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2. Беляєв А.В. Синдром капиллярной утечки // Мистецтво лікування. – 2005. – № 24. – С. 92-101.
3. Беляєв А.В., Танцюра Л.Д. Алгоритм подбора положительного давления в конце выдоха (ПДКВ) при респираторном дистресс-синдроме у новорожденных // Збірник наукових праць співробітників НМАПО імені П.Л. Шупика. – К., 2010. – Вип. 19, кн. 2. – С. 602–608.
4. Беляєв А.В., Танцюра Л.Д. Положительное давление в конце выдоха и рекрутирование с позиций доказательной медицины (литературный обзор) // Біль, знеболення і інтенсивна терапія. – 2010. – №1. – С. 44–52.
5. Біляєв А.В., Танцюра Л.Д. Пат. 48989 Україна, МПК А 61 В 5/08. Спосіб оптимізації позитивного тиску в кінці видиху (ПТКВ) при проведенні штучної вентиляції легень у новонароджених. № 200911224; заявл. 05.11.09; опубл. 12.04.10, Бюл. №7.
6. Танцюра Л.Д. Беляєв А.В. Использование приема recruitment у новорожденных во время проведения искусственной вентиляции легких // Біль, знеболення і інтенсивна терапія. – 2008. – №2 д. – С. 298–299.
7. Танцюра Л.Д. Індивідуалізація підбору позитивного тиску в кінці видиху під час штучної вентиляції легень у новонароджених. Автореф... к.мед.н., Київ, 2011.
8. Танцюра Л.Д., Беляєв А.В. Сравнение различных методов подбора ПДКВ при респираторном дистресс-синдроме у новорожденных // Біль, знеболення і інтенсивна терапія. – 2010. – №3. – С. 28–34.
9. Танцюра Л.Д., Біляєв А.В. Пат. 37429 Україна, МПК А 61 М 16/00. Спосіб лікування дихальної недостатності у новонароджених. – № 200808409; заявл. 23.06.08; опубл. 25.11.08, Бюл. №22.
10. Тітов І.І. Синдром гострого легеневого пошкодження при критичних станах і методи його корекції (експериментально-клінічне дослідження). Автор. д.мед.н. – Київ, 2003 р. – 36 с.
11. Acute Respiratory Distress Syndrome Network. Ventilation with lower tidal volumes as compared with traditional tidal volumes for acute lung injury and the acute respiratory distress syndrome // N. Engl. J. Med. – 2000. – V. 342. – P.1301–1310.

12. Adhikari N., Burns K.E., Meade M.O. Pharmacologic therapies for adults with acute lung injury and acute respiratory distress syndrome // *Cochrane Database Syst. Rev.* – 2004:CD004477.
13. Adhikari N.K., McAndrews M.P., Tansey C.M. et al. Self-reported symptoms of depression and memory dysfunction in survivors of ARDS // *Chest.* – 2009. – V. 135. – P. 678–687.
14. Afshari A., Brok J., Møller A.M., Wetterslev J. Aerosolized prostacyclin for acute lung injury (ALI) and acute respiratory distress syndrome (ARDS) // *Cochrane Database Syst. Rev.* – 2010. – 8:CD007733.
15. Alffey J.G., Engelberts D., Kavanagh B.P. Injurious effects of hypocapnic acidosis in the isolated lung // *Am. J. Respir. Crit. Care Med.* – 2000. – V. 162. – P. 399–405.
16. Alhazzani W., Alshahrani M., Jaeschke R. et al. Neuromuscular blocking agents in acute respiratory distress syndrome: a systematic review and meta-analysis of randomized controlled trials // *Crit Care.* – 2013. – V. 17:R43.
17. Ali S., Fergusin N.D. High-frequency oscillatory ventilation in ALI/ARDS // *Crit. Care Clin.* – 2011. – V. 27. – P. 487–499.
18. Amato M.B.P., Barbas C.S.V., Medeiros D.M. et al. Effect of a protective-ventilation strategy on mortality in the acute respiratory distress syndrome // *N. Engl. J. Med.* – 1998. – V. 338. – P. 347–354.
19. American Thoracic Society, Infectious Diseases Society of America. Guidelines for the management of adults with hospital-acquired, ventilator-associated, and health-associated pneumonia // *Am. J. Respir. Crit. Care Med.* – 2005. – V. 171. – P. 388–416.
20. Anderson W.R., Thielen K. Correlative study of adult respiratory distress syndrome by light, scanning, and transmission electron microscopy // *Ultrastruct. Pathol.* – 1991. – V. 16. – P. 615–628.
21. Angus D.C., Musthafa A.A., Clermont G. et al. Quality-adjusted survival in the first year after the acute respiratory distress syndrome // *Am. J. Respir. Crit. Care Med.* – 2001. – V. 163. – P. 1389–1394.
22. Anzueto A., Guntapalli K. Adunctive therapy to mechanical ventilation: surfactant therapy, liquid ventilation, and prone position // *Clin. Chest Med.* – 2006. – V. 27. – P. 637–654.
23. Aranda M., Pearl R.G. Inhaled nitric oxide and pulmonary vasoreactivity // *J. Clin. Monit.* – 2000. – V. 16. – P. 393–401.
24. Ashbaugh D.G., Bigelow D.B., Petty T.L. et al. Acute respiratory distress in adults // *Lancet.* – 1967. – V. 2. – P. 319–323.
25. Ashbaugh D.G., Marrier R.V. Idiopathic pulmonary fibrosis in adult respiratory distress syndrome. Diagnosis and treatment // *Arch. Surg.* – 1985. – V. 120. – P. 530–535.

26. Barnett N., Ware L.B. Biomarkers in acute lung injury – marking forward progress // *Crit. Care Clin.* – 2011. – V. 27. – P. 661–683.
27. Bernard G.R., Artigas A., Brigham K.L. et al. The American-European Consensus Conference on ARDS: definitions, mechanisms, relevant outcomes, and clinical trial coordination // *Am. J. Crit. Care Med.* – 1994. – V. 149. – P. 818–824.
28. Bernard G.R., Vincent J.L., Laterre P.F. et al. Recombinant human protein C Worldwide Evaluation in Severe Sepsis (PROWESS) study group: Efficacy and safety of recombinant human activated protein C for severe sepsis // *N. Engl. J. Med.* – 2001. – V. 344. – P. 699–709.
29. Blank R., Napolitano L.M. Epidemiology of ARDS and ALI // *Crit. Care Clin.* – 2011. – V. 27. – P. 439–458.
30. Briel M., Bucher H.C., Boscacci R. et al. Adjunctive corticosteroids for *Pneumocystis jirovecii* pneumonia in patients with HIV-infection // *Cochrane Database Syst. Rev.* – 2006. – V. 3:CD006150.
31. Brower R.G., Lanken P.N., MacIntyre N. et al. Higher versus lower positive end-expiratory pressures in patients with the acute respiratory distress syndrome // *N. Engl. J. Med.* – 2004. – V. 351. – P. 327–336.
32. Brower R.G., Matthay M.A., Morris A. et al., ARDS Network. Ventilation with lower tidal volumes as compared with traditional tidal volumes for acute lung injury and the acute respiratory distress syndrome // *N.Engl. J. Med.* – 2000. – V. 342. – P. 1301–1308.
33. Brun-Buisson C., Richard J.C., Mercat A. et al. Early corticosteroids in severe influenza A/H1N1 pneumonia and acute respiratory distress syndrome // *Am. J. Respir. Crit. Care Med.* – 2011. – V. 183. – P. 1200–1206.
34. Budinger G.R.S., Sznajder J.I. The alveolar-epithelial barrier: a target for potential therapy // *Clin. Chest Med.* – 2006. – V. 27. – P. 655–669.
35. Bugler E.M., May S., Kerby J.D. et al. Out-of-hospital hypertonic resuscitation after traumatic hypovolemic shock: a randomized, placebo controlled trial // *Ann. Surg.* – 2011. – V. 253. – P. 431–441.
36. Carson C.W., Cannon G.W., Egger M.J. et al. Pulmonary disease during the treatment of rheumatoid arthritis with low dose pulse methotrexate // *Semin. Arthritis Rheum.* – 1987. – V. 16. – P. 186–195.
37. Casaer M.P., Mesotten D., Hermans G. et al. Early versus late parenteral nutrition in critically ill adults // *N. Engl. J. Med.* – 2011. – V. 365. – P. 506–517.
38. Chen Y., Li K., Pu H., Wu T. Corticosteroids for pneumoniae // *Cochrane Database Syst. Rev.* – 3: CD007729.

39. Chermesh I., Azoulay O., Alpert E. et al. Parenteral nutrition – guidelines of the Israeli Society for Clinical Nutrition // e-SPEN. – 2009. – V. 4. – P. e270–e288.
40. Clark C., Gollan F. Survival of mammals breathing organic liquids equilibrated with oxygen at atmospheric pressure // J. Appl. Physiol. – 1966. – V. 21. – P. 1755–1756.
41. Comis R.L. Bleomycin pulmonary toxicity: Current status and future directions // Semin. Oncol. – 1992. – V. 19. – P. 64–70.
42. Cooper A.B., Ferguson N.D., Hanly P.J. et al. Long-term follow-up of survivors of acute lung injury: lack of effect of a ventilation strategy to prevent barotrauma // Crit. Care Med. – 1999. – V. 27. – P. 2616–2621.
43. Cooper J.A.J., White D.A., Matthay R.A. Drug-induced pulmonary disease. Part I: Cytotoxic drugs // Am. Rev. Respir. Dis. – 1986. – V. 133. – P. 321–340.
44. Daoud E.G., Farag H.L., Chatburn R.L. Airway pressure release ventilation: what do we know? // Respir Care. – 2012. – V.57. – P. 282–292.
45. Davydow D.S., Desai S.V., Needham D.M. et al. Psychiatric morbidity in survivors of the acute respiratory distress syndrome: a systematic review // Psychosom. Med. – 2008. – V. 70. – P. 512–529.
46. de Jonghe B., Lacherade J.C., Sharshar T. et al. Intensive care unit-acquired weakness: risk factors and prevention // Crit. Care Med. – 2009. – V. 37. – P.S309–315.
47. Dellinger R.P., Levy M.M., Rhodes A. et al., Surviving Sepsis Campaign Guidelines Committee including the Pediatric Subgroup. Surviving Sepsis Campaign: International Guidelines for Management of Severe Sepsis and Septic Shock: 2012 // Crit. Care Med. – 2013. – V. 41. – P. 580–637.
48. Desai S.R., Wells A.U., Rubens M.B. et al. Acute respiratory distress syndrome: CT abnormalities at long-term follow-up // Radiology. – 1999. – V. 210. – P. 29–35.
49. Dickinson S., Park P.K., Napolitano L.M. Prone-positioning therapy in ARDS // Crit. Care Clin. – 2011. – V. 27. – P. 511–523.
50. Dowdy D.W., Eid M.P., Dennison C.R. et al. Quality of life after acute respiratory distress syndrome: a meta-analysis // Intensive Care Med. – 2006. – V. 32. – P. 1115–1124.
51. Duffett M., Choong K., Ng V. et al. Surfactant therapy for acute respiratory failure in children: a systematic review and meta-analysis // Crit. Care. – 2007. – 11:R66.

52. Erickson S.E., Martin G.S., Davis J.L. et al. Recent trends in acute lung injury mortality: 1996–2005 // *Crit. Care Med.* – 2009. – V. 37. – P. 1574–1579.
53. Esteban A., Fernandez-Segoviano P., Frutos-Vivar F. et al. Comparison of clinical criteria for the acute respiratory distress syndrome with autopsy findings // *Ann. Intern. Med.* – 2004. – V. 141. – P. 440–445.
54. Fan E., Wilcox M.E., Bower R.G. et al. Recruitment maneuvers for acute lung injury // *Am. j. Respir. Crit. Care Med.* – 2008. – V. 178. – P. 1156–1163.
55. Feihl F., Perret C. Permissive hypercapnia. How permissive should we be? // *Am. J. Respir. Crit. Care Med.* – 1994. – V. 150. – P. 1722–1737.
56. Ferguson N.D., Cook D.J., Guyatt H.H. et al. High-frequency oscillation in early acute respiratory distress syndrome // *N. Engl. J. Med.* – 2013. – V. 368. – P. 795–805.
57. Ferguson N.D., Davis A.M., Slutsky A.S. et al. Development of a clinical definition for acute respiratory distress syndrome using the Delphi technique // *J. Crit. Care.* – 2005. – V. 20. – P. 147–154.
58. Ferguson N.D., Frutos-Vivar F., Esteban A. et al. Acute respiratory distress syndrome: underrecognition by clinicians and diagnostic accuracy of three clinical definitions // *Crit. Care Med.* – 2005. – V. 33. – P. 2228–2234.
59. Fernandez R., Trenchs X., Klamburg J. et al. Prone positioning in acute respiratory distress syndrome: a multicenter randomized clinical trial // *Intensive Care Med.* – 2008. – V. 34. – P. 1487–1491.
60. Fessler H.E., Derdak S., Ferguson N.D. et al. A protocol for high-frequency oscillatory ventilation in adults: results from a roundtable discussion // *Crit. Care Med.* – 2007. – V. 35. – P. 1649–1654.
61. Frostell C., Fratacci M.D., Wain J.C. et al. Inhaled nitric oxide. A selective pulmonary vasodilator reversing hypoxic pulmonary vasoconstriction // *Circulation.* – 1991. – V. 83. – P. 2038–2047.
62. Fusch C., Bauer K., Bohles H.J. et al. Working group for developing the guidelines for parenteral nutrition of The German Society for Nutritional Medicine. Neonatology/Paediatrics – Guidelines on Parenteral Nutrition, Chapter 13 // *GMS Ger. Med. Sci.* – 2009; 7: Doc15.
63. Gadek J.E., DeMichele D.J., Karlstad M.D. et al. Effect of enteral feeding with eicosapentaenoic acid, gamma-linolenic acid, and antioxidants in patients with acute respiratory distress syndrome // *Crit. Care Med.* – 1999. – V. 27. – P. 1409–1420.
64. Galvin I.M., Steel A., Pinto R. et al. Partial liquid ventilation for preventing death and mortality in adults with acute lung injury and acute

- respiratory distress syndrome // *Cochrane Database Syst. Rev.* – 2013:CD003707.
65. Gattinoni L., Kolobow T., Tomlinson T. et al. Control of intermittent positive pressure breathing (IPPB) by extracorporeal removal of CO₂ // *Br. J. Anaesth.* – 1978. – V. 50. – P. 753–758.
 66. Gattinoni L., Koobow T., Tomlinson T. et al. Low-frequency positive pressure ventilation with extracorporeal CO₂ removal (LFPPV-ECCO₂R): an experimental study // *Anesth. Analg.* – 1978. – V. 57. – P. 470–477.
 67. Gattinopni L., Caironi P., Pelosi P. et al. What has computed tomography taught us about the acute respiratory distress syndrome? *Am. J. Respir. Crit. Care Med.* – 2001. – V. 164. – P. 1707–1711.
 68. Goss C.H., Brower R.G., Hudson L.D. et al. Incidence of acute lung injury in the United States // *Crit Care Med.* – 2003. – V. 31. – P. 1607–1611.
 69. Goss G.A., Hayes J.A., Burdon J.G.W. Deoxyhaemoglobin in the detection of central cyanosis // *Thorax.* – 1988. – V. 43. – P. 212–213.
 70. Gotts J.E., Matthay M.A. Mesenchymal stem cells and acute lung injury // *Crit. Care Clin.* – 2011. – V. 27. – P. 719–733.
 71. Guérin C., Reignier J., Richard J.C. et al; PROSEVA Study Group. Prone positioning in severe acute respiratory distress syndrome // *N. Engl. J. Med.* – 2013. – V. 368. – P. 2159–2168.
 72. Gurtoo H.L., Hipkens J.H., Sharma S.D. Role of glutathione in the metabolism-dependent toxicity and chemotherapy of cyclophosphamide // *Cancer Res.* – 1981. – V. 41. – P. 3584–3591.
 73. Haas C.F. Lung protective mechanical ventilation in acute respiratory distress syndrome // *Respir. Care Clin. N. Am.* – 2003. – V. 9. – P. 363–396.
 74. Haas C.F. Mechanical ventilation with protective strategies: what works? // *Crit. Care Clin.* – 2011. – V. 27. – P. 469–486.
 75. Hager D.N., Fessler H.E., Kaczka D.W. et al. Tidal volume delivery during high-frequency oscillatory ventilation in adults with acute respiratory distress syndrome // *Crit. Care Med.* – 2007. – V. 35. – P. 1522–1529.
 76. Hager D.N., Fuld M., Kaczka D.W. et al. Four methods of measuring tidal volume during high-frequency oscillatory ventilation // *Crit. Care Med.* – 2006. – V.34. – P. 751–757.
 77. Herridge M.S. Recovery and long-term outcome in acute respiratory distress syndrome // *Crit. Care Clin.* – 2011. – V. 27. – P. 685–704.

78. Herridge M.S., Tansey C.M., Matte A. et al. Canadian Critical Care Trial Group. Functional disability 5 years after acute respiratory distress syndrome // *N. Engl. J. Med.* – 2011. – V. 364. – P. 1293–1304.
79. Heyland D.K., Dhaliwal R., Drover J.W. et al., Canadian Critical Care Clinical Practice Guidelines Committee. Canadian clinical practice guidelines for nutrition support in mechanically ventilated, critically ill adult patients // *J.P.E.N. J. Parenter. Enreal. Nutr.* – 2003. – V. 27. – P. 355–373.
80. Heyland D.K., Groll D., Caesar M. Survivors of acute respiratory distress syndrome: relationship between pulmonary dysfunction and long-term health-related quality of life // *Crit. Care Med.* – 2005. – V. 33. – P. 1549–1556.
81. Hirschl R.B., Conrad S., Kaiser R. et al. Partial liquid ventilation in adult patients with ARDS: A multicenter phase I-II trial. Adult PLV Study Group // *Ann. Surg.* – 1998. – V. 228. – P. 692–700.
82. Hivkling K.G. Ventilatory management of ARDS: can it affect the outcome? // *Intensive Care Med.* – 1990. – V. 16. – P. 219–226.
83. Hoelz C., Negri E.M., Lichtenfels A.J. et al. Morphometric differences in pulmonary lesions in primary and secondary ARDS: a preliminary study in autopsies // *Pathol. Res. Pract.* – 2001. – V. 197. – P. 521–530.
84. Hopkins R.O., Herridge M.S. Quality of life, emotional abnormalities, and cognitive dysfunction in survivors of acute lung injury / acute respiratory distress syndrome // *Clin. Chest Med.* – 2006. – V. 27. – P. 679–689.
85. Hopkins R.O., Weaver L.K., Collingridge D. et al. Two-year cognitive, emotional, and quality-of-life outcomes in acute respiratory distress syndrome // *Am. J. Respir. Crit. Care Med.* – 2005. – V. 171. – P. 340–347.
86. Hopkins R.O., Weaver L.K., Pope D. et al. Neuropsychological sequelae and impaired health status in survivors of severe acute respiratory distress syndrome // *Am. J. Respir. Crit. Care Med.* – 1999. – V. 160. – P. 50–60.
87. Hough C.L. Neuromuscular sequelae in survivors of acute lung injury // *Clin. Chest Med.* – 2006. – V. 27. – P. 691–703.
88. Hudson L.D., Hough C.L. Therapy for late-phase acute respiratory distress syndrome // *Clin. Chest Med.* – 2006. – V. 27. – P. 671–677.
89. International Consensus Conference in Intensive Care Medicine: Ventilator-associated lung injury in ARDS // *Am. J. Respir. Crit. Care Med.* – 1999. – V. 160. – P. 2118–2124.

90. Jones C., Griffiths R.D., Slater T. et al. Significant cognitive dysfunction in non-delirious patients identified during and persisting following critical illness // *Intensive Care Med.* – 2006. – V. 32. – P. 923–926.
91. Jules-Elysee K., White D.A. Bleomycin-induced pulmonary toxicity // *Clin. Chest Med.* – 1990. – V. 11. – P. 1–20.
92. Kapfhammer H.P., Rothenhausler H.B., Krauseneck T. et al. Post-traumatic stress disorder and health-related quality of life in long-term survivors of acute respiratory distress syndrome // *Am. J. Psychiatry.* – 2004. – V. 161. – P. 45–52.
93. Kaushal A., McDonnell C.G., Davies M.W. Partial liquid ventilation for the prevention of mortality and morbidity in paediatric acute lung injury and acute respiratory distress syndrome // *Cochrane Database Syst. Rev.* – 2013:CD003845.
94. Kim S.H., Hong S.B., Yun S.C. et al. Corticosteroid treatment in critically ill patients with pandemic influenza A/H1N1 infection: analytic strategy using propensity scores // *Am. J. Respir. Crit. Care Med.* – 2011. – V. 183. – P. 1207–1214.
95. Kolobow T., Gattinoni L., Tomlinson T. et al. An alternative to breathing // *J. Thorac. Cardiovasc. Surg.* – 1978. – V. 75. – P. 261–266.
96. Kraft P., Fridrich P., Pernersstorfer T. et al. The acute respiratory distress syndrome: definitions, severity and clinical outcome. An analysis of 101 clinical investigations // *Intensive Care med.* – 1996. – V. 22. – P. 519–529.
97. Kraut J.A., Kurtz I. Use of base in the treatment of severe acidemic states // *Am. J. Kidney Dis.* – 2001. – V. 38. – P. 703–727.
98. Kreymann G., Adolph M., Druml W. et al. Intensive medicine – Guidelines on Parenteral Nutrition. Chapter 14 // *GMS.* – 2009. – V.7. – P. 1–6.
99. Kreymann K.G., Berger M.M., Deutz N.E.P. et al. ESPEN Guidelines on Enteral Nutrition: Intensive care // *Clin. Nutr.* – 2006. – V. 25. – P. 210 – 223.
100. Krzak A., Pleva M., Napolitano L.M. Nutrition therapy for ALI and ARDS // *Crit. Care Clin.* – 2011. – V. 27. – P. 647–659.
101. Lachmann B. Open up the lung and keep the lung open // *Intensive Care Med.* – 1992. – V. 18. – P. 319–321.
102. Li G., Malinchoc M., Cartin-Ceba R. et al. Eight-year trend of acute respiratory distress syndrome: a population-based study in Olmsted County, Minnesota // *Am. J. Respir. Crit. Care Med.* – 2011. – V. 183. – P. 59–66.

103. Lin X., Dean D.A. Gene therapy for ALI/ARDS // *Crit. Care Clin.* – 2011. – V. 27. – P. 705–718.
104. Linden V.B., Lidegran M.K., Frisen G. et al. ECMO in ARDS: a long-term follow-up study regarding pulmonary morphology and function and health-related quality of life // *Acta Anaesthesiol. Scand.* – 2009. – V. 53. – P. 489–495.
105. Lunkenheimer P.P., Rafflenbeul W., Keller H et al. Application trans-tracheal pressure oscillations as a modification of “diffusion respiration” // *Br. J. Anaesth.* – 1972. – V. 44. – P. 627.
106. Lynch J.E., Hayes D., Zwischenberger J.B. Extracorporeal CO₂ removal in ARDS // *Crit. Care Clin.* 2011. – V. 27. – P. 609–625.
107. Mancebo J., Fernandez R., Blanch L. et al. A multicenter trial of prolonged prone ventilation in severe acute respiratory distress syndrome // *Am. J. Respir. Crit. Care Med.* – 2006. – V. 173. – P. 1233–1239.
108. Marik P.E., Meduri G.U., Rocco P.R.M., Annane D. Glucocorticoid treatment in acute lung injury and acute respiratory distress syndrome // *Crit. Care Clin.* – 2011. – V. 27. – P. 589–607.
109. Marik P.E., Pasores M., Annane D. et al. Recommendations for the diagnosis and management of corticosteroid insufficiency in critically ill adult patients: consensus statements from an international task force by the American College of Critical Care Medicine // *Crit. Care Med.* – 2008. – V. 36. – P. 1937–1949.
110. Marti-Carvajal A.J., Sola I., Lathyris D. et al. Human recombinant activated protein C for severe sepsis // *Cochrane Database Syst. Rev.* – 2012: CD004388.
111. Martin G.S., Mangialardi R.J., Wheeler A.P. et al. Albumin and furosemide therapy in hypoproteinemic patients with acute lung injury // *Crit. Care Med.* – 2002. – V. 30. – P. 2175–2182.
112. Martin G.S., Moss M., Wheeler A.P. et al. A randomized, controlled trial of furosemide with or without albumin in hypoproteinemic patients with acute lung injury // *Crit. Care Med.* – 2005. – V. 33. – P. 1681–1687.
113. Martindale R.G., McClave S.A., Vanek V,W. et al. American College of Critical Care Medicine, A.S.P.E.N. Board of Directors. Guidelines for the provision and assessment of nutrition support therapy in the adult critically ill patient: Society of Critical Care Medicine and American Society for Parenteral and Enteral Nutrition: executive summary // *Crit. Care Med.* – 2009. – V. 37. – P. 1757–1761.

114. Martin-Loeches I., Lisboa T., Rhodes A. et al. Use of corticosteroid therapy in patients affected by severe pandemic H1N1 Influenzae A infection // *Intensive Care Med.* – 2011. – V. 37. – P. 272–283.
115. Masclans J.R., Roca O., Munoz X. et al. Quality of life, pulmonary function and tomographic scan abnormalities after an acute respiratory distress syndrome // *Chest.* – 2011. – V. 139. – P. 1340–1346.
116. Mattox K.L., Maningas P.A., Moore E.E. et al. Prehospital hypertonic saline/dextran infusion for posttraumatic hypotension. The U.S.A. Multicenter Trial // *Ann. Surg.* – 1991. – V. 213. – P. 482–491.
117. Maung A.A., Kaplan L.J. Airway pressure release ventilation in acute respiratory distress syndrome // *Crit. Care Clin.* – 2011. – V. 27. – P. 501–509.
118. McClave S.A., Martindale R.G., Vanek V.W. et al., A.S.P.E.N. Board of Directors, American College of Critical Care Medicine, Society of Critical Care Medicine. Guidelines for the provision and assessment of nutrition support therapy in the adult critically ill patient: Society of Critical Care Medicine (SCCM) and American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.) // *JPEN J. Parenter. Enteral. Nutr.* – 2009. – V. 33. – P. 277–316.
119. McHugh L.G., Milberg J.A., Whitcomb M.E. et al. Recovery of function in survivors of the acute respiratory distress syndrome // *Am. J. Respir. Crit. Care Med.* – 1994. – V. 150. – P. 90–94.
120. Mead J., Takishima T., Leith D. Stress distribution in lungs: A model of pulmonary elasticity // *J. Appl. Physiol.* – 1970. – V. 28. – P. 596–608.
121. Meade M.O., Cook D.J., Guyatt G.H. et al. Ventilation strategy using low tidal volumes, recruitment maneuvers, and high positive end-expiratory pressure for acute lung injury and acute respiratory distress syndrome. A randomized controlled trial // *JAMA.* – 2008. – V. 299. – P. 637–645.
122. Meduri G.U., Headley S., Golden E. et al. Effect of prolonged methylprednisolone therapy in unresolving acute respiratory distress syndrome. A randomized controlled trial // *JAMA.* – 1998. – V. 280. – P. 159–165.
123. Meduri G.U., Headley S., Tolley E. et al. Plasma and BAL cytokine response to corticosteroid rescue treatment in late ARDS // *Chest.* – 1995. – V. 108. – P. 1315–1325.
124. Meduri G.U., Muthiah M.P., Carratu P. et al. Nuclear factor-kappaB and glucocorticoid receptor alpha-mediated mechanisms in the regulation of systemic and pulmonary inflammation during sepsis and acute respiratory distress syndrome. Evidence for inflammation-induced tar-

- get tissue resistance to glucocorticoids // *Neuroimmunomodulation*. – 2005. – V. 12. – P. 321–338.
125. Meduri G.U., Tolley E.A., Chrousos G.P. et al. Prolonged methylprednisolone treatment suppresses systemic inflammation in patients with unresolving acute respiratory distress syndrome: evidence for inadequate endogenous glucocorticoid secretion and inflammation-induced immune cell resistance to glucocorticoids // *Am. J. Respir. Crit. Care Med.* – 2002. – V. 165. – P. 983–991.
 126. Meduri G.U., Yates C.R. Systemic inflammation-associated glucocorticoid resistance and outcome of ARDS // *Ann. N. Y. Acad. Sci.* – 2004. – V. 1024. – P. 24–53.
 127. Menezes S.L., Bozza P.T., Neto H.C. et al. Pulmonary and extrapulmonary acute lung injury: inflammatory and ultrastructural analyses // *J. Appl. Physiol.* – 2005. – V. 98. – P. 1777–1783.
 128. Mercat A., Richard J.-C.M., Vieille B. et al. Positive end-expiratory pressure setting in adults with acute lung injury and acute respiratory distress syndrome. A randomized controlled trial // *JAMA*. – 2008. – V. 299. – P. 646–655.
 129. Miller O., Tang S., Keech A. et al. Rebound pulmonary hypertension on withdrawal from inhaled nitric oxide // *Lancet*. – 1995. – V. 346. – P. 51–52.
 130. Murray J.F., Matthay M.A., Luce J.M. et al. An expanded definition of the adult respiratory distress syndrome // *Am. Rev. Respir. Dis.* – 1988. – V. 138. – P. 720–723.
 131. Neff T.A., Stocker R., Frey H.R. et al. Long-term assessment of lung function in survivors of severe ARDS // *Chest*. – 2003. – V. 123. – P. 845–853.
 132. Negri E.M., Hoelz C., Barbas C.S. et al. Acute remodeling of parenchyma in pulmonary and extrapulmonary ARDS. An autopsy study of collagen-elastic system fibers // *Pathol. Res. Pract.* – 2002. – V. 198. – P. 355–361.
 133. Noah M.A., Peek G.J., Finney S.J. et al. Referral to an extracorporeal membrane oxygenation center and mortality among patients with severe 2009 influenza A (H1N1) // *JAMA*. – 2011. – V. 306. – P. 1659–1668.
 134. Nobauer-Huhmann I.M., Eibenberger K., Schaefer-Prokop C. et al. Changes in lung parenchyma after acute respiratory distress syndrome (ARDS): assessment with high-resolution computed tomography // *Eur. Radiol.* – 2001. – V. 11. – P. 2436–2443.
 135. Orme J.Jr., Romney J.S., Hopkins R.O. et al. Pulmonary function and health-related quality of life in survivors of acute respiratory distress

- syndrome // *Am. J. Respir. Crit. Care Med.* – 2003. – V. 167. – P. 690–694.
136. Park P.K., Napolitano L.M., Bartlett R.H. Extracorporeal membrane oxygenation in adult acute respiratory distress syndrome // *Crit. Care Clin.* – 2011. – V. 27. – P. 627–646.
 137. Patroni N., Zangrillo A., Pappalardo F. et al. The Italian ECMO network experience during the 2009 influenza A (H1N1) pandemic: preparation for severe respiratory emergency outbreaks // *Intensive Care Med.* – 2011. – V. 37. – P. 1447–1457.
 138. Penuelas O., Aramburu J.A., Frutos-Vivar F. et al. Pathology of acute lung injury and acute respiratory distress syndrome: a clinical-pathology correlation // *Clin. Chest Med.* – 2006. – V. 27. – P. 571–578.
 139. Phua J., Badia J.R., Adhikari N.K. et al. Has mortality from acute respiratory distress syndrome decreased over time? A systematic review // *Am. J. Respir. Crit. Care Med.* – 2009. – V. 179. – P. 220–227.
 140. Piacentini E., Villagra A., Lopez-Aguilar J., Blanch L. Clinical review: The implications of experimental and clinical studies of recruitment maneuvers in acute lung injury // *Crit. Care.* – 2004. – V. 8. – P. 115–121.
 141. Piehl M.A., Brown R.S. Use of extreme position changes in acute respiratory failure // *Crit. Care Med.* – 1976. – V. 4. – P. 13–14.
 142. Ponets-Arruda A., Aragao A.M., Albuquerque J.D. The effects of enteral feeding with eicosapentaenoic acid, gamma-linolenic acid and antioxidants in mechanically ventilated patients with severe sepsis and septic shock // *Crit. Care Med.* – 2006. – V. 34. – P. 2325–2333.
 143. Pontes-Arruda A., DeMichele S.J., Seth A. et al. The use of an inflammation-modulating diet in patients with acute lung injury or acute respiratory distress syndrome: a meta-analysis of outcome data // *JPEN J. Parenter. Enteral. Nutr.* – 2008. – V. 32. – P. 596–605.
 144. Puri N., Dellinger R.P. Inhaled nitric oxide and inhaled prostacyclin in acute respiratory distress syndrome: what is the evidence? // *Crit. Care Clin.* – 2011. – V. 27. – P. 561–587.
 145. Quinlan G.J., Upton R.L. Oxidant /antioxidant balance in acute respiratory distress syndrome. – Evand T.W., Griffiths M.J.D., Keogh B.F., eds. *ARDS, 20th edn.* Leeds: Maney Publishing, 2002: 33–46.
 146. Raghavendran K., Napolitano L.M. Definition of ALI / ARDS // *Crit. Care Clin.* – 2011. – V. 27. – P. 429–437.
 147. Raghavendran K., Willson D., Notter R.H. Surfactant therapy for acute lung injury and acute respiratory distress syndrome // *Crit. Care Clin.* – 2011. – V. 27. – P. 525–559.

148. Rice T.W., Wheeler A.P., Thompson B.T. et al. Enteral omega-3 fatty acid, gamma-linolenic acid, and antioxidant supplementation in acute lung injury // *JAMA*. – 2011. – V. 306. – P. 1574–1581.
149. Roch A., Guervilly C., Papazian L. Fluid management in acute lung injury and ARDS // *Ann. Intensive Care*. – 2011. – V. 1. – P. 16.
150. Roquilly A., Mahe P.J., Seguin P. et al. Hydrocortisone therapy for patients with multiple trauma. The randomized controlled HYPOLYTE study // *JAMA*. – 2011. – V. 305. – P. 1201–1209.
151. Rossaint R., Falke K.F., Lopez F. et al. Inhaled nitric oxide for the adult respiratory distress syndrome // *N. Engl. J. Med.* – 1993. – V. 328. – P. 399–405.
152. Rothenhausler H.B., Ehrentraut S., Stoll C. et al. The relationship between cognitive performance and employment and health status in long-term survivors of the acute respiratory distress syndrome: results of an exploratory study // *Gen. Hosp. Psychiatry*. – 2001. – V. 23. – P. 90–96.
153. Rubenfeld G.D., Caldwell E., Peabody E. et al. Incidence and outcomes of acute lung injury // *N. Engl. J. Med.* – 2005. – V. 353. – P. 1685–1693.
154. Salluh J.I.F., Povoia P., Soares M. et al. The role of corticosteroids in severe community-acquired pneumonia: a systematic review // *Critical Care*. – 2008, 12:R76.
155. Schelling G., Stoll C., Haller M. et al. Health-related quality of life and posttraumatic stress disorder in survivors of the acute respiratory distress syndrome // *Crit. Care Med.* – 1998. – V. 26. – P. 651–659.
156. Schelling G., Stoll C., Vogelmeier C. et al. Pulmonary function and health-related quality of life in a sample of long-term survivors of the acute respiratory distress syndrome // *Intensive Care Med.* – 2000. – V. 26. – P. 1304–1311.
157. Sedeek K.A., Takeuchi M., Suchodolski K. et al. Determinants of tidal volume during high-frequency oscillation // *Crit. Care Med.* – 2003. – V. 31. – P. 227–231.
158. Seger N., Soll R. Animal derived surfactant extract for treatment of respiratory distress syndrome // *Cochrane Database Syst. Rev.* – 2009:CD007836.
159. Shaffer T.H., Moskowitz G.D. Demand-controlled liquid ventilation of the lungs // *J. Appl. Physiol.* – 1974. – V. 36. – P. 208–213.
160. Shibata K., Cregg N., Engelberts D. et al. Hypercapnic acidosis may attenuate lung injury by inhibition of endogenous xantine oxidase // *Am. J. Respir. Crit. Care Med.* – 1998. – V. 158. P. 1578–1584.

161. Singer P., Berger M.M., Van den Berghe G. et al. ESPEN guidelines on parenteral nutrition: Intensive care // *Clin. Nutr.* – 2009. – V. 28. – P. 387–400.
162. Singer P., Theilla M., Fisher H. et al. Benefit of an enteral diet enriched with eicosapentaenoic acid and gamma-linolenic acid in ventilated patients with acute lung injury // *Crit. Care Med.* – 2006. – V. 34. – P. 1033–1038.
163. Soll R., Ozek E. Multiple versus single doses of exogenous surfactant for the prevention or treatment of neonatal respiratory distress syndrome // *Cochrane Database Syst. Rev.* – 2009:CD000141.
164. Spragg R.G., Bernard G.R., Checley W. et al. Beyond mortality: future clinical research in acute lung injury // *Am. J. Respir. Crit. Care Med.* – 2010. – V. 181. – P. 1121–1127.
165. Steinberg K.P., Hudson L.D., Goodman R.B. et al. The Acute Respiratory Distress Syndrome Network. Efficacy and safety of corticosteroids for persistent acute respiratory distress syndrome // *N. Engl. J. Med.* – 2006. – V. 354. – P. 1671–1684.
166. Stevens R.D., Dowdy D.W., Mochaels R.K. et al. Neuromuscular dysfunction acquired in critical illness: a systematic review // *Intensive Care Med.* – 2007. – V. 33. – P. 1876–1891.
167. Sukantarat K.T., Burgess P.W., Williamson R.C. et al. Prolonged cognitive dysfunction in survivors of critical illness // *Anaesthesia.* – 2005. – V. 60. – P. 847– 53.
168. Suratt B.T., Parsons P.E. Mechanisms of acute lung injury / acute respiratory distress syndrome // *Clin. Chest. Med.* – 2006. – V. 27. – P. 579–589.
169. Talpers S.S., Romerger D.J., Bunce S.B. et al. Nutritionally associated increased carbon dioxide production. Excess total calories vs high proportion of carbohydrate calories // *Chest.* – 1992. – V. 102. – P. 551–555.
170. The Acute Respiratory Distress Syndrome Network. Ventilation with lower tidal volumes as compared with traditional tidal volumes for acute lung injury and the acute respiratory distress syndrome // *N. Engl. J. Med.* – 2000. – V. 342. – P. 1301–1308.
171. The ARDS Definitions Task Force. Acute respiratory distress syndrome: the Berlin definition // *JAMA.* – 2012. – V. 307. – P. 2526–2533.
172. Thompson B.T., Bernard G.R. ARDS Network (NLBI) studies: successes and challenges in ARDS clinical research // *Crit. Care Clin.* – 2011. – V. 27. – P. 459–468.

173. Trachsel D., McCrindle B.W., Nakagawa S. et al. Oxygenation index predicts outcome in children with acute hypoxemic respiratory failure // *Am. J. Respir. Crit. Care Med.* – 2005. – V. 172. – P. 206–211.
174. Tuxen D.V. Permissive hypercapnic ventilation // *Am. J. Respir. Crit. Care Med.* – 1994. – V. 150. – P. 870–874.
175. Twohig K.J., Matthay R.A. Pulmonary effects of cytotoxic agents other than bleomycin // *Clin. Chest. Med.* – 1990. – V. 11. – P. 31–54.
176. Ventilation with lower tidal volumes as compared with traditional tidal volumes for acute lung injury and the acute respiratory distress syndrome. The Acute Respiratory Distress Syndrome Network // *N. Engl. J. Med.* – 2000. – V. 342. – P. 1301–1308.
177. Verweij J., van Zanten T., Souren T. et al. Prospective study on the dose relationship of mitomycin C-induced interstitial pneumonitis // *Cancer.* – 1987. – V. 60. – P. 756–761.
178. Villar J., Pérez-Méndez L., López J. et al., HELP Network. An early PEEP/FIO₂ trial identifies different degrees of lung injury in patients with acute respiratory distress syndrome // *Am. J. Respir. Crit. Care Med.* – 2007. – V. 176. – P. 795–804.
179. Vincent J.-L., Zambon M. Why do patients who have acute lung injury / acute respiratory distress syndrome die from multiple organ dysfunction syndrome? Implications for management // *Clin. Chest Med.* – 2006. – V. 27. – P. 725–731.
180. Weinert C.R., Gross C.R., Kangas J.R. et al. Health-related quality of life after acute lung injury // *Am. J. Respir. Crit. Care Med.* – 1997. – V. 156. – P. 1120–1128.
181. White D.A., Rankin J.A., Stover D.E. et al. Methotrexate pneumonitis: Bronchoalveolar lavage findings suggest an immunologic disorder // *Am. Rev. Respir. Dis.* – 1989. – V. 139. – P. 18–21.
182. Whitely J.P., Gavaghan D.J., Hahn C.E. Variation of venous admixture, SF₆ shunt, PaO₂, and PaO₂/FIO₂ ratio with FIO₂ // *Br. J. Anaesth.* – 2002. – B. 88. – P. 771–778.
183. Wiedemann H.P., Wheeler A.P., Bernard G.R. et al. Comparison of two fluid-management strategies in acute lung injury // *N. Engl. J. Med.* – 2006. – V. 354. – P. 2564–2575.
184. Young D., Lamb D.M., Shah S. et al. High-frequency oscillation for acute respiratory distress syndrome // *N. Engl. J. Med.* – 2013. – V. 368. – P. 806–813.
185. Zambon M., Vincent J.L. Mortality rates for patients with acute lung injury/ARDS have decreased over time // *Chest.* – 2008. – V. 133. – P. 1120–1127.