proven influenza pneumonia were collected, while all of those patients with ARDS and receiving prone positioning were enrolled. Demographic data, laboratory examinations, management records, ventilator settings and clinical outcomes were collected for analysis. <br/>Result(s): During the study period, 336 patients with severe influenza pneumonia were screened and 263 patients met the diagnosis of ARDS. Totally, 65 patients receiving prone positioning were included for analysis. The 60-day survivors had lower Acute Physiology and Chronic Health Evaluation (APACHE) II score, pneumonia severity index (PSI), creatinine level and lower rate of receiving renal replacement therapy than non-survivors (22.4 +/- 8.5 vs. 29.2 +/- 7.4, p = 0.003; 106.6 +/- 40.9 vs. 135.3 +/- 48.6, p = 0.019; 1.2 +/- 0.9 mg/dL vs. 3.1 +/- 3.6 mg/dL, p = 0.040; and 4% vs. 42%, p &lt; 0.005). Multivariate Cox regression analysis identified PSI (hazard ratio 1.020, 95% confidence interval 1.009-1.032; p &lt; 0.001), renal replacement therapy (hazard ratio 6.248, 95% confidence interval 2.245-17.389; p &lt; 0.001), and increase in dynamic driving pressure (hazard ratio 1.372, 95% confidence interval 1.095-1.718; p = 0.006) which were independent predictors associated with 60-day mortality. <br/>Conclusion(s): In the present study, in evaluating the effect of prone positioning in patients with influenza pneumonia-related ARDS, pneumonia severity index, renal replacement therapy and increase in dynamic driving pressure were associated with 60-day mortality in patients with influenza pneumonia-related ARDS receiving prone positioning.<br/>Copyright &#xa9; 2018, The Author(s).

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=d707b10e5f5d89c951724d3f11f156f1)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=1fea264278eb78139c7c4488aa0eb572)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=02d0aeb83da5e97f5f5a14394238fd46)

1. **Prone positioning in patients with acute respiratory distress syndrome: Predictors of ICU mortality**  
   Tsai-Nguyen G. Critical Care Medicine 2018;46:518.

Learning Objectives: Standard mechanical ventilation management in patients with Acute Respiratory Distress Syndrome (ARDS) utilizes low tidal volumes and limited plateau pressures. However, refractory hypoxemia may persist despite these measures. Previous studies have shown that prone positioning in severe ARDS resulted in improvement of 28-day survival. Whether mechanical ventilation strategies or other parameters affect survival in patients undergoing prone positioning is unknown. <br/>Method(s): A retrospective analysis of a consecutive series of patients between November 2013 and December 2016 with severe ARDS treated with prone positioning was included. Demographic, clinical information involving mechanical ventilation strategies, and other variables associated with prone positioning were collected. The rate of in-hospital mortality was obtained, and a comparison of the above parameters between survivors and non-survivors was done. <br/>Result(s): Forty-three patients with severe ARDS were treated with prone positioning. Twenty-seven (63%) died in the ICU during hospitalization. Three parameters were found to be significant predictors of survival: plateau pressure (p = 0.02), driving pressure (p = 0.04), and APACHE II (p = 0.03). Plateau pressure in non-survivors was 34 cmH2O vs. 30 cmH2O in survivors. Driving pressure was 22 cmH2O in non-survivors vs. 17 cm H20 in survivors. APACHE II was 30 in non-survivors vs. 26 in survivors. The predicting ability for ICU mortality for each of these parameters was assessed with ROC curves. The AUC for plateau pressure, driving pressure, and APACHE II were 0.69, 0.67, and 0.74, respectively. <br/>Conclusion(s): In a group of patients with severe ARDS treated with prone positioning only plateau pressure, driving pressure and APACHE II were associated with ICU mortality.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=e298a946c2f9247f52140f5f46e7f0ee)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=e298a946c2f9247f52140f5f46e7f0ee)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=e5be6b40c1adbdb55830f10fda919e3c)

1. **Prone positioning is a safe and effective method in the management of acute lung injury after cardiac surgery**  
   Saha S. Thoracic and Cardiovascular Surgeon 2018;66:No page numbers.

Objectives: The aim of the study was to determine the benefit of prone positioning in patients developing acute lung injury (ALI) following cardiac surgery. <br/>Method(s): A review of 438 consecutive patients who underwent cardiac surgery at our institution from October 2016 to May 2017 revealed 14 patients who underwent prone positioning (PP) for the treatment of ALI. We excluded 3 patients who underwent simultaneous ECMO therapy. Data collection included the Horowitz index (HI) and peak inspiratory pressure (PIP) at the time of PP, 6 hours after PP, at the end of PP and 6 hours after return to supine position (SP). Results are presented as medians with interquartile ranges. <br/>Result(s): The median EuroSCORE II was 3.1% (1.3-7.9). Three patients had a history of COPD and two were diagnosed with pulmonary hypertension. Five patients underwent emergency surgery. The median duration of postoperative mechanical ventilation was 285 hours (179-535), 6 patients suffered from nosocomial pneumonia. The median duration of PP was 12 hours (12-12) and the median number of days after surgery where PP was implemented was 2 (0-9). We observed an increase in HI at the end of PP as compared with before PP (90 (73- 123) vs 198 (101-243), p = 0.004). This was followed by an insignificant decline in HI 6 hours after return to SP (168 (131-253), p = 0.657). In sum, the overall increase in HI compared with baseline values and values at 6 hours after return to SP indicated a significant respiratory improvement (90 (73-123) vs 168 (131-253), p = 0.006). Accordingly, we observed a significant decrease in PIP at the beginning of PP and 6 hours after return to SP (26 cm H<sub>2</sub>O (20-28) vs 22 cm H<sub>2</sub>O (21-28), p = 0.05). A total of 4 patients underwent percutaneous dilative tracheostomy after PP. The median duration of ICU stay was 15 days (12-19). There were no adverse events reported during the positioning of the patients. 8 patients survived to discharge. <br/>Conclusion(s): Prone positioning is a safe and effective treatment for ALI after cardiac surgery improving short and medium term respiratory condition.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=ecd2d45e10f2de1d9e46e7d9c21cfc37)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=0bd57f46cecfc54bcfe97d61ffe2cb3c)

1. **Protocol driven management improves outcomes in acute respiratory distress syndrome**  
   Duggal A. Intensive Care Medicine Experimental 2018;6:No page numbers.

INTRODUCTION. Acute respiratory distress syndrome (ARDS) remains under-recognized, under-treated and is associated with a high mortality. There is a potential for improvement in the management of these patients. OBJECTIVES. To study the impact of an evidence based ARDS man-agement on outcomes (28 and 90-day mortality, Ventilator Free days, use of adjunctive). METHODS. A prospective before-after study for patients with ARDS admitted to 5 intensive care units (ICUs) from 2012-2017 at Cleveland Clinic. An ARDS management protocol addressing multiple domains (adherence to lung protective strategy: tidal volume&lt; 8; Plateau Pressure&lt; 30; PEEP titrated to ARDSnet PEEP: FiO2; volume conservative strategies; sedation, analgesia and neuromuscular blocker protocol; prone position ventilation protocol) was developed and launched in 2016 in all the participating ICUs. RESULTS. 546 patients with ARDS were admitted during the study period. After the implementation of the protocol clinician recognition of ARDS improved significantly (23% vs 9%; P&lt; 0.0001 of mechanically ventilated patients). There was no difference in the demographics, causes of ARDS, co-morbidities, severity of illness score (APACHE III and SOFA) in the before and after group. After the implementation of the protocol there was no difference in the median tidal volume over the first 72 hours (7.4 vs 7.6; p 0.11), but the Plateau Pressure (25 vs 29; p &lt; 0.001) and driving pressure (14 vs 15, P0.004) were significantly lower. Similarly, after the implementation of the protocol PEEP discrepancy from the ARDSnet protocol was lower (-6 vs-7.2; P0.03), minute ventilation was lower (10.7 vs 11.3; p 0.002). Use of adjunctive therapies decreased significantly after the implementation of the protocol (40% vs 46%; p0.01). After the implementation of the Protocol the ventilator free days increased (4.5 vs 0 p&lt; 0.001) and both 28-day (42% vs 54% p0.009) and 90-day (52% vs 66% p 0.002) mortality decreased significantly. We also developed a sub-group analysis for patients with moderate-severe ARDS (PF&lt; 150), and there was significantly higher adherence with lung protective ventilation (p0.001), and PEEP based on ARDSnet recommendations (p0.02). The cumulative fluid balance was significantly lower (4 vs 6.5 liter p0.04) after the implementation of the protocol. Use of adjunctive therapies, and 28 and 90-day mortality remained significantly lower after the implementation of the protocol. A cox proportional hazard model was developed and after adjustment for Charlson index, APACHE III, PF ratio, PEEP and volume status on day 7, the mor-tality remained significantly lower after the implementation of the ARDS protocol (HR 0.54 (0.38-0.78), P&lt; 0.001). CONCLUSIONS. Implementation of an evidence based protocol im-proves clinician recognition of ARDS, and is associated with a significant decrease in 28 and 90-day mortality. This approach also decreases the use of adjunctive therapy. [Figure Presented].

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=ead8d94ba871c2c366e1f349effda5e5)

[2&spage=40 this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=905976245ff176d0ca494bb84170f055)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=cf2ef8e08d8dfd7dd029e00ba702cc4d)

1. **Use of prone positioning and airway pressure release ventilation (APRV) for patients with acute respiratory distress syndrome (ARDS) in intensive care units in London and the South-East of England**  
   Lakhani R.D. Intensive Care Medicine Experimental 2018;6:No page numbers.

INTRODUCTION. ARDS carries significant morbidity and mortality (35%-46% in mild to severe forms)<sup>1</sup>. There is good evidence to support prone positioning in the management of ARDS<sup>2</sup>. Evidence is also emerging to support APRV<sup>3</sup>. Despite this, use of both remains inconsistent, with literature suggesting prone positioning is only used for between 8-33% of patients with ARDS<sup>1,2</sup>. OBJECTIVES. To review the use of prone positioning and APRV in the treatment of ARDS in critical care units within one region of the UK. METHODS. An online survey consisting of 25 questions on ICU demographics, prone positioning and the use of APRV was distributed to ICUs in the South-East Coast and London Critical Care Networks. RESULTS. There were 18 responses, mainly from mixed medical & surgical ICUs (67%), with a median size of 13.5 beds (total range 2-68). 50% (n=9) reported proning patients on a regular basis, with reasons for not proning being lack of a protocol, lack of experience, risk of complications, the procedure being too labour intensive or rarely clinically required. The median number of patients proned by these units in the last 12 months was 4 (IQR 2-6). 33% (n=6) of respondents had a protocol for when to prone patients. P:F ratio (PaO<sub>2</sub>/FiO<sub>2</sub>), PaO<sub>2</sub>, and FiO<sub>2</sub> were the most common variables used to determine when to prone patients. 33% had a protocol for how to prone patients, with common factors including the use of neuromuscular blockade, five or more staff required, and pronation during the daytime, with durations of 12-18 hours. 56% (n=10) used APRV infrequently, with only 17% (n=3) using it frequently. There was a protocol for when to commence APRV in 22% (n=4), and how to start it in 33% (n=6). CONCLUSIONS. In spite of compelling evidence, only half of the ICUs in this region use prone positioning regularly. The main impediments appear to involve human factors, such as risk of complications or labour intensiveness. However, where pronation does take place, there appears to be some consistency regarding when and how this should be done. APRV is used infrequently and tends to be initiated based upon clinician decision. This may be due to the lack of a large multi-centre trial supporting its use. However, if more convincing evidence does emerge, APRV may represent a valuable alternative rescue technique for ARDS which avoids the risks and difficulties of prone positioning.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=ead8d94ba871c2c366e1f349effda5e5)

[2&spage=40 this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=905976245ff176d0ca494bb84170f055)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=cf2ef8e08d8dfd7dd029e00ba702cc4d)

1. **Variation in US management practices in moderate-to-severe ARDS: The severe ARDS: Generating evidence (SAGE) study**  
   Park P.K. American Journal of Respiratory and Critical Care Medicine 2018;197:No page numbers.

RATIONALE: The international LUNG-SAFE study demonstrated variable compliance with evidence-based ARDS management. Data on current US management practices is lacking, particularly in moderate-to-severe ARDS. <br/>OBJECTIVE(S): To examine moderate-to-severe ARDS in US hospitals and describe variations in current management practices. <br/>METHOD(S): Multicenter, observational study of mechanically ventilated patients with moderate-to-severe ARDS conducted at 25 centers between October 2016 and April 2017, enrolling consecutive patients meeting inclusion criteria of a PaO<sub>2</sub>/FiO<sub>2</sub> ratio &lt; 150 on a minimum PEEP of 5 cm H<sub>2</sub>O. <br/>RESULT(S): Of 18,475 patients screened, 1994 (10.8%) were identified with moderate-to-severe ARDS, with a median Day1 PaO<sub>2</sub>/FiO<sub>2</sub> of 95 (IQR 72, 123). The mean age was 57.1 + 16.2 years, with 57% being male. The most common risk factors for ARDS development were sepsis (63.5%) and pneumonia (61.1%). Shock was present in over 1/2 of patients and vasopressors administered in 65.1%. Care was withdrawn or limited for 29.2% of patients. In-hospital mortality at 28 days was 34.94%. Of the survivors, 68.2% were discharged from the hospital on unassisted breathing. The majority (59.6%) were managed in medical ICUs, but a substantial proportion were managed in mixed medical-surgical, surgical and cardiothoracic ICUs (14.1%, 12.3% and 5.8%, respectively). 37.7% received noninvasive ventilation or HFNC support before intubation. During, initial ventilator management on study Day1, 82% received volume ventilation (assist-controlled, pressure-regulated volume control or SIMV), 11.8% pressure ventilation (assist-controlled or SIMV) and 6% spontaneous ventilation (pressure-support, APRV) or other modes. While the overall cohort Day1 median tidal volume was 6.5 ml/kg predicted body weight (PBW) (IQR, 5.96, 7.55) and Day1 median PEEP was 10 cm H<sub>2</sub>O (IQR, 7.00, 12.00), substantial variation between sites was noted (Figure 1). 16.4% of patients still received an initial tidal volume &gt; 8 ml/kg PBW. Evidence-based (neuromuscular blockade, prone positioning) and non-evidence-based (systemic steroids, inhaled vasodilators, ECMO) adjunctive therapies were used in 60% of patients, with wide variation by therapy and by site (26.2% - 96.6%). Only 8% of patients were concurrently enrolled in an interventional ICU or ARDS clinical trial. CONCLUSIONS In this US study of moderate-to-severe ARDS, compliance with low tidal volume ventilation is better, but mortality remains high and similar to LUNG-SAFE. Application of low-tidal volume strategies varies between sites and a significant proportion of patients still receive TV&gt;8 cc/kg PBW. The majority of patients received varied rates of evidence-based and non-evidence-based adjuvant therapies. Further understanding of baseline site-to-site variation and implementation strategies is needed.

1. **Analysis of complications of prone position in acute respiratory distress syndrome: quality standard, incidence and related factors.**  
   Jové Ponseti E. Enfermeria intensiva 2017;28(3):125-134.

INTRODUCTIONThe monitoring system based on standards of quality allows clinicians to evaluate and improve the patient's care. According to the quality indicators recommended by Sociedad Española de Medicina Intensiva Crítica y Unidades Coronarias, and due to the importance of prone position (PP) as a treatment in patients with acute respiratory distress syndrome, it is fundamental to keep accurate record of serious adverse events occurring during the prone position procedure and its posterior analysis.OBJECTIVESTo establish fulfilment of the Sociedad Española de Medicina Intensiva Crítica y Unidades Coronarias standards of quality according to the register of serious complications. To identify the incidence of serious complications registered as well as to identify possible factors related to these complications.METHODRetrospective, cross-sectionsl descriptive study, polyvalent ICU (16 beds). Study population Patients with acute respiratory distress syndrome treated with PP (January 2012-December 2013). Study variables PP recording, accidental extubation, removal of catheters, decubitus ulcers (DU), ETT obstruction, urgency of the procedure, hours in PP, nutritional intake, type of feeding tube, food regurgitation/retention and use of prokinetics/muscle relaxant.RESULTSThe study sample comprised 38 cases, with an adequate record of complications in 92.1% of the cases. DU were the only serious complication recorded, with a 25.7% incidence. Possible factors related to DU: more hours in PP in patients developing DU (p= .067). Less incidence of DU in well-nourished patients (p= .577). 82.9% of patients were not appropriately nourished.CONCLUSIONSThe percentage of records duly completed is very high. The presence of DU (grade 1-2 mostly) is to be noted. There is no stastistical significance, although a trend is obversed, between DU and hours in PP.

1. **Evaluation of the practice of proning in patients with ARDS across 22 Intensive Care Units in London, United Kingdom**  
   Samee T. Intensive Care Medicine Experimental 2017;5(2):No page numbers.

INTRODUCTION. Despite lung-protective ventilation and other measures inpatient mortality for acute respiratory distress syndrome (ARDS) remains high at over 40%1. Proning has long been suggested to improve oxygenation in mechanically ventilated patients with ARDS. Recent research demonstrated that proning longer than 16 hours within 36 hours of starting mechanical ventilation significantly reduces 28-day mortality in patients with severe ARDS2. There are further meta-analyses which also recommend proning1,3. However, the United Kingdom currently has no national guidelines on proning. The European Society for Intensive Care Medicine has not published any either so the management of ARDS patients is currently entirely dictated by local practice and individual preferences. OBJECTIVES. The primary aim of our project was to establish how many hospitals in London had a pre-set formal local or regional proning guideline for patients with ARDS. We also sought to evaluate their specific triggers for proning and the duration. Our hypothesis was that there was likely to be wide variations in practice. METHODS. A total of 23 intensive care units in London were contacted via telephone and/or email. Senior staff members were asked to complete eight questions about their local proning practice. 22 intensive care units were very forthcoming and provided insight into their local practice. RESULTS. Of the 22 hospitals, only 18% (n = 4) had set guidelines on proning. 64% (n = 14)of the ITUs routinely considered it as a way of treating patients with ARDS whereas 36% (n = 8) did not. 67% (n = 14) favoured proning only in severe ARDS compared to 33% (n = 7) which used proning in moderate ARDS. The mean maximum duration of proning was 18.3 hours over a 24 hour period, ranging from 4-24 hours. The triggers for proning varied greatly between the different units. CONCLUSIONS. We found considerable variations in practice in the 22 units evaluated. Given that current evidence supports proning as a beneficial measure in managing ARDS patients, there is an urgent need for national guidelines to streamline the management of this particular patient group.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=0bbd36e98f3d81940b47781bf89a491c)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=623b204a3c241428369ea573d059960e)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=b878fb8df7a80428fb483839df38df6d)

1. **Geo-economic variations in epidemiology, patterns of care, and outcomes in patients with acute respiratory distress syndrome: insights from the LUNG SAFE prospective cohort study**  
   Laffey J.G. The Lancet Respiratory Medicine 2017;5(8):627-638.

Background Little information is available about the geo-economic variations in demographics, management, and outcomes of patients with acute respiratory distress syndrome (ARDS). We aimed to characterise the effect of these geo-economic variations in patients enrolled in the Large Observational Study to Understand the Global Impact of Severe Acute Respiratory Failure (LUNG SAFE). Methods LUNG SAFE was done during 4 consecutive weeks in winter, 2014, in a convenience sample of 459 intensive-care units in 50 countries across six continents. Inclusion criteria were admission to a participating intensive-care unit (including transfers) within the enrolment window and receipt of invasive or non-invasive ventilation. One of the trial's secondary aims was to characterise variations in the demographics, management, and outcome of patients with ARDS. We used the 2016 World Bank countries classification to define three major geo-economic groupings, namely European high-income countries (Europe-High), high-income countries in the rest of the world (rWORLD-High), and middle-income countries (Middle). We compared patient outcomes across these three groupings. LUNG SAFE is registered with ClinicalTrials.gov, number NCT02010073. Findings Of the 2813 patients enrolled in LUNG SAFE who fulfilled ARDS criteria on day 1 or 2, 1521 (54%) were recruited from Europe-High, 746 (27%) from rWORLD-High, and 546 (19%) from Middle countries. We noted significant geographical variations in demographics, risk factors for ARDS, and comorbid diseases. The proportion of patients with severe ARDS or with ratios of the partial pressure of arterial oxygen (PaO<sub>2</sub>) to the fractional concentration of oxygen in inspired air (F<sub>I</sub>O<sub>2</sub>) less than 150 was significantly lower in rWORLD-High countries than in the two other regions. Use of prone positioning and neuromuscular blockade was significantly more common in Europe-High countries than in the other two regions. Adjusted duration of invasive mechanical ventilation and length of stay in the intensive-care unit were significantly shorter in patients in rWORLD-High countries than in Europe-High or Middle countries. High gross national income per person was associated with increased survival in ARDS; hospital survival was significantly lower in Middle countries than in Europe-High or rWORLD-High countries. Interpretation Important geo-economic differences exist in the severity, clinician recognition, and management of ARDS, and in patients' outcomes. Income per person and outcomes in ARDS are independently associated. Funding European Society of Intensive Care Medicine, St Michael's Hospital, University of Milan-Bicocca.<br/>Copyright &#xa9; 2017 Elsevier Ltd

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=f83f4a1d5b1a1a8f7643556cf8d6e08f)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=79796e2ab921301c7cc43ae8b6f739da)

1. **Prone positioning as a bridge to recovery from refractory hypoxaemia following lung transplantation.**  
   Riera Jordi Interactive cardiovascular and thoracic surgery 2017;25(2):292-296.

OBJECTIVESRefractory hypoxaemia is the leading cause of mortality in the postoperative period after lung transplantation. The role of prone positioning as a rescue therapy in this setting has not been assessed. We evaluated its effects in lung transplant recipients presenting refractory hypoxaemia following the surgery.METHODSProspectively collected data from 131 consecutive adult patients undergoing lung transplantation between January 2013 and December 2014 were evaluated. Twenty-two patients received prone position therapy. Indications, associated complications, time to initiation and duration of the manoeuvre were analysed and the effects of prone position on gas exchange were evaluated. Finally, outcomes in this cohort were compared against the rest of lung transplant recipients.RESULTSProne positioning was more frequently implemented within the first 72 h (68.2%) and its main indication was primary graft dysfunction. The manoeuvre was maintained during a median of 21 h. After prone position, the pressure of arterial oxygen/fraction of inspired oxygen ratio significantly increased from 81.0 mmHg [interquartile range (IQR) 71.5-104.0] to 220.0 (IQR 160.0-288.0) (P < 0.001). No complications related with the technique were reported. Patients who underwent the manoeuvre had longer hospital stay [50.0 days (IQR 36.0-67.0) vs 30.0 (IQR 23.0-56.0), P = 0.006] than the rest of the population. No differences were found comparing either 1-year mortality (9.1% vs 15.6%; P = 0.740) or 1-year graft function [forced expiratory volume in 1 second of 70.0 (IQR 53.0-83.0) vs 68.0 (IQR 53.5-80.5), P = 0.469].CONCLUSIONSProne positioning is safe and significantly improves gas exchange in patients with refractory hypoxaemia after lung transplantation. It should be considered as a possible treatment in these patients.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=504a3291ad3570621010f12aab6386cb)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=bbd1da3cda567016e25665ed601a3969)

1. **Prone positioning in severe Acute Respiratory Distress Syndrome (ARDS)**  
   Laajili A. Intensive Care Medicine Experimental 2017;5(2):No page numbers.

BACKGROUND. Prone positioning (PP) has been used to improve oxygenation in patients who require mechanical ventilator support for management of ARDS. Randomized controlled trials demonstrated that survival rate is significantly better with PP. PURPOSE. We proposed to determine the effect of PP on prognosis of ARDS. METHODS. It was a retrospective study, including 76 cases of ARDS admitted in our respiratory ICU from January 2015 to November 2016. We have defined 2 groups: GI (44 patients positioned in PP), GII (32 without PP). We compare clinical data, therapeutic, side effects and outcomes. PP was indicated in severe cases of ARDS with persistent hypoxemia despite ventilatory optimization. PP was maintained for 18 consecutive hours daily. Discontinuation of PP was decided after clinical improvement. RESULTS. At admission, no significant difference was found between the 2 groups in mean age (56vs50 years, p = 0,5) and APACHEII score (20 +/- 10vs17 +/- 7, p = 0,09). However, sex ratio (1vs2.5; p = 0,03) and mean IGSII score (44 +/- 18 vs 35 +/- 13; p = 0,02) were significantly different. Cardiovascular co-morbidities were more frequent in GI (75%vs66%, p = 0,3). Septic shock was present in 36% in GI vs 22% in GII (p = 0,1). Pneumonia was the most common cause in 2 groups (73% vs 90%, p = 0,053). Patients in GI were more hypoxemic and significant differences were noted in the means of pH (7.31 +/- 0.15 vs 7.42 +/- 0.12; p = 0,001), PaCO2 (55 +/- 23mmHg vs 43 +/- 19mmHg; p = 0,019), and PaO2/FiO2 (103 +/- 51 vs 135 +/- 54; p = 0,01). All patients underwent echocardiography. Acute cor pulmonale was more frequently observed in GI (27% vs 3%; p = 0,01). Invasive mechanical ventilation was needed in all patients of GI, otherwise it was prescribed in only 50% in the second group(p &lt; 0,001). Mean duration of mechanical ventilation was significantly longer in GI (12 +/- 9 vs 7 +/- 10 days; p = 0,04). Mean positive end-expiratory pressure (PEEP) received in GI was significantly higher than that of GII (12 +/- 5 vs 8 +/- 3 cmH<sub>2</sub>O; p = 0,002). 66% of patients in G1 received a PEEP more than 12 cmH<sub>2</sub>O in contrast of 6% in GII (p = 0,002). Mean plateau pressure were similar in 2 groups (29 +/- 4 vs 29 cmH<sub>2</sub>O). Use of neuromuscular blockers was significantly more frequent in GI (100% vs 19%; p &lt; 0,001). Most frequent side effects occurred in GI were pressure ulcer and hemodynamic instability. GI had significantly more nosocomial infection (48% vs 25%; p = 0,044), longer mean duration of ICU stay (12 +/- 10 vs 10 +/- 9 days, p = 0,3) and higher mortality rate (89% vs 56%; p = 0,001). Multivariate analysis showed that female gender (p = 0,03), presence of acute cor pulmonale (p = 0,01), invasive mechanical ventilation with use of sedative and neuromuscular blockers (p &lt; 0,001), PEEP &gt;= 10 cmH<sub>2</sub>O (p = 0,007), and nosocomial infection (p = 0,044) were independent predictor factors of mortality. CONCLUSION. Our study doesn't confirm the benefit of PP in ARDS. However, patients who require this technique were more severe, have more organ dysfunction and consequently a worse prognosis.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=0bbd36e98f3d81940b47781bf89a491c)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=623b204a3c241428369ea573d059960e)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=b878fb8df7a80428fb483839df38df6d)

1. **Epidemiology, patterns of care, and mortality for patients with acute respiratory distress syndrome in intensive care units in 50 countries**  
   Bellani G. JAMA - Journal of the American Medical Association 2016;315(8):788-800.

IMPORTANCE: Limited information exists about the epidemiology, recognition, management, and outcomes of patients with the acute respiratory distress syndrome (ARDS). <br/>OBJECTIVE(S): To evaluate intensive care unit (ICU) incidence and outcome of ARDS and to assess clinician recognition, ventilation management, and use of adjuncts-for example prone positioning-in routine clinical practice for patients fulfilling the ARDS Berlin Definition. DESIGN, SETTING, AND PARTICIPANTS: The Large Observational Study to Understand the Global Impact of Severe Acute Respiratory Failure (LUNG SAFE) was an international, multicenter, prospective cohort study of patients undergoing invasive or noninvasive ventilation, conducted during 4 consecutive weeks in the winter of 2014 in a convenience sample of 459 ICUs from 50 countries across 5 continents. EXPOSURES Acute respiratory distress syndrome. MAIN OUTCOMES AND MEASURES: The primary outcomewas ICU incidence of ARDS. Secondary outcomes included assessment of clinician recognition of ARDS, the application of ventilatory management, the use of adjunctive interventions in routine clinical practice, and clinical outcomes from ARDS. <br/>RESULT(S): Of 29 144 patients admitted to participating ICUs, 3022 (10.4%) fulfilled ARDS criteria. Of these, 2377 patients developed ARDS in the first 48 hours and whose respiratory failure was managed with invasive mechanical ventilation. The period prevalence of mild ARDS was 30.0%(95%CI, 28.2%-31.9%); of moderate ARDS, 46.6%(95%CI, 44.5%-48.6%); and of severe ARDS, 23.4%(95%CI, 21.7%-25.2%). ARDS represented 0.42 cases per ICU bed over 4 weeks and represented 10.4%(95%CI, 10.0%-10.7%) of ICU admissions and 23.4%of patients requiring mechanical ventilation. Clinical recognition of ARDS ranged from 51.3% (95%CI, 47.5%-55.0%) in mild to 78.5%(95%CI, 74.8%-81.8%) in severe ARDS. Less than two-thirds of patients with ARDS received a tidal volume 8 of mL/kg or less of predicted body weight. Plateau pressure was measured in 40.1%(95%CI, 38.2-42.1), whereas 82.6%(95%CI, 81.0%-84.1%) received a positive end-expository pressure (PEEP) of less than 12 cm H<sub>2</sub>O. Prone positioning was used in 16.3%(95%CI, 13.7%-19.2%) of patients with severe ARDS. Clinician recognition of ARDS was associated with higher PEEP, greater use of neuromuscular blockade, and prone positioning. Hospital mortality was 34.9%(95%CI, 31.4%-38.5%) for those with mild, 40.3%(95%CI, 37.4%-43.3%) for those with moderate, and 46.1%(95%CI, 41.9%-50.4%) for those with severe ARDS. CONCLUSIONS AND RELEVANCE: Among ICUs in 50 countries, the period prevalence of ARDS was 10.4%of ICU admissions. This syndrome appeared to be underrecognized and undertreated and associated with a high mortality rate. These findings indicate the potential for improvement in the management of patients with ARDS.<br/>Copyright 2016 American Medical Association. All rights reserved.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=7c6bde9e0a1847e7292e689d3a135f5a)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=eec98886ac23e856aa7ac90e12fee498)

1. **Good practices for prone positioning at the bedside: Construction of a care protocol.**  
   Oliveira Vanessa Martins de Revista da Associacao Medica Brasileira (1992) 2016;62(3):287-293.

Last year, interest in prone positioning to treat acute respiratory distress syndrome (ARDS) resurfaced with the demonstration of a reduction in mortality by a large randomized clinical trial. Reports in the literature suggest that the incidence of adverse events is significantly reduced with a team trained and experienced in the process. The objective of this review is to revisit the current evidence in the literature, discuss and propose the construction of a protocol of care for these patients. A search was performed on the main electronic databases: Medline, Lilacs and Cochrane Library. Prone positioning is increasingly used in daily practice, with properly trained staff and a well established care protocol are essencial.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=c533b8c9e593503805b956fa50519591)

1. **Increasing positive end-expiratory pressure (re-)improves intraoperative respiratory mechanics and lung ventilation after prone positioning**  
   Spaeth J. British Journal of Anaesthesia 2016;116(6):838-846.

Background Turning a patient prone, changes the respiratory mechanics and potentially the level of positive end-expiratory pressure (PEEP) that is necessary to prevent alveolar collapse. In this prospective clinical study we examined the impact of PEEP on the intratidal respiratory mechanics and regional lung aeration in the prone position. We hypothesized that a higher PEEP is required to maintain compliance and regional ventilation in the prone position. Methods After ethical approval, 45 patients with healthy lungs undergoing lumbar spine surgery were examined in the supine position at PEEP 6 cm H<sub>2</sub>O and in the prone position at PEEP (6, 9 and 12 cm H<sub>2</sub>O). Dynamic compliance (C<sub>RS</sub>) and intratidal compliance-volume curves were determined and regional ventilation was measured using electrical impedance tomography. The compliance-volume curves were classified to indicate intratidal derecruitment, overdistension, or neither. Results C<sub>RS</sub> did not differ between postures and PEEP levels (P&gt;0.28). At a PEEP of 6 cm H<sub>2</sub>O a compliance-volume profile indicating neither derecruitment nor overdistension was observed in 38 supine, but only in 20 prone positioned patients (P&lt;0.001). The latter increased to 33 and 37 (both P&lt;0.001) when increasing PEEP to 9 and 12 cm H<sub>2</sub>O, respectively. Increasing PEEP from 6 to 9 cm H<sub>2</sub>O in the prone position increased peripheral ventilation significantly. Conclusions Respiratory system mechanics change substantially between supine and prone posture, which is not demonstrated in routine measurements. The intratidal compliance analysis suggests that in most patients a PEEP above commonly used settings is necessary to avoid alveolar collapse in the prone position. Clinical trial registration DRKS 00005692.<br/>Copyright &#xa9; 2016 The Author 2016. Published by Oxford University Press on behalf of the British Journal of Anaesthesia. All rights reserved.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=3228cbf554473f21d8542751833c3b0a)

1. **Patients with severe ARDS already positioned prone: why don't we leave them in the prone position during transport and CT scan?**  
   Brederlau J.örg Minerva anestesiologica 2016;82(6):720-721.

1. **Prone position and lung ultrasound (PROPLUS) in ARDS**  
   Persona P. Intensive Care Medicine Experimental 2016;4:No page numbers.

Introduction ARDS is a life-threatening condition characterized by increased lung weight and loss of lung aeration. Recently, prone position as adjunct to lung protective ventilation demonstrated significant mortality reduction in ARDS patients[1]. Lung Ultrasound (LUS) has emerged as a powerful diagnostic tool that could help in diagnosis and guide management at the bedside. Performance of serial CT scans, the gold standard for lung recruitment assessment, can be challenging and not feasible outside research protocols. Objectives We hypothesized that, in ARDS patients, LUS could detect changes in regional inflation during prone position compared to supine position and over time. We also hypothesized that such changes correlate with commonly monitored parameters of aeration, oxygenation and ventilation, as measured by arterial blood gas analysis and respiratory mechanics. Finally, we hypothesized that specific LUS aeration patterns, identified immediately before and after prone position initiation, are predictive of clinical response to this adjunctive treatment. Method In this observational prospective study on ARDS patients, we performed LUS on the first day of prone position treatment at different time points: before (supine-S0), immediately after (P0) and 1 hour after (P1) initiation of prone position, immediately before (Pfin) and after returning the patient supine (Sfin). For the LUS protocol, we used a 2-4 MHz curvilinear transducer and we divided each hemithorax in 2 anterior, 2 lateral and 3 posterior zones. The worst LUS pattern detected in each zone was considered as characterizing the examined region. Off-line image review by two independent physicians, unaware of timing, position and patient's characteristics, was used to calculate a modified LUS aeration score, as previously described[2]. Spearman's rank correlation coefficient was used to correlate changes in LUS score (V-LUSS) with changes in compliance and PaO2/FiO<sub>2</sub> (P/F). Results We enrolled 13 ARDS patients, admitted to the Padova University Hospital ICU [median age 58 years (IQR 53-61); median SAPSII 45.5 (IQR 33-52)]. V-LUSS between P0 and P1 correlated with changes in compliance (r = 0.690; p &lt; 0.05) and P/F (r = 0.70; p &lt; 0.02) between S0 and Sfin. V-LUSS P0-Pfin also correlated with changes in P/F (r = 0.61; p &lt; 0.05) and compliance (r = 0.60; p &lt; 0.05) between S0 and SFin. Conclusions LUS is feasible in ARDS patients in prone position and V-LUSS correlates with changes in compliance and P/F. Moreover, the V-LUSS at 1 hour after initiation of prone position may predict the change in compliance and P/F at the end of a pronation cycle, after returning the patient in supine position.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=44b62c4d1df20f5434a65e839f18d868)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=68d930d24f157dc7adb0bee46ff200fc)

1. **Prone to inconsistency? What is the usage of prone ventilation amongst acute respiratory distress syndrome patients at a large district general hospital?**  
   Edwards S. Journal of the Intensive Care Society 2016;17(4):145.

Acute respiratory distress syndrome (ARDS) is a syndrome of non-cardiogenic, inflammatory pulmonary oedema which may lead to catastrophic refractory hypoxia. Prone ventilation is postulated to improve this through a variety of mechanisms including optimisation of regional ventilation-perfusion differences and shunt. However, there is challenging decision making regarding patient selection, timing and practical feasibility on the ICU at the time. This project aimed to evaluate the proning strategy employed as a unit for our patients with ARDS, and assess whether we are proning patients who the literature says will benefit. Single-centre retrospective audit of patients diagnosed as ARDS. The unit database was screened for adult patients ventilated for greater than three days between January 2015 and January 2016. Notes and chest imaging were then reviewed to check for bilateral infiltrates consistent with ARDS and to exclude cardiac failure. Patient characteristics, classification into mild/moderate/severe by PaO<sub>2</sub>:FiO<sub>2</sub> ratio, 6-h ventilatory data, underlying diagnosis, 30-day mortality, and whether the patient was proned or not were recorded. These data were compared against criteria for proning in the Proseva trial1 (PaO<sub>2</sub>:FiO<sub>2</sub>&lt;150 mmHg, FiO<sub>2</sub>&gt;0.6, PEEP&gt;6 cmH2O, tidal volume 6 ml/kg), and for use as rescue therapy (PaO<sub>2</sub>:FiO<sub>2</sub>&lt;100 mmHg). A total of 176 patients were ventilated for three days or more over the study period, and 135 were excluded after review of notes and imaging. Therefore, 41 patients were included as having ARDS. Median age was 58. Median APACHE-II score was 20. Eighty per cent had primary lung insult, e.g. pneumonia. Six were classified as mild, 32 as moderate, 3 as severe based on median P:F ratio. Overall 30-day mortality was 17%. Seven patients were proned - one in the mild group, four moderate, two severe. Two out of seven proned patients died within 30 days. Twenty-seven patients were eligible for proning by Proseva criteria, of which seven of these were proned. Twenty-four patients met criteria as rescue therapy, of which six were proned. Proning is potentially a powerful tool in the management of refractory hypoxia in ARDS. The patients who will benefit from proning remain debated, but comparison of our hospital data to inclusion criteria for positive trials has revealed heterogeneity in our proning strategy. It is possible that the data to explain this fell within the 6 h gaps in ventilatory data, or practical considerations prevented proning. However, given debate over evidence for proning, deviance from the literature base is perhaps unsurprising. The introduction of a Standard Operating Procedure for Proning should reduce variance and improve performance.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=2c52cc7c21c213cb129e50a961349906)

1. **Ventilator-associated pneumonia in ARDS patients: the impact of prone positioning. A secondary analysis of the PROSEVA trial.**  
   Ayzac L. Intensive care medicine 2016;42(5):871-878.

BACKGROUNDThe goal of this study was to assess the impact of prone positioning on the incidence of ventilator-associated pneumonia (VAP) and the role of VAP in mortality in a recent multicenter trial performed on patients with severe ARDS.METHODSAn ancillary study of a prospective multicenter randomized controlled trial on early prone positioning in patients with severe ARDS. In suspected cases of VAP the diagnosis was based on positive quantitative cultures of bronchoalveolar lavage fluid or tracheal aspirate at the 10(4) and 10(7) CFU/ml thresholds, respectively. The VAP cases were then subject to central, independent adjudication. The cumulative probabilities of VAP were estimated in each position group using the Aalen-Johansen estimator and compared using Gray's test. A univariate and a multivariate Cox model was performed to assess the impact of VAP, used as a time-dependent covariate for mortality hazard during the ICU stay.RESULTSIn the supine and prone position groups, the incidence rate for VAP was 1.18 (0.86-1.60) and 1.54 (1.15-2.02) per 100 days of invasive mechanical ventilation (p = 0.10), respectively. The cumulative probability of VAP at 90 days was estimated at 46.5 % (27-66) in the prone group and at 33.5 % (23-44) in the supine group. The difference between the two cumulative probability curves was not statistically significant (p = 0.11). In the univariate Cox model, VAP was associated with an increase in the mortality rate during the ICU stay [HR 1.65 (1.05-2.61), p = 0.03]. HR increased to 2.2 (1.39-3.52) (p < 0.001) after adjustment for position group, age, SOFA score, McCabe score, and immunodeficiency.CONCLUSIONSIn severe ARDS patients prone positioning did not reduce the incidence of VAP and VAP was associated with higher mortality.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=26fcb5204abf44fd9b225fdab3101ffe)

1. **A Multicenter Retrospective Review of Prone Position Ventilation (PPV) in Treatment of Severe Human H7N9 Avian Flu.**  
   Xu Yuanda PloS one 2015;10(8):e0136520.

BACKGROUNDPatients with H7N9 avian flu concurrent with severe acute respiratory distress syndrome (ARDS) usually have a poor clinical outcome. Prone position ventilation (PPV) has been shown to improve the prognosis of patients with severe ARDS. This study explored the effects of PPV on the respiratory and circulatory mechanics of H7N9-infected patients with severe ARDS.METHODSIndividuals admitted to four hospitals designated for H7N9 patients in Guangdong province were treated with PPV, and their clinical data were recorded before and after receiving PPV.RESULTSSix of 20 critically ill patients in the ICU received PPV. After treatment with 35 PPV sessions, the oxygenation index (OI) values of the six patients when measured post-PPV and post-supine position ventilation (SPV) were significantly higher than those measured pre-PPV (P < 0.05).The six patients showed no significant differences in their values for respiratory rate (RR), peak inspiratory pressure (PIP), tidal volume (TV) or arterial partial pressure of carbon dioxide (PaCO2) when compared pre-PPV, post-PPV, and post-SPV. Additionally, there were no significant differences in the mean values for arterial pressure (MAP), cardiac index (CI), central venous pressure (CVP), heart rate (HR), lactic acid (LAC) levels or the doses of norepinephrine (NE) administered when compared pre-PPV, post-PPV, and post-SPV.CONCLUSIONPPV provided improved oxygenation that was sustained after returning to a supine position, and resulted in decreased carbon dioxide retention. PPV can thus serve as an alternative lung protective ventilation strategy for use in patients with H7N9 avian flu concurrent with severe ARDS.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=80db27774bca14e12c7b5209019640ac)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=9a82d156b36d3acc7f1581b1bd1d853b)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=b98d64d20a2f951a493efc85475a5321)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=116e48e1ff6326f91af9345790b9553c)

1. **Controversies in the Management of Severe ARDS: Optimal Ventilator Management and Use of Rescue Therapies**  
   O'Gara B. Seminars in Respiratory and Critical Care Medicine 2015;36(6):823-834.

Groundbreaking research into the pathophysiology of the adult acute respiratory distress syndrome (ARDS) and the prevention of ventilator-induced lung injury has led to dramatic improvements in survival. Investigations over the last two decades have revolved around the development of rescue therapies that can be used for patients with severe ARDS and refractory hypoxemia. To date, the techniques of using high levels of positive end-expiratory pressure (PEEP), prompt institution of neuromuscular blockade, and early prolonged prone positioning have been shown to reduce mortality in patients with severe ARDS. PEEP titration using transpulmonary pressure estimations assisted by esophageal manometry has been shown to result in a substantial improvement in oxygenation. Extracorporeal membrane oxygenation (ECMO) has been used increasingly since the mid-2000s in part due to the H1N1 epidemic. A major randomized controlled trial conducted during this period showed a significant mortality benefit for patients with severe ARDS who were referred to a center with ECMO capabilities. The routine use of inhaled nitric oxide for patients with severe ARDS has not been shown to lead to more than a transient and limited improvement in oxygenation, which may hinder its use as a sole rescue therapy. Finally, recent studies have found that the routine use of high-frequency oscillatory ventilation in severe ARDS does not result in decreased mortality, although the technique has not been specifically investigated as rescue therapy for severe refractory hypoxemia.<br/>Copyright &#xa9; 2015 by Thieme Medical Publishers, Inc.

1. **Prone Positioning of Patients With Acute Respiratory Distress Syndrome**  
   Drahnak Dawn M. Critical Care Nurse 2015;35(6):29-37.

Effectively treating critically ill patients with acute respiratory distress syndrome (ARDS) is a challenge for many intensive care nurses. Multiple disease processes and injuries contribute to the complexity of ARDS and often complicate therapy. As a means of supportive care for ARDS, practitioners resort to rescue therapies to improve oxygenation and salvage the patient. The pathophysiology of ARDS and the use of prone positioning to improve pulmonary ventilation and oxygenation in ARDS patients are described. Educating nursing and medical staff on the use of prone positioning allows ease of patient placement with an emphasis on safety of both patients and staff. Scrupulous assessment of patients coupled with judicious timing of prone positioning expedites weaning from ventilatory support and contributes to positive outcomes for patients. References

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=7915eaf87a69d3b6df1fd279acd3f3bf)

1. **Combination of positioning therapy and venovenous extracorporeal membrane oxygenation in ARDS patients**  
   Kredel M. Perfusion 2014;29(2):171-177.

Positioning therapy may improve lung recruitment and oxygenation and is part of the standard care in severe acute respiratory distress syndrome (ARDS). Venovenous extracorporeal membrane oxygenation (vvECMO) is a rescue strategy that may ensure sufficient gas exchange in ARDS patients failing conventional therapy. The aim of this case series was to describe the feasibility and pitfalls of combining positioning therapy and vvECMO in patients with severe ARDS. A retrospective cohort of nine patients is described. The patients received 20 (15-86) hours (median, 25<sup>th</sup> and 75<sup>th</sup> percentile) of positioning therapy while being treated with vvECMO. The initial PaO<sub>2</sub>/FiO<sub>2</sub> index was 64 (51-67) mmHg and the arterial carbon dioxide tension was 60 (50-71) mmHg. Positioning therapy included 135 degrees prone, prone positioning and continuous lateral rotational therapy. During the first three days, the oxygenation index improved from 47 (41-47) to 12 (11-14) cmH<sub>2</sub>O/mmHg. The lung compliance improved from 20 (17-28) to 42 (27-43) ml/cmH<sub>2</sub>O. Complications related to positioning therapy were facial oedema (n=9); complications related to vvECMO were entrance of air (n=1) and pump failure (n=1). However, investigation of root causes revealed no association with the positioning therapy and had no documented effect on the outcome. The reported cases suggest that positioning therapy can be performed safely in ARDS patients treated with vvECMO, providing appropriate precautions are in place and a very experienced team is present.<br/>Copyright &#xa9; The Author(s) 2013.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=9d89298e22dc0b21d7927c42f17b6b84)

1. **Prone positioning during veno-venous extracorporeal membrane oxygenation for severe acute respiratory distress syndrome in adults.**  
   Guervilly C. Minerva anestesiologica 2014;80(3):307-313.

BACKGROUNDVeno-venous extracorporeal membrane oxygenation (VV-ECMO) is an effective rescue therapy for improving oxygenation in selected severe acute respiratory distress syndrome (ARDS). Prone position (PP) is usually considered before vvECMO and few data are available on the association of PP during VV-ECMO. Thus, we investigated the effect on oxygenation and the safety of PP during vvECMO.METHODSDuring a two-year period, 15 patients with severe ARDS were turned into PP during VV-ECMO therapy for at least one of the three following conditions: severe hypoxemia (PaO2/FiO2 ratio below 70) despite maximal oxygenation, injurious ventilation parameters with plateau pressure exceeding 32 cmH2O or failure of attempt to wean ECMO after at least 10 days on ECMO support.RESULTSPP was considered after a median of 9 days of ECMO and applied for a median of 12 hours and an average of 1.4 sessions per patient resulting in a total of 21 procedures. We found significant improvement in PaO2/FiO2 ratio at 6 hours (P=0.03) and 12 hours (P=0.007) after reversal. The improvement in oxygenation has still persisted 1hour (P=0.017) and 6 hours (P=0.013) after back to the supine position. No change in PaCO2, respiratory system (RS) compliance was observed. ECMO flow was maintained constant during the procedure. No complication related to PP was detected.CONCLUSIONPP may be considered in selected patients difficult to wean or remaining very hypoxemic despite VV-ECMO support.

1. **The impact of patient positioning on pressure ulcers in patients with severe ARDS: Results from a multicentre randomised controlled trial on prone positioning**  
   Girard R. Intensive Care Medicine 2014;40(3):397-403.

Purpose: Placing patients with severe acute respiratory distress syndrome (ARDS) in the prone position has been shown to improve survival as compared to the supine position. However, a higher frequency of pressure ulcers has been reported in patients in the prone position. The objective of this study was to verify the impact of prone positioning on pressure ulcers in patients with severe ARDS. <br/>Method(s): This was an ancillary study of a prospective multicentre randomised controlled trial in patients with severe ARDS in which the early application of long prone-positioning sessions was compared to supine positioning in terms of mortality. Pressure ulcers were assessed at the time of randomisation, 7 days later and on discharge from the intensive care unit (ICU), using the four-stage Pressure Ulcers Advisory Panel system. The primary end-point was the incidence (with reference to 1,000 days of invasive mechanical ventilation or 1,000 days of ICU stay) of new patients with pressure ulcers at stage 2 or higher from randomisation to ICU discharge. <br/>Result(s): At randomisation, of the 229 patients allocated to the supine position and the 237 patients allocated to the prone position, the number of patients with pressure ulcers was not significantly different between groups. The incidence of new patients with pressure ulcers from randomisation to ICU discharge was 20.80 and 14.26/1,000 days of invasive mechanical ventilation (P = 0.061) and 13.92 and 7.72/1,000 of ICU days (P = 0.002) in the prone and supine groups, respectively. Position group [odds ratio (OR) 1.5408, P = 0.0653], age &gt;60 years (OR 1.5340, P = 0.0019), female gender (OR 0.5075, P = 0.019), body mass index of &gt;28.4 kg/m<sup>2</sup> (OR 1.9804, P = 0.0037), and a Simplified Acute Physiology Score II at inclusion of &gt;46 (OR 1.2765, P = 0.3158) were the covariates independently associated to the acquisition of pressure ulcers. <br/>Conclusion(s): In patients with severe ARDS, prone positioning was associated with a higher frequency of pressure ulcers than the supine position. Prone positioning improves survival in patients with severe ARDS and, therefore, survivors who received this intervention had a greater likelihood of having pressure ulcers documented as part of their follow-up. There are risk groups for the development of pressure ulcers in severe ARDS, and these patients need surveillance and active prevention. &#xa9; 2013 Springer-Verlag Berlin Heidelberg and ESICM.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=5e6e062b7f108bc5ea146d5ee7afa0b5)

1. **Feasibility and effectiveness of prone position in morbidly obese patients with ARDS: a case-control clinical study.**  
   De Jong Audrey Chest 2013;143(6):1554-1561.

BACKGROUNDObese patients are at risk for developing atelectasis and ARDS. Prone position (PP) may reduce atelectasis, and it improves oxygenation and outcome in severe hypoxemic patients with ARDS, but little is known about its effect in obese patients with ARDS.METHODSMorbidly obese patients (BMI ≥ 35 kg/m²) with ARDS (Pao₂/FIo₂ ratio ≤ 200 mm Hg) were matched to nonobese (BMI < 30 kg/m²) patients with ARDS in a case-control clinical study. The primary end points were safety and complications of PP; the secondary end points were the effect on oxygenation (Pao₂/FIo₂ ratio at the end of PP), length of mechanical ventilation and ICU stay, nosocomial infections, and mortality.RESULTSBetween January 2005 and December 2009, 149 patients were admitted for ARDS. Thirty-three obese patients were matched with 33 nonobese patients. Median (25th-75th percentile) PP duration was 9 h (6-11 h) in obese patients and 8 h (7-12 h) in nonobese patients (P = .28). We collected 51 complications: 25 in obese and 26 in nonobese patients. The number of patients with at least one complication was similar across groups (n = 10, 30%). Pao₂/FIo₂ ratio increased significantly more in obese patients (from 118 ± 43 mm Hg to 222 ± 84 mm Hg) than in nonobese patients (from 113 ± 43 mm Hg to 174 ± 80 mm Hg; P = .03). Length of mechanical ventilation, ICU stay, and nosocomial infections did not differ significantly, but mortality at 90 days was significantly lower in obese patients (27% vs 48%, P < .05).CONCLUSIONSPP seems safe in obese patients and may improve oxygenation more than in nonobese patients. Obese patients could be a subgroup of patients with ARDS who may benefit the most of PP.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=84cb2befe12278c4fdcbea4e29510cc4)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=b7b95fd85d16307b18f62e1492ffedff)

1. **Prone positioning use to hasten veno-venous ECMO weaning in ARDS**  
   Kimmoun A. Intensive Care Medicine 2013;39(10):1877-1879.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=fa86ec36fafa5550b0ffaaf9a1624d79)

1. **Clinical course of ICU patients with severe pandemic 2009 influenza a (H1N1) pneumonia: Single center experience with proning and pressure release ventilation**  
   Sundar K.M. Journal of Intensive Care Medicine 2012;27(3):184-190.

Background: A number of different modalities have been employed in addition to conventional ventilation to improve oxygenation in patients with severe 2009 pandemic influenza A (H1N1) pneumonia. Outcomes with ventilatory and rescue therapies for H1N1 influenza-related acute respiratory distress syndrome (ARDS) have been varied.1-6 A single intensive care unit (ICU) experience with management of laboratory-confirmed 2009 pandemic influenza A (H1N1) ARDS with a combination of proning and airway pressure release ventilation (APRV) is described. <br/>Method(s): A retrospective review of medical records of ICU patients seen at Utah Valley Regional Medical Center during the first and second waves of the H1N1 influenza pandemic was done. <br/>Result(s): Fourteen ICU patients were managed with invasive ventilation for 2009 pandemic influenza A (H1N1)-related ARDS. Hypoxemia refractory to conventional ventilation was noted in 11 of 14 patients despite application of APRV. Following proning in patients on APRV, improvement of hypoxemia and hemodynamic status was achieved. Only 2 of 11 patients on APRV and proning required continuous dialysis. Mortality in intubated patients receiving a combination of proning and APRV was 27.3% (3/11) with 2 of these dying during the first wave of the H1N1 influenza pandemic. In all, 3 of 11 patients on proning and APRV underwent tracheostomy, with 2 of these undergoing tube thoracostomy. ARDSnet fluid-conservative protocol was safely tolerated in 8 of 11 of the intubated patients following initiation of proning and APRV. <br/>Conclusion(s): Proning in combination with APRV provides improvement of hypoxemia with limitation of end-organ dysfunction and thereby facilitates recovery from severe 2009 pandemic influenza A (H1N1). &#xa9; 2012 The Author(s).

1. **Long-term outcomes in survivors of acute respiratory distress syndrome ventilated in supine or prone position.**  
   Chiumello D. Intensive care medicine 2012;38(2):221-229.

PURPOSEThe aim of this study is to examine long-term pulmonary function and quality of life in survivors of acute respiratory distress syndrome (ARDS) previously enrolled in a randomized multicenter trial testing prone compared with supine positioning (PSII study) at five Italian centers.DESIGNObservational prospective study.SUBJECTS AND MEASUREMENTSPulmonary function [spirometric test, gas exchange, carbon monoxide diffusion capacity (DLCO)], high-resolution computed tomography (CT) scan, and health-related quality of life [Short Form-36 (SF-36) and St. George's Respiratory Questionnaire] were evaluated at 12 months.RESULTSTwenty-six patients (13 in each group, mean age 54.1 ± 2.8 years, body mass index 24.5 ± 1.4 kg/m(2), PaO(2)/FiO(2) 117 ± 49 mmHg) were evaluated. There were no significant differences in demographic data, illness severity, or outcome between the prone and supine groups. The overall survival rate was 40%. Pulmonary function was in the normal range without any differences between the two groups. Quantitative lung CT scan analysis showed similar amounts for not aerated (8.1 ± 3.2% versus 7.3 ± 3.4%), poorly aerated (15.3 ± 3.6% versus 17.1 ± 4.9%), and well-aerated (64.0% ± 8.4 versus 70.2 ± 8.4%) lung regions, while overaerated lung region was slightly higher in the prone compared with the supine group (12.5 ± 6.5% versus 5.3 ± 5.5%). Health-related quality of life was similar to in healthy population. However, these patients showed reduction in daily activity specifically due to pulmonary disease as measured by the St. George's Respiratory Questionnaire.CONCLUSIONSNo differences in pulmonary function or quality of life were observed in this small group of ARDS survivor patients treated in prone versus supine position.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=2a43d73057a4c5a75cfd16a76d5a72b9)

1. **Prone positioning improves oxygenation in adult burn patients with severe acute respiratory distress syndrome.**  
   Hale Diane F. The journal of trauma and acute care surgery 2012;72(6):1634-1639.

BACKGROUNDProne positioning (PP) improves oxygenation and may provide a benefit in patients with acute respiratory distress syndrome (ARDS). This approach adds significant challenges to patients in intensive care by limiting access to the endotracheal or tracheostomy tube and vascular access. PP also significantly complicates burn care by making skin protection and wound care more difficult. We hypothesize that PP improves oxygenation and can be performed safely in burn patients with ARDS.METHODSPP was implemented in a burn intensive care unit for 18 patients with severe refractory ARDS. The characteristics of these patients were retrospectively reviewed to evaluate the impact of PP on Pao2:FiO2 ratio (PFR) during the first 48 hours of therapy. Each patient was considered his or her own control before initiation of PP, and trends in PFR were evaluated with one-way analysis of variance. Secondary measures of complications and mortality were also evaluated.RESULTSMean PFR before PP was 87 (± 38) with a mean sequential organ failure assessment score of 11 (± 4). PFR improved during 48 hours in 12 of 14 survivors (p < 0.05). Mean PFR was 133 (± 77) immediately after PP, 165 (± 118) at 6 hours, 170 (± 115) at 12 hours, 214 (± 126) at 24 hours, 236 (± 137) at 36 hours, and 210 (± 97) at 48 hours. At each measured time interval except the last, PFR significantly improved. There were no unintended extubations. Facial pressure ulcers developed in four patients (22%). Overall, 14 survived 48 hours (78%), 12 survived 28 days (67%), and six survived to hospital discharge (33%).CONCLUSIONSPP improves oxygenation in burn patients with severe ARDS and was safely implemented in a burn intensive care unit. Mortality in this population remains high, warranting investigation into additional complementary rescue therapies.LEVEL OF EVIDENCETherapeutic study, level IV.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=40297e14c73382b343d91ec30e9edab6)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=40297e14c73382b343d91ec30e9edab6)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=3c162378ae0722de62a4eca493b9a678)

1. **Prone Positioning: Is It Safe and Effective?**  
   Dirkes Susan RN MSA CCRN Critical Care Nursing Quarterly 2012;35(1):64.

Prone positioning has been used as a treatment option for patients with acute lung injury or acute respiratory distress syndrome (ARDS) since the early 1970s. Prone position and extended prone position ventilation have been shown to increase end-expiratory lung volume, alveolar recruitment, and oxygenation in patients with severe hypoxemic and acute respiratory failure. Prone positioning is not a benign procedure, and there are potential risks (complications) that can occur to both the patient and the health care worker. Notable complications that can arise include: unplanned extubation, lines pulled, tubes kinked, and back and other injuries to personnel. Prone positioning is a viable, inexpensive therapy for the treatment of severe ARDS. This maneuver consistently improves systemic oxygenation in 70% to 80% of patients with ARDS. With the utilization of a standardized protocol and a trained and dedicated critical care staff, prone positioning can be performed safely. [PUBLICATION ABSTRACT]

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=38d672ce30e8a6fe0a7c547f6502dabc)

1. **Routine prone positioning in patients with severe ARDS: Feasibility and impact on prognosis**  
   Charron C. Intensive Care Medicine 2011;37(5):785-790.

Since 1997, we have routinely used prone positioning (PP) in patients who have a PaO<sub>2</sub>/FiO<sub>2</sub> below 100 mmHg after 24-48 h of mechanical ventilation and who are ventilated using a low stretch ventilation strategy. We report here the characteristics and prognosis of this subgroup of patients with severe lung injury to illustrate the feasibility, role, and impact of routine PP in acute respiratory distress syndrome (ARDS). A total of 218 patients were admitted because of ARDS between 1997 and 2009. Of these patients, 57 (26%) were positioned prone because of a PaO<sub>2</sub>/FiO<sub>2</sub> below 100 mmHg after 24-48 h of mechanical ventilation. Age was 51 +/- 16 years, PaO<sub>2</sub>/FiO<sub>2</sub> 74 +/- 19, and PaCO<sub>2</sub> 54 +/- 10 mmHg. The lung injury score was 3.13 +/- 0.15. Tidal volume was 7 +/- 2 mL/kg, PEEP 5.6 +/- 1.2 cmH<sub>2</sub>O, and plateau pressure 27 +/- 3 cmH<sub>2</sub>O. Prone sessions lasted 18 h/day and 3.4 +/- 1.1 sessions were required to obtain an FiO<sub>2</sub> below 60%. The 60-day mortality was 19% and death occurred after 12 +/- 5 days. The ratio between observed and predicted mortality was 0.43. In patients with a PaO <sub>2</sub>/FiO<sub>2</sub> below 60 mmHg, the 60-day mortality was 28%. Logistic regression analysis showed that among the 218 patients, PP appeared to be protective with an odds ratio of 0.35 [0.16-0.79]. We demonstrate the clinical feasibility of routine PP in patients with a PaO<sub>2</sub>/FiO <sub>2</sub> below 100 mmHg after 24-48 h and suggest that, when combined with a low stretch ventilation strategy, it is protective with a high survival rate. &#xa9; 2011 Copyright jointly held by Springer and ESICM.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=521ce48a44682a3ad98cd87703a2844b)

1. **Short-term effects of combining upright and prone positions in patients with ARDS: a prospective randomized study.**  
   Robak Oliver Critical care (London, England) 2011;15(5):R230.

INTRODUCTIONProne position is known to improve oxygenation in patients with acute lung injury (ALI) and the acute respiratory distress syndrome (ARDS). Supine upright (semirecumbent) position also exerts beneficial effects on gas exchange in this group of patients. We evaluated the effect of combining upright and prone position on oxygenation and respiratory mechanics in patients with ALI or ARDS in a prospective randomized cross-over study.METHODSAfter turning them prone from a supine position, we randomized the patients to a prone position or combined prone and upright position. After 2 hours, the position was changed to the other one for another 6 hours. The gas exchange and static compliance of the respiratory system, lungs, and chest wall were assessed in the supine position as well as every hour in the prone position.RESULTSTwenty patients were enrolled in the study. The PaO₂/FiO₂ ratio improved significantly from the supine to the prone position and further significantly increased with additional upright position. Fourteen (70%) patients were classified as responders to the prone position, whereas 17 (85%) patients responded to the prone plus upright position compared with the supine position (P = n.s.). No statistically significant changes were found with respect to compliance.CONCLUSIONSCombining the prone position with the upright position in patients with ALI or ARDS leads to further improvement of oxygenation.TRIAL REGISTRATIONClinical Trials No. NCT00753129.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=1bd1276fc337b42707b3bc4fc864ce41)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=642ec7c031a21cab08148ad574e91582)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=b0c1363fa02dfbee3ed0bcd2d00866a3)

1. **Systematic approach for severe respiratory failure due to novel a (H1N1) influenza**  
   Cornejo R. Minerva Anestesiologica 2011;77(5):510-521.

Aim. In April 2009, a novel influenza A (H1N1) virus appeared in Mexico. It rapidly acquired the characteristics of a pandemic disease. Our objective is to present a case series of mechanically ventilated patients with severe influenza, treated with a systematic approach. Methods. Prospective, observational, single-center study in a University Hospital. A (H1N1) virus was confirmed by rRT-PCR. In this report, we only considered patients that required mechanical ventilation (MV). All patients received antibiotics, steroids and oseltamivir from the time of admission. The main strategies incorporated in the systematic approach were a lung-protective strategy, PEEP adjusted for each patient, protocol-guided sedoanalgesia, restrictive fluid management, weaning protocol, and prolonged prone ventilation and extracorporeal membrane oxygenation (ECMO) as rescue therapies. Results. We studied 19 patients: age 41+/-13 years old, APACHE II 16+/-7 and SOFA 8+/-4. All patients presented PaO<sub>2</sub>/FiO<sub>2</sub>&lt;=200 before connection to MV. Their worst values within the first 24 hours for oxygenation index, PaO<sub>2</sub>/ FiO<sub>2</sub>, and PaCO<sub>2</sub> on MV were 21.8+/-13, 98+/-39, and 48+/-16 mmHg, respectively. Sixteen patients achieved ARDS; three exhibited acute lung injury criteria. Ten required a prone position, and two required ECMO (one patient required both therapies). Time on MV was 16+/-13 days. Length of stay in the ICU and in hospital was 18+/-12 and 28+/-17 days, respectively. Mortality was 21%. Conclusion. Severe hypoxemia and a high rate of rescue therapies were observed among our patients. Nevertheless, mortality was lower than previously reported in comparable populations, which may be related to the management by a critical care team and the use of a systematic approach for ventilatory and non-ventilatory therapeutic strategies.

1. **Automated prone positioning and axial rotation in critically ill, nontrauma patients with acute respiratory distress syndrome (ARDS)**  
   Bajwa A.A. Journal of Intensive Care Medicine 2010;25(2):121-125.

The objective of this study was to evaluate the use of kinetic therapy beds for automated prone positioning and axial rotation in critically ill nontrauma patients with acute respiratory distress syndrome (ARDS). There were 17 patients with ARDS who underwent automated prone positioning using a kinetic therapy bed. The mean age was 51 +/- 14 years, 12 were females and 12 were Caucasian. The most common admission diagnosis was sepsis (n = 5). The mean Acute Physiology and Chronic Health Evaluation (APACHE) 2 score was 30 +/- 9 with mean predicted mortality of 65% +/- 25%. At the time of prone positioning, all patients met the criteria for ARDS. The mean ratio of PaO 2 to FIO2 (P/F ratio) before initiation of prone positioning was 89 +/- 33 and rose to 224 +/- 92 after at least 30 minutes of prone positioning (P &lt;.0001). There was no significant change in PaCO 2 or mean airway pressure. There were no instances of accidental endotracheal tube and central or peripheral venous or arterial catheter dislodgement. Eleven (65%) patients developed new pressure ulcers, 10 (59%) patients developed new skin tears, and all had conjunctival edema during the course of prone positioning. The median duration of automated prone positioning was 6 (interquartile range [IQR] 3.5-8.5) days. Eleven (65%) patients died during hospitalization and 7 required percutaneous tracheostomy for long-term ventilator support. Automated prone positioning using a kinetic therapy bed is a safe and effective means of improving oxygenation in critically ill patients with ARDS. Larger randomized studies are needed to compare it to conventional ventilation strategies conventional prone positioning, and to assess the impact on mortality.

1. **Before-after study of a standardized ICU protocol for early enteral feeding in patients turned in the prone position**  
   Reignier J. Clinical Nutrition 2010;29(2):210-216.

Backgrounds & aims: To evaluate an intervention for improving the delivery of early enteral nutrition (EN) in patients receiving mechanical ventilation with prone positioning (PP). <br/>Method(s): Eligible patients receiving EN and mechanical ventilation in PP were included within 48. h after intubation in a before-after study. Patients were semi-recumbent when supine. Intolerance to EN was defined as residual gastric volume greater than 250. ml/6. h or vomiting. In the before group (n=34), the EN rate was increased by 500. ml every 24. h up to 2000. ml/24. h; patients were flat when prone and received erythromycin (250. mg. IV/6. h) to treat intolerance. In the intervention group (n=38), the EN rate was increased by 25. ml/h every 6. h to 85. ml/h, 25degree head elevation was used in PP, and prophylactic erythromycin was started at the first turn. <br/>Result(s): Compared to the before group, larger feeding volumes were delivered in the intervention group (median volume per day with PP, 774. ml [IQR 513-925] vs. 1170. ml [IQR 736-1417]; P&lt;0.001) without increases in residual gastric volume, vomiting, or ventilator-associated pneumonia. <br/>Conclusion(s): An intervention including PP with 25degree elevation, an increased acceleration to target rate of EN, and erythromycin improved EN delivery. &#xa9; 2009 Elsevier Ltd and European Society for Clinical Nutrition and Metabolism.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=9f6bc9c9cce7ca4e6d193ad9697ee154)

1. **Better postoperative oxygenation in thoracoscopic esophagectomy in prone positioning.**  
   Yatabe Tomoaki Journal of anesthesia 2010;24(5):803-806.

Intrathoracic procedures can be performed with thoracoscopy in esophagectomy because the laparoscopic technique has recently been developed. During intrathoracic procedures, prone positioning of the patient allows gravity to facilitate optimal exposure of the esophagus, thereby affording a superb surgical view. In the current study, we compared the influence of prone positioning with lateral decubitus positioning on oxygenation in esophagectomy. We enrolled 18 patients and divided them into two groups: patients who underwent esophagectomy via thoracoscopy in the prone position (group P) and patients who underwent thoracotomy in the lateral decubitus position (control group, group L). Arterial blood gas analyses were performed before the operation was started (T1), 20 min after the initiation of one-lung ventilation (OLV) (T2), and two other points. The P/F ratio at T2 in group P was higher. Further, percent (%) change of the P/F ratios from T1 and thereafter in group P was higher at all points. We thought the reason why the prone position had contributed to maintenance oxygenation was as follows. First, the functional residual capacity and ventilation/perfusion matching in the prone position are satisfactory. Second, a bronchial blocker might contribute to reduction of atelectasis. Third, minimally invasive esophagectomy might reduce respiratory complications and blood loss because this procedure reduces edema and inflammation in the lung. In conclusion, the oxygenation provided by prone positioning is better than that provided by the lateral decubitus position during OLV in esophagectomy.

1. **Variables affecting outcomes in critical care trials: Is prone positioning research exempt from these factors?**  
   Alviar Carlos L. Journal of Critical Care 2010;25(2):354.

[...]a recent study comparing the outcomes of intubated patients placed in prone positioning [2] is a good example of the different challenges faced by critical care researchers who have to deal with multiple variables that characterize intensive care settings.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=38350211ad81b14f6fdb1e037ca48727)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=d75c1a0773e48fa597bbd8fac0d56850)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=ebe6dc45d1e196700f601c2f5836cf5a)

1. **Prone positioning in acute respiratory distress syndrome: A multicenter randomized clinical trial**  
   Fernandez R. Intensive Care Medicine 2008;34(8):1487-1491.

Objective: We examined the effect on survival of prone positioning as an early and continuous treatment in ARDS patients already treated with protective ventilation. Design and setting: Open randomized controlled trial in 17 medical-surgical ICUs. <br/>Patient(s): Forty mechanically ventilated patients with early and refractory ARDS despite protective ventilation in the supine position. <br/>Intervention(s): Patients were randomized to remain supine or be moved to early (within 48 h) and continuous (&gt;= 20 h/day) prone position until recovery or death. The trial was prematurely stopped due to a low patient recruitment rate. Measurements and results: Clinical characteristics, oxygenation, lung pressures, and hemodynamics were monitored. Need for sedation, complications, length of MV, ICU, and hospital stays, and outcome were recorded. PaO<sub>2</sub>/FIO <sub>2</sub> tended to be higher in prone than in supine patients after 6 h (202 +/- 78 vs. 165 +/- 70 mmHg); this difference reached statistical significance on day 3 (234 +/- 85 vs. 159 +/- 78). Prone-related side effects were minimal and reversible. Sixty-day survival reached the targeted 15% absolute increase in prone patients (62% vs. 47%) but failed to reach significance due to the small sample. <br/>Conclusion(s): Our study adds data that reinforce the suggestion of a beneficial effect of early continuous prone positioning on survival in ARDS patients. &#xa9; 2008 Springer-Verlag.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=512a1b2526d1927ad659717126eb5369)

1. **[Mechanical ventilation in Acute Lung Injury (ALI)/Acute Respiratory Discomfort Syndrome (ARDS)].**  
   Amato Marcelo B. P Jornal brasileiro de pneumologia : publicacao oficial da Sociedade Brasileira de Pneumologia e Tisilogia 2007;33:No page numbers.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=c18f7af0f1be54a644e87a1d31f761e3)

1. **Effects of prone position on the oxygenation of patients with acute respiratory distress syndrome**  
   Rosseiti H.B. Sao Paulo Medical Journal 2006;124(1):15-20.

Context and objective: Acute respiratory distress syndrome (ARDS) is characterized by arterial hypoxemia, and prone position (PP) is one possible management strategy. The objective here was to evaluate the effects of PP on oxygenation. Design and setting: Non-randomized, open, prospective, controlled clinical trial, in a surgical intensive care unit at a tertiary university hospital. <br/>Method(s): Forty-one ARDS patients underwent PP for three-hour periods. Arterial partial oxygen pressure (PaO<sub>2</sub>) was measured immediately before changing to PP, after 30, 60, 120 and 180 minutes in PP and 60 minutes after returning to dorsal recumbent position (DP). The paired-t and Dunnett tests were used. <br/>Result(s): A notable clinical improvement in oxygenation (&gt; 15%) was detected in 78.0% of patients. This persisted for 60 minutes after returning to DP in 56% and lasted for 12 and 48 hours in 53.6% and 46.3%, respectively. Maximum improvement was seen after 30 minutes in 12.5% of responding patients and after 180 minutes in 40.6%. No statistically significant associations between PP response and age, gender, weight, PEEP level, tidal volume, respiratory rate, PaO<sub>2</sub>/FiO<sub>2</sub> or duration of mechanical ventilation were detected. One accidental extubation and four cases of deterioration through oxygenation were detected. The 48-hour mortality rate was 17%. <br/>Conclusion(s): For a significant number of ARDS patiens, PP may rapidly enhance arterial oxygenation and its inclusion for management of severe ARDS is justified. However, it is not a cost-free maneuver and caution is needed in deciding on using PP. Copyright &#xa9; 2006, Associacao Paulista de Medicina.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=efe695130e325446cc051d3113558e49)

1. **Comparison of prone positioning and high-frequency oscillatory ventilation in patients with acute respiratory distress syndrome.**  
   Papazian Laurent Critical care medicine 2005;33(10):2162-2171.

OBJECTIVEBoth prone position and high-frequency oscillatory ventilation (HFOV) have the potential to facilitate lung recruitment, and their combined use could thus be synergetic on gas exchange. Keeping the lung open could also potentially be lung protective. The aim of this study was to compare physiologic and proinflammatory effects of HFOV, prone positioning, or their combination in severe acute respiratory distress syndrome (ARDS).DESIGN: Prospective, comparative randomized study.SETTINGA medical intensive care unit.PATIENTSThirty-nine ARDS patients with a Pao2/Fio2 ratio <150 mm Hg at positive end-expiratory pressure > or =5 cm H2O.INTERVENTIONSAfter 12 hrs on conventional lung-protective mechanical ventilation (tidal volume 6 mL/kg of ideal body weight, plateau pressure not exceeding the upper inflection point, and a maximum of 35 cm H2O; supine-CV), 39 patients were randomized to receive one of the following 12-hr periods: conventional lung-protective mechanical ventilation in prone position (prone-CV), HFOV in supine position (supine-HFOV), or HFOV in prone position (prone-HFOV).MEASUREMENTS AND MAIN RESULTSProne-CV (from 138 +/- 58 mm Hg to 217 +/- 110 mm Hg, p < .0001) and prone-HFOV (from 126 +/- 40 mm Hg to 227 +/- 64 mm Hg, p < 0.0001) improved the Pao2/Fio2 ratio whereas supine-HFOV did not alter the Pao2/Fio2 ratio (from 134 +/- 57 mm Hg to 138 +/- 48 mm Hg). The oxygenation index ({mean airway pressure x Fio2 x 100}/Pao2) decreased in the prone-CV and prone-HFOV groups and was lower than in the supine-HFOV group. Interleukin-8 increased significantly in the bronchoalveolar lavage fluid (BALF) in supine-HFOV and prone-HFOV groups compared with prone-CV and supine-CV. Neutrophil counts were higher in the supine-HFOV group than in the prone-CV group.CONCLUSIONSAlthough HFOV in the supine position does not improve oxygenation or lung inflammation, the prone position increases oxygenation and reduces lung inflammation in ARDS patients. Prone-HFOV produced similar improvement in oxygenation like prone-CV but was associated with higher BALF indexes of inflammation. In contrast, supine-HFOV did not improve gas exchange and was associated with enhanced lung inflammation.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=165ca44e30a92dea215e248f1a077f90)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=165ca44e30a92dea215e248f1a077f90)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=ba94144d7074cf0fb3c31cbe75573409)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=ebe6dc45d1e196700f601c2f5836cf5a)

1. **Prone position reduces lung stress and strain in severe acute respiratory distress syndrome**  
   Mentzelopoulos S.D. European Respiratory Journal 2005;25(3):534-544.

The present authors hypothesised that in severe acute respiratory distress syndrome (ARDS), pronation may reduce ventilator-induced overall stress (i.e. transpulmonary pressure (PL)) and strain of lung parenchyma (i.e. tidal volume (VT)/end-expiratory lung volume (EELV) ratio), which constitute major ventilator-induced lung injury determinants. The authors sought to determine whether potential pronation benefits are maintained in post-prone semirecumbent (SRPP) posture under pressure-volume curve-dependent optimisation of positive end-expiratory pressure (PEEP). A total of 10 anesthetised/paralysed, mechanically ventilated (VT=9.0+/-0.9 mL.kg<sup>-1</sup> predicted body weight; flow=0.91+/-0.04 L.s<sup>-1</sup>; PEEP=9.4+/-1.3 cmH<sub>2</sub>O) patients with early/severe ARDS were studied in pre-prone semirecumbent (SRBAS), prone, and SRPP positions. Partitioned respiratory mechanics were determined during iso-flow (0.91 L.s<sup>-1</sup>) experiments (VT varied within 0.2-1.0 L), along with haemodynamics, gas exchange, and EELV. Compared with SRBAS, pronation/SRPP resulted in reduced peak/plateau PL at VTs&gt;=0.6 L; static lung elastance and additional lung resistance decreased and chest wall elastance (in prone position) increased; EELV increased (23-33%); VT/EELV decreased (27-33%); arterial oxygen tension/inspiratory oxygen fraction and arterial carbon dioxide tension improved (21-43/10-14%, respectively), and shunt fraction/physiological dead space decreased (21-50/20-47%, respectively). In early/severe acute respiratory distress syndrome, pronation under positive end-expiratory pressure optimisation may reduce ventilator-induced lung injury risk. Pronation benefits may be maintained in post-prone semirecumbent position. Copyright &#xa9; ERS Journals Ltd 2005.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=0d4c76bc0e2402b273ec99973824f9f2)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=3fd9fa61fb43b535bd5ac72903b6db22)

1. **Recruitment maneuvers during prone positioning in patients with acute respiratory distress syndrome.**  
   Oczenski Wolfgang Critical care medicine 2005;33(1):54.

OBJECTIVETo evaluate the interaction of recruitment maneuvers and prone positioning on gas exchange and venous admixture in patients with early extrapulmonary acute respiratory distress syndrome ventilated with high levels of positive end-expiratory pressure. We hypothesized that a sustained inflation performed after 6 hrs of prone positioning would induce sustained improvement in oxygenation (Pao2/Fio2) and venous admixture.DESIGNProspective, interventional study.SETTINGTertiary care, postoperative intensive care unit.PATIENTSFifteen patients with early extrapulmonary acute respiratory distress syndrome.INTERVENTIONSAfter 6 hrs of prone positioning, a sustained inflation was performed with 50 cm H2O maintained for 30 secs. Data were recorded in supine position, after 6 hrs of prone positioning, at 3, 30, and 180 mins following the sustained inflation.MEASUREMENTS AND MAIN RESULTSA response to prone positioning was observed in nine of 15 patients leading to an improvement of Pao2/Fio2 (147 +/- 37 torr vs. 225 +/- 77 torr, p = .005) and venous admixture (35.4 +/- 8.3% vs. 28.9 +/- 9.8%, p = .001). Six patients did not respond to prone positioning. Following the sustained inflation, the responders to prone positioning showed a further increase of Pao2/Fio2 and decrease of venous admixture at 3 mins (Pao2/Fio2, 225 +/- 77 torr vs. 368 +/- 90 torr, p = .018; venous admixture, 28.9 +/- 9.8% vs. 18.9 +/- 6.7%, p = .05). In all six nonresponders to prone positioning, an improvement of Pao2/Fio2 and venous admixture occurred at 3 mins following the sustained inflation (128 +/- 18 torr vs. 277 +/- 59 torr, p = .03; venous admixture, 34.2 +/- 6.0% vs. 23.8 +/- 6.3%, p = .05). The beneficial effects of the sustained inflation remained significantly elevated over 3 hrs in responders and nonresponders to prone positioning.CONCLUSIONIn patients with early extrapulmonary acute respiratory distress syndrome, a sustained inflation performed after 6 hrs of prone positioning induced further and sustained improvement of oxygenation and venous admixture in both responders and nonresponders to prone positioning.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=a2f72ffe7439e248ff77cce042aa0b09)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=a2f72ffe7439e248ff77cce042aa0b09)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=6f2b106cdcb997bf7b7ac966814bd90d)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=ebe6dc45d1e196700f601c2f5836cf5a)

1. **Ventilatory management of acute lung injury and acute respiratory distress syndrome**  
   Fan E. Journal of the American Medical Association 2005;294(22):2889-2896.

Context: The acute lung injury and acute respiratory distress syndrome are critical illnesses associated with significant morbidity and mortality. Mechanical ventilation is the cornerstone of supportive therapy. However, despite several important advances, the optimal strategy for ventilation and adjunctive therapies for patients with acute lung injury and acute respiratory distress syndrome is still evolving. <br/>Evidence Acquisition: To identify reports of invasive ventilatory and adjunctive therapies in adult patients with acute lung injury and acute respiratory distress syndrome, we performed a systematic English-language literature search of MEDLINE (1966-2005) using the Medical Subject Heading respiratory distress syndrome, adult, and related text words, with emphasis on randomized controlled trials and meta-analyses. EMBASE and the Cochrane Central Register of Controlled Trials were similarly searched. The search yielded 1357 potential articles of which 53 were relevant to the study objectives and considered in this review. <br/>Evidence Synthesis: There is strong evidence to support the use of volume- and pressure-limited lung-protective ventilation in adult patients with acute lung injury and acute respiratory distress syndrome. The benefit of increased levels of positive end-expiratory pressure and recruitment maneuvers is uncertain and is being further evaluated in ongoing trials. Existing randomized controlled trials of alternative ventilation modes, such as high-frequency oscillation and adjunctive therapies, including inhaled nitric oxide and prone positioning demonstrate no significant survival advantage. However, they may have a role as rescue therapy for patients with acute respiratory distress syndrome with refractory life-threatening hypoxemia. <br/>Conclusion(s): Volume- and pressure-limited ventilation strategies should be used in managing adult acute lung injury and acute respiratory distress syndrome patients. Further research is needed to identify barriers to widespread adoption of this strategy, as well as the role of alternative ventilation modes and adjunctive therapies. &#xa9;2005 American Medical Association. All rights reserved.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=68b67b94143202914ffd8828e3efe977)

1. **Non-ventilatory-based strategies in the management of acute respiratory distress syndrome.**  
   Klein Yoram The Journal of trauma 2004;57(4):915-924.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=6c9046ab32cd05a4d8c44f8213c6b075)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=6c9046ab32cd05a4d8c44f8213c6b075)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=64771d0aa13dffcfa87f971f5acc7728)

1. **Nursing patients with ARDS in the prone position**  
   Harcombe Christine J. Nursing Standard (through 2013) 2004;18(19):33.

  This article examines the main features of acute respiratory distress syndrome (ARDS), including the pathophysiology, clinical manifestations, complications and treatment. Patients with ARDS are critically ill and require close monitoring and mechanical ventilation in an intensive care unit. The benefits of prone positioning, one of the main treatment options for these patients, are discussed in detail. By understanding the physiological principles that underpin the prone position, the critical care nurse will be more effective in identifying patients who might benefit from this treatment.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=9478bef3b3a678650f4fdfac4c6d7a01)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=9478bef3b3a678650f4fdfac4c6d7a01)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=cf37130aea6c0e5aa2f898eded81c18d)

1. **Prognostic factors in acute respiratory distress syndrome: A retrospective multivariate analysis including prone positioning in management strategy**  
   Venet C. Intensive Care Medicine 2003;29(9):1435-1441.

Objective: To investigate the prognostic factors in acute respiratory distress syndrome (ARDS) patients focusing on the use of prone positioning (PP). Design and setting: Retrospective study conducted in an intensive care unit of a university hospital. <br/>Patient(s): All consecutive mechanically ventilated ARDS patients surviving on day 7 after the diagnosis of ARDS. <br/>Method(s): The study included all ARDS patients who survived more than 7 days after ARDS diagnosis between January 1995 and December 2002. Demographic and respiratory variables were collected on day 1, and the management of ARDS was analyzed during the first 7 days (n=125). We performed a univariate analysis and a stepwise logistic regression analysis comparing survivors and nonsurvivors on day 28 and at 2 and 6 months. <br/>Result(s): Mortality rates on day 28 and at 2 and 6 months were 21.6%, 32%, and 44% respectively. A SAPS II score less than 49, McCabe score, and the use of PP introduced in the first 7 days of ARDS management appeared to be independently correlated with a decrease in mortality. <br/>Conclusion(s): The SAPS II score, the McCabe score, and use of PP are independently correlated with the outcome in ARDS patients.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=b3242deaabf47d51872f0f802a71829e)

1. **[Techniques and complementary techniques. Complementary treatments: nitric oxide, prone positioning and surfactant].**  
   Martos S.ánchez I. Anales de pediatria (Barcelona, Spain : 2003) 2003;59(5):483-490.

The management of hypoxic respiratory failure is based on oxygen delivery and ventilatory support with lung-protective ventilation strategies. Better understanding of acute lung injury have led to new therapeutic approaches that can modify the outcome of these patients. These adjunctive oxygenation strategies include inhaled nitric oxide and surfactant delivery, and the use of prone positioning. Nitric oxide is a selective pulmonary vasodilator that when inhaled, improves oxygenation in clinical situations such as persistent pulmonary hypertension of the newborn, pulmonary hypertension associated with congenital heart disease, and acute respiratory distress syndrome (ARDS). When applied early in ARDS, prone positioning improves distribution of ventilation and reduces the intrapulmonary shunt. The surfactant has dramatically decreased mortality caused by hyaline membrane disease in premature newborns, although the results have been less successful in ARDS. Greater experience is required to determine whether the combination of these treatments will improve the prognosis of these patients.

1. **Pro/con clinical debate: The use of prone positioning in the management of patients with acute respiratory distress syndrome**  
   Marini J.J. Critical Care 2002;6(1):15-17.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=d1c68a77a0d26edb960ad08af2612db6)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=3d23bea0a64457c1168d3e070246ff97)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=a884b4a57c6dda4689f68925d86050d0)

1. **Prone position in acute respiratory distress syndrome.**  
   Pelosi P. The European respiratory journal 2002;20(4):1017-1028.

In the last few years prone positioning has been used increasingly in the treatment of patients with acute respiratory distress syndrome (ARDS) and this manoeuvre is now considered a simple and safe method to improve oxygenation. However, the physiological mechanisms causing respiratory function improvement as well as the real clinical benefit are not yet fully understood. The aim of this review is to discuss the physiological and clinical effects of prone positioning in patients with ARDS. The main physiological aims of prone positioning are: 1) to improve oxygenation; 2) to improve respiratory mechanics; 3) to homogenise the pleural pressure gradient, the alveolar inflation and the ventilation distribution; 4) to increase lung volume and reduce the amount of atelectatic regions; 5) to facilitate the drainage of secretions; and 6) to reduce ventilator-associated lung injury. According to the available data, the authors conclude that: 1) oxygenation improves in approximately 70-80% of patients with early acute respiratory distress syndrome; 2) the beneficial effects of oxygenation reduce after 1 week of mechanical ventilation; 3) the aetiology of acute respiratory distress syndrome may markedly affect the response to prone positioning; 4) extreme care is necessary when the manoeuvre is performed; 5) pressure sores are frequent and related to the number of pronations; 6) the supports used to prone and during positioning are different and nonstandardised among centres; and 7) intensive care unit and hospital stay and mortality still remain high despite prone positioning.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=0d3c80d964425ba3bc83fef07acd1d21)

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=d6b8f89cc8eb9da9b0b4df2c1f100506)

1. **What is the optimal duration of ventilation in the prone position in acute lung injury and acute respiratory distress syndrome?**  
   McAuley D. Intensive Care Medicine 2002;28(4):414-418.

Objective: To evaluate the effects of prone ventilation on respiratory parameters and extravascular lung water (EVLW) in patients with acute lung injury (ALI) and acute respiratory distress syndrome (ARDS) in order to characterise the optimal duration of ventilation in the prone position. <br/>Design(s): Prospective, observational study. <br/>Setting(s): Nine-bed general intensive care unit. <br/>Patient(s): Eleven patients with refractory hypoxaemia due to ALI/ARDS were prospectively investigated during 12 consecutive episodes of prone ventilation. <br/>Intervention(s): Ventilation in the prone position for 18 h. <br/>Measurements and Main Results: Measurements were obtained supine and after 1, 2, 6, 12 and 18 h in the prone position and 1 h after returning supine. There was a progressive improvement in PaO<sub>2</sub>/fraction of inspired oxygen (FIO<sub>2</sub>) ratio which reached significance after 12 h [121 (81-151) to 258 (187-329) torr; p&lt;0.05]. EVLW index increased transiently at 1 h [14.2 (7.6-20.8) to 15.1 (9.0-20.2); p=0.05] and thereafter declined progressively and was significantly decreased at 18 h [12.1 (7.2-17.0); p=0.043]. The shunt fraction showed an early fall [0.41 (0.40-0.42) to 0.31 (0.30-0.32) at 1 h;p&lt;0.001] preceding a subsequent progressive fall [0.22 (0.21-0.23) at 18 h;p&lt;0.001]. <br/>Conclusion(s): Over the 18h period studied there was progressive improvement in gas exchange, pulmonary shunt and EVLW. Although it is not possible to exclude that improvement over this period was unrelated to prone positioning, these findings suggests that ventilation in the prone position for more prolonged periods may be required for optimal improvement and warrants further study.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=9783c4b2c4e5a2983bee35e7c3b6472b)

1. **Complications of prone ventilation in patients with multisystem trauma with fulminant acute respiratory distress syndrome**  
   Offner P.J. Journal of Trauma - Injury, Infection and Critical Care 2000;48(2):224-228.

Introduction: Prone ventilation improves oxygenation in selected patients with acute respiratory distress syndrome (ARDS). However, prone positioning of critically ill patients with multiple invasive lines and tubes is potentially dangerous. Trauma patients, in particular, may require special consideration because of skeletal fixation devices or prior operative procedures. Our objective was to critically evaluate our experience with prone positioning in patients with severe postinjury ARDS. <br/>Method(s): Injured patients admitted to our Level I trauma center who developed ARDS were prospectively identified. Serial lung injury severity and pulmonary mechanical data, as well as complications of prone ventilation were recorded. <br/>Result(s): During the 12-month period ending August of 1998, nine patients with postinjury ARDS were treated with prone ventilation because of hypoxemia refractory to other ventilatory strategies. All patients suffered blunt trauma. Their mean age was 29 +/- 4.5 years; seven patients were men. The average Injury Severity Score was 26 +/- 5; and, at the time of prone positioning, the mean Lung Injury Score was 3.5. The mean PaO<sub>2</sub>/FIO<sub>2</sub> ratio increased from 75 +/- 7 to 147 +/- 27 with prone ventilation (p &lt; 0.05, paired t test); and in six patients, the FIO<sub>2</sub> could be decreased. Four major complications occurred (44%). One patient experienced a midline abdominal wound dehiscence. Severe facial or upper chest wall pressure necrosis developed in two patients, despite extensive padding and careful attention to skin care. The fourth patient sustained a cardiac arrest immediately after prone positioning. <br/>Conclusion(s): Prone ventilation in postinjury patients with ARDS may improve oxygenation but has the potential for significant complications. Careful consideration is required before prone positioning in this subset of patients.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=715d3edff77118a14c39628461a7ddce)

1. **Postural technique in prone position: hemodynamic and respiratory parameters and complications.**  
   Martín de la Torre Martín M. Enfermería Intensiva 2000;11(3):127-135.

Therapeutic strategies used in the treatment of adult respiratory distress syndrome (ARDS) recommend placing the patient in prone position as an effective method for optimizing ventilation-perfusion parameters. We evaluated the therapeutic effect of postural treatment in prone position with the following goals: Comparison of hemodynamic and respiratory parameters before and after placing the patient in prone position, while in prone position, and before and after postural treatment. Complications associated with turning and time in prone position. A prospective study was made of 30 turns in 15 patients admitted to the Polyvalent ICU between January 1999 and April 2000 for medical-surgical pathology, mean age 55.4 +/- 16.3 years, diagnosed as ARDS during their stay in the ICU, Lung Injury Score (Murray) > 2.5, and a medical prescription for prone position. Nurses were experienced in postural treatment in prone position in accordance with two protocols, the technique for placing the patient in prone position and nursing care for patients in prone position. Comparison of paired means of the hemodynamic variables MBP, HR and CVP did not disclose any statistically significant difference between the time before turning, while in prone position, and before and after postural treatment. Comparison of paired means of the respiratory variables PaO2/FiO2, Sat O2, tidal volume (TV), PCO2, pH, and PaO2/FiO2 ratio showed a significant increase after placing the patient in prone position, another increase after 2 hours in prone position, and before and after postural treatment. Sat O2 increased significantly 2 hours after turning, and remained raised while the patient was in prone position. TV increased significantly before and after postural treatment. The reduction in PCO2 occurred after 2 hours in prone position. Comparisons before and after postural treatment disclosed a clinically significant difference but no change in pH. Following the protocol for placing the patient in prone position, no complications were associated with the turning procedure (accidental loss of TOT, tracheostomy, SNG, urinary catheter, vascular catheters, chest tubes, and drainage tubes). While patients were in prone position, stage II and III UPP, palpebral and/or conjunctival edema, and intolerance of enteral feeding occurred, but our results do not indicate that these complications appeared solely as a result of prone position.

1. **Prone positioning for acute respiratory distress syndrome in the surgical intensive care unit: Who, when, and how long?**  
   Johannigman J.A. Surgery 2000;128(4):708-716.

Background. We evaluated the effects of prone positioning (PP) on surgery and trauma patients with acute respiratory distress syndrome (ARDS). Methods. Patients with ARDS were studied. Exclusion criteria were contraindications to PP. Patients were evaluated in the supine position and after being turned to the PP. After 6 hours, patients were returned to the supine position for 3 hours. One hour after each position change, arterial and mixed venous blood was drawn and analyzed for blood gases and pH, and hemodynamics were measured. Results. Over 20 months, 27 patients met the criteria, and 20 of the patients were entered into the study. On day 1, 18 of 20 patients (90%) responded with an increase in PaO<sub>2</sub> during PP. On day 2, 16 of 17 patients (94%) responded; on day 3, 15 of l 6 patients responded (94%); on day 4, 11 of 13 patients responded (85%); on day 5, 8 of 8 patients responded (100%); and on day 6, 4 of 5 patients responded (80%). PaO<sub>2</sub>/FIO<sub>2</sub> and Qs/Qt were significantly improved (P &lt; .05) during PP. There were 91 periods of PP, lasting 10.3 +/- 1.2 hours. Of 91 changes to PP, 78 changes (86%) resulted in an improvement in PaO<sub>2</sub>/FIO<sub>2</sub> of more than 20%. Conclusions. PP improves oxygenation in ARDS for 6 days with few complications.

1. **Proning patients in intensive care.**  
   Holden J. Nursing in critical care 2000;5(3):125-129.

Patients with acute lung injury pose significant problems for the intensive care team. The use of the prone position with these patients is attracting increasing interest. Information on the practicalities of proning was obtained from other intensive care units by using a simple questionnaire. The necessity for nursing guidelines for proning is discussed, and the consequent development of these is described.

### Opening Internet Links

The links to internet sites in this document are 'live' and can be opened by holding down the CTRL key on your keyboard while clicking on the web address with your mouse

### Full text papers

Links are given to full text resources where available. For some of the papers, you will need an **NHS OpenAthens Account**. If you do not have an account you can [register online](https://openathens.nice.org.uk/).

You can then access the papers by simply entering your username and password. If you do not have easy access to the internet to gain access, please let us know and we can download the papers for you.

### Guidance on searching within online documents

Links are provided to the full text of each document. Relevant extracts have been copied and pasted into these results. Rather than browse through lengthy documents, you can search for specific words as follows:

**Portable Document Format / pdf / Adobe**  
Click on the Search button (illustrated with binoculars). This will open up a search window. Type in the term you need to find and links to all of the references to that term within the document will be displayed in the window. You can jump to each reference by clicking it.

**Word documents**  
Select Edit from the menu, the Find and type in your term in the search box which is presented. The search function will locate the first use of the term in the document. By pressing 'next' you will jump to further references.

## E. Search History

NICE Evidence Search at [www.evidence.nhs.uk](http://www.evidence.nhs.uk) search strategy and results:

[https://www.evidence.nhs.uk/search?q=%28coronavirus+or+ards+or+sars+or+covid\*+or+corona%29+and+%28prone\*+or+proning%29+and+%28risk\*+or+manag\*%29&Route=search&ps=100](https://www.evidence.nhs.uk/search?q=%28coronavirus+or+ards+or+sars+or+covid*+or+corona%29+and+%28prone*+or+proning%29+and+%28risk*+or+manag*%29&Route=search&ps=100)

Cochrane Library at [www.cochranelibrary.com](http://www.cochranelibrary.com) search strategy:

ID    Search    Hits  
#1    (prone\* or proning\*):ti,ab,kw (Word variations have been searched)    4444  
#2    MeSH descriptor: [Prone Position] explode all trees    290  
#3    #1 or #2    4444  
#4    (COVID\* OR coronavir\* OR "Corona virus" OR "2019-nCoV" OR "SARS-CoV" OR "MERS-CoV" OR "Severe Acute Respiratory Syndrome" OR "Middle East Respiratory Syndrome" or "adult respiratory distress" or "acute respiratory distress" or sars or mers or ards):ti,ab,kw (Word variations have been searched)    5057  
#5    MeSH descriptor: [Respiratory Distress Syndrome, Adult] explode all trees    1333  
#6    MeSH descriptor: [Severe Acute Respiratory Syndrome] explode all trees    196  
#7    MeSH descriptor: [Coronavirus Infections] explode all trees    297  
#8    MeSH descriptor: [Coronavirus] explode all trees    35  
#9    ((critical\* next ill\*) OR "critical care"):ti,ab,kw (Word variations have been searched)    10352  
#10    MeSH descriptor: [Critical Illness] explode all trees    2218  
#11    MeSH descriptor: [Critical Care] explode all trees    2039  
#12    MeSH descriptor: [Critical Care Nursing] explode all trees    40  
#13    MeSH descriptor: [Critical Care Outcomes] explode all trees    2  
#14    #4 or #5 or #6 or #7 or #8 or #9 or #10 or #11 or #12 or #13    15752  
#15    #3 and #14    265  
#16    MeSH descriptor: [Risk Management] explode all trees    8969  
#17    (risk\* near/3 (manag\* or assess\*)):ti,ab,kw (Word variations have been searched)    30679  
#18    #16 or #17    30848  
#19    #15 and #18    27  
#20    MeSH descriptor: [Patient Care] explode all trees    62706  
#21    (manag\*):ti,ab,kw (Word variations have been searched)    130591  
#22    #20 or #21    184851  
#23    #15 and #22    96  
#24    #19 or #23 with Cochrane Library publication date from Jan 2000 to present    95

|  | **Source** | **Criteria** | **Results** |
| --- | --- | --- | --- |
| 22. | EMBASE | exp \*"PRONE POSITION"/ | 682 |
| 23. | EMBASE | (proning\* OR (prone\* ADJ3 (procedur\* OR technique\* OR position\*))).ti,ab | 11674 |
| 24. | EMBASE | (22 OR 23) | 11742 |
| 25. | EMBASE | (COVID\* OR coronavir\* OR "Corona vir\*" OR "2019-nCoV\*" OR "SARS-CoV\*" OR "MERS-CoV\*" OR "Severe Acute Respiratory Syndr\*" OR "Middle East Respiratory Syndr\*" OR (critical\* ADJ ill\*) OR "critical care").ti,ab | 171920 |
| 26. | EMBASE | exp \*CORONAVIRINAE/ | 9019 |
| 27. | EMBASE | exp \*"CORONAVIRUS INFECTION"/ | 8917 |
| 28. | EMBASE | exp \*"RESPIRATORY DISTRESS SYNDROME"/ | 34525 |
| 29. | EMBASE | exp \*"INTENSIVE CARE"/ | 259190 |
| 30. | EMBASE | exp \*"INTENSIVE CARE NURSING"/ | 997 |
| 31. | EMBASE | exp \*"CRITICAL ILLNESS"/ | 11966 |
| 32. | EMBASE | (25 OR 26 OR 27 OR 28 OR 29 OR 30 OR 31) | 432897 |
| 33. | EMBASE | (24 AND 32) | 1720 |
| 34. | EMBASE | (risk\* ADJ3 (manag\* OR assess\*)).ti,ab | 204234 |
| 35. | EMBASE | exp \*RISK/ | 312545 |
| 36. | EMBASE | (34 OR 35) | 470621 |
| 37. | EMBASE | (33 AND 36) | 29 |
| 38. | EMBASE | (manag\*).ti,ab | 1865351 |
| 39. | EMBASE | exp \*"PATIENT CARE"/ | 173656 |
| 40. | EMBASE | (38 OR 39) | 2005468 |
| 41. | EMBASE | (33 AND 40) | 537 |
| 42. | EMBASE | (37 OR 41) | 557 |
| 43. | EMBASE | (37 OR 41) [DT FROM 2000] [English language] [Human age groups Adult 18 to 64 years OR Aged 65+ years] | 227 |
| 44. | EMCARE | exp \*"PRONE POSITION"/ | 282 |
| 45. | EMCARE | (proning\* OR (prone\* ADJ3 (procedur\* OR technique\* OR position\*))).ti,ab | 3594 |
| 46. | EMCARE | (44 OR 45) | 3629 |
| 47. | EMCARE | (COVID\* OR coronavir\* OR "Corona vir\*" OR "2019-nCoV\*" OR "SARS-CoV\*" OR "MERS-CoV\*" OR "Severe Acute Respiratory Syndr\*" OR "Middle East Respiratory Syndr\*" OR (critical\* ADJ ill\*) OR "critical care").ti,ab | 58607 |
| 48. | EMCARE | exp \*CORONAVIRINAE/ | 1052 |
| 49. | EMCARE | exp \*"CORONAVIRUS INFECTION"/ | 2416 |
| 50. | EMCARE | exp \*"RESPIRATORY DISTRESS SYNDROME"/ | 9921 |
| 51. | EMCARE | exp \*"INTENSIVE CARE"/ | 75573 |
| 52. | EMCARE | exp \*"INTENSIVE CARE NURSING"/ | 911 |
| 53. | EMCARE | exp \*"CRITICAL ILLNESS"/ | 4079 |
| 54. | EMCARE | (47 OR 48 OR 49 OR 50 OR 51 OR 52 OR 53) | 128855 |
| 55. | EMCARE | (46 AND 54) | 755 |
| 56. | EMCARE | (risk\* ADJ3 (manag\* OR assess\*)).ti,ab | 56273 |
| 57. | EMCARE | exp \*RISK/ | 135029 |
| 58. | EMCARE | (56 OR 57) | 173027 |
| 59. | EMCARE | (55 AND 58) | 6 |
| 60. | EMCARE | (manag\*).ti,ab | 553989 |
| 61. | EMCARE | exp \*"PATIENT CARE"/ | 54742 |
| 62. | EMCARE | (60 OR 61) | 595439 |
| 63. | EMCARE | (55 AND 62) | 218 |
| 64. | EMCARE | (59 OR 63) | 221 |
| 65. | EMCARE | (59 OR 63) [DT FROM 2000] [English language] [Human age groups Adult 18 to 64 years OR Aged 65+ years] | 71 |
| 87. | Medline | exp "PRONE POSITION"/ | 4043 |
| 88. | Medline | (proning\* OR (prone\* ADJ3 (procedur\* OR technique\* OR position\*))).ti,ab | 7769 |
| 89. | Medline | (87 OR 88) | 9259 |
| 90. | Medline | (COVID\* OR coronavir\* OR "Corona vir\*" OR "2019-nCoV\*" OR "SARS-CoV\*" OR "MERS-CoV\*" OR "Severe Acute Respiratory Syndr\*" OR "Middle East Respiratory Syndr\*").ti,ab | 56455 |
| 91. | Medline | exp "RESPIRATORY DISTRESS SYNDROME, ADULT"/ | 19532 |
| 92. | Medline | exp "SEVERE ACUTE RESPIRATORY SYNDROME"/ | 4848 |
| 93. | Medline | exp CORONAVIRUS/ | 26412 |
| 94. | Medline | exp "CORONAVIRUS INFECTIONS"/ | 27453 |
| 95. | Medline | ((critical\* ADJ ill\*) OR "critical care").ti,ab | 72141 |
| 96. | Medline | exp "CRITICAL CARE"/ | 57838 |
| 97. | Medline | exp "CRITICAL CARE NURSING"/ | 2048 |
| 98. | Medline | exp "CRITICAL CARE OUTCOMES"/ | 55 |
| 99. | Medline | exp "CRITICAL ILLNESS"/ | 28914 |
| 100. | Medline | (90 OR 91 OR 92 OR 93 OR 94 OR 95 OR 96 OR 97 OR 98 OR 99) | 196755 |
| 101. | Medline | (89 AND 100) | 1038 |
| 102. | Medline | (risk\* ADJ3 (manag\* OR assess\*)).ti,ab | 166409 |
| 103. | Medline | exp "RISK MANAGEMENT"/ | 302880 |
| 104. | Medline | (102 OR 103) | 421207 |
| 105. | Medline | (101 AND 104) | 25 |
| 106. | Medline | (manag\*).ti,ab | 1341088 |
| 107. | Medline | exp "PATIENT CARE MANAGEMENT"/ | 1822563 |
| 108. | Medline | exp "PATIENT CARE"/ | 1271736 |
| 109. | Medline | (106 OR 107 OR 108) | 3452233 |
| 110. | Medline | (101 AND 109) | 514 |
| 111. | Medline | (105 OR 110) | 520 |
| 112. | Medline | (105 OR 110) [DT FROM 2000] [Human age groups Adult OR Middle Aged OR Aged OR Aged,80 and over] [Languages English] | 136 |
| 113. | CINAHL | exp "PRONE POSITION"/ | 2057 |
| 114. | CINAHL | (proning\* OR (prone\* ADJ3 (procedur\* OR technique\* OR position\*))).ti,ab | 2413 |
| 115. | CINAHL | (113 OR 114) | 3357 |
| 116. | CINAHL | exp "RESPIRATORY DISTRESS SYNDROME, ACUTE"/ | 7683 |
| 117. | CINAHL | exp CORONAVIRUS/ | 8431 |
| 118. | CINAHL | exp "CORONAVIRUS INFECTIONS"/ | 13573 |
| 119. | CINAHL | ((critical\* ADJ ill\*) OR "critical care").ti,ab | 43322 |
| 120. | CINAHL | (COVID\* OR coronavir\* OR "Corona vir\*" OR "2019-nCoV\*" OR "SARS-CoV\*" OR "MERS-CoV\*" OR "Severe Acute Respiratory Syndr\*" OR "Middle East Respiratory Syndr\*").ti,ab | 15165 |
| 121. | CINAHL | exp "CRITICAL CARE"/ | 28845 |
| 122. | CINAHL | exp "CRITICAL CARE NURSING"/ | 27658 |
| 123. | CINAHL | exp "CRITICAL CARE OUTCOMES"/ | 0 |
| 124. | CINAHL | exp "CRITICAL ILLNESS"/ | 12414 |
| 125. | CINAHL | (116 OR 117 OR 118 OR 119 OR 120 OR 121 OR 122 OR 123 OR 124) | 108897 |
| 126. | CINAHL | (115 AND 125) | 685 |
| 127. | CINAHL | (risk\* ADJ3 (manag\* OR assess\*)).ti,ab | 53387 |
| 128. | CINAHL | exp "RISK MANAGEMENT"/ | 19986 |
| 129. | CINAHL | (127 OR 128) | 69557 |
| 130. | CINAHL | (126 AND 129) | 5 |
| 131. | CINAHL | (manag\*).ti,ab | 507675 |
| 132. | CINAHL | exp "PATIENT CARE"/ | 773290 |
| 133. | CINAHL | (131 OR 132) | 1166182 |
| 134. | CINAHL | (126 AND 133) | 280 |
| 135. | CINAHL | (130 OR 134) | 282 |
| 136. | CINAHL | (130 OR 134) [DT FROM 2000] [Human age groups All Adult] [Languages eng] | 40 |
| 137. | BNI | (proning\* OR (prone\* ADJ3 (procedur\* OR technique\* OR position\*))).ti,ab | 247 |
| 138. | BNI | ((critical\* ADJ ill\*) OR "critical care").ti,ab | 9124 |
| 139. | BNI | (COVID\* OR coronavir\* OR "Corona vir\*" OR "2019-nCoV\*" OR "SARS-CoV\*" OR "MERS-CoV\*" OR "Severe Acute Respiratory Syndr\*" OR "Middle East Respiratory Syndr\*").ti,ab | 2311 |
| 140. | BNI | CORONAVIRUSES/ | 1762 |
| 141. | BNI | "CRITICAL CARE"/ | 3415 |
| 142. | BNI | (138 OR 139 OR 140 OR 141) | 13082 |
| 143. | BNI | (137 AND 142) | 27 |
| 144. | BNI | (137 AND 142) [DT FROM 2000] | 26 |
| 145. | Medline | (89 AND 100) [DT FROM 2000] [Document type Consensus Development Conference OR Consensus Development Conference, Nih OR Guideline OR Practice Guideline] | 12 |
| 146. | CINAHL | (115 AND 125) [Publication types Critical Path OR Meta Synthesis OR Practice Guidelines OR Protocol] | 16 |

For more information about the resources please go to: <http://www.bartshealth.nhs.uk/library>.

**Disclaimer**  
We hope that you find the evidence search service useful. Whilst care has been taken in the selection of the materials included in this evidence search, the Library and Knowledge Service is not responsible for the content or the accuracy of the enclosed research information. Accordingly, whilst every endeavour has been undertaken to execute a comprehensive search of the literature, the Library and Knowledge Service is not and will not be held responsible or liable for any omissions to pertinent research information not included as part of the results of the enclosed evidence search. Users are welcome to discuss the evidence search findings with the librarian responsible for executing the search. We welcome suggestions on additional search strategies / use of other information resources for further exploration. You must not use the results of this search for commercial purposes. Any usage or reproduction of the search output should acknowledge the Library and Knowledge Service that produced it.