COLLECTION OF SCIENTIFIC PAPERS
SCIENTIA

10 MARCH, 2023
VALENCIA, KINGDOM OF SPAIN

SCIENTIFIC FORUM: THEORY AND PRACTICE OF RESEARCH

III INTERNATIONAL SCIENTIFIC AND THEORETICAL CONFERENCE

EUROPEAN SCIENTIFIC PLATFORM

DOI 10.36074/scientia-10.03.2023 ISBN 979-8-88955-787-6

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SCIENTIFIC FORUM: THEORY AND PRACTICE OF RESEARCH

III International Scientific and Theoretical Conference

Valencia, 2023

UDC 001(08)
S 40

https://doi.org/10.36074/scientia-10.03.2023

Chairman of the Organizing Committee: Holdenblat M.

Responsible for the layout: Bilous T.
Responsible designer: Bondarenko I.

S 40 Scientific forum: theory and practice of research: collection of scientific papers «SCIENTIA» with Proceedings of the III International Scientific and Theoretical Conference, March 10, 2023. Valencia, Kingdom of Spain: European Scientific Platform.

ISBN 979-8-88955-787-6
DOI 10.36074/scientia-10.03.2023

Papers of participants of the III International Multidisciplinary Scientific and Theoretical Conference «Scientific forum: theory and practice of research», held on March 10, 2023 in Valencia are presented in the collection of scientific papers.

The conference is included in the Academic Research Index ReserchBib International catalog of scientific conferences and registered for holding on the territory of Ukraine in UKRISTEI (Certificate № 22 dated January 17th, 2023).

UDC 001 (08)

ISBN 979-8-88955-787-6

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SECTION 21.
MEDICAL SCIENCES AND PUBLIC HEALTH

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VENTILATION CONTROL THROUGH PRESSURE CONTROL, WHAT IS NECESSARY FOR THE OPENING OF THE ALVEOLI

Background. Extensive multicenter studies show that among patients who urgently admitted to intensive care units (ISU), the frequency of acute respiratory distress syndrome (ARDS) reaches 10% [1]. One of the serious reasons for the development of acute respiratory failure and ARDS is a pulmonary contusion [1, 2]. Lung contusion is one of the most frequent injuries in blunt chest injuries. In various studies, the prevalence of pulmonary contusion in blunt thoracic trauma ranges from 25 to 75%. Pulmonary contusion primarily causes by damage to alveolar vessels without rupture of lung tissue. The condition of the patients slowly deteriorates during the first 24-48 hours after receiving the injury and leads to leakage of blood and fluid into the alveolar space adjacent to the damaged parenchyma. Subsequent edema is a result of inflammation and activation of capillary leakage by hypoxia increases the damage to the lung structure, which leads to impaired ventilation, perfusion, and gas exchange. Mortality among patients with pulmonary contusion ranges from 10 to 35% [3]. The main component of intensive care for patients with pulmonary contusion and ARDS is respiratory support. With ARDS, specialists in intensive therapy for respiratory support most often use invasive forced mechanical ventilation with the creation of constant positive pressure in the airways. Positive end expiratory pressure (PEEP) is necessary to open the alveoli and to improve the respiratory-perfusion ratio, thereby reducing shunting and arterial hypoxemia [4]. The opening of the alveoli occurs under driving pressure. The driving pressure is the difference between the plateau pressure and the PEEP. Many modern respirators have regulation of ventilation according to driving pressure [5, 6]. The purpose of our research is to establish the effectiveness of respiratory support based on driving pressure in patients with pulmonary contusion based on own observations and analysis of information on websites for professionals on the Internet.

Materials and methods. We used our experience of conducting intensive therapy in 100 patients with pulmonary contusion and ARDS in the conditions of a multidisciplinary city hospital of emergency medical care and compared it with the results of modern foreign research on this problem.

Results. According to Murray's lung damage severity scale, there are 4 gradations of reduction in the value of the oxygenation index (PaO_2/FiO_2): 1) 225-299; 2) 175-224; 3) 100-174; and 4) <100. According to the severity of the lung's lesion, in order to improve the ventilationperfusion ratio and eliminate hypoxemia, during respiratory support, the PEEP level will be needed, which is: 1) 6-8 cm H_2O; 2) 9-11 cm H_2O; 3) 12-14 cm H_2O; 4) 15 or more cm H_2O. Gradations of decrease in lung compliance according to the severity of the lesion are: 1) 60-79 ml/cm H_2O; 2) 40-59 ml/cm H_2O; 3) 20-39 ml/cm H_2O; 4)19 ml/cm H_2O and less. We have never observed a decrease in pulmonary compliance to 19 cm H_2O or less, but we note that in 42% of our patients with pulmonary contusion and ARDS, the level of pulmonary compliance was within 20-39 ml/cm H_2O. The value of pulmonary compliance fully corresponded to the severity of ARDS and the indicators of the oxygenation index in such patients. We have never had a need to use PEEP value greater than 14 cm H_2O [4]. With controlled mechanical ventilation, the plateau pressure is the pressure exerted at the end of inspiration on the small airways and alveoli. It measure during a pause at the end of inhalation on the ventilator. Plateau pressure is a pressure that generate in the alveoli by the elastic return of the respiratory system. PEEP and driving pressure is a considering constituent parts of the P plateau. The more severe the damage to the lungs and the more pronounced the alveolar collapse, the greater the P plateau value will needed for effective lung inflation and decrease of the venous-arterial shunt in the lungs. The P value of the plateau during the most severe ARDS flow can reach 25-30 cm H_2O. It is not recommend use P plateau higher than 30 cm H_2O, as this threatens barotrauma of the lungs. We use the maximum value of P plateau in the range of 25-27 cm H_2O. ARDS patients receiving low tidal volume ventilation often have P plateau that exceed Acute Respiratory Distress Syndrome Network targets. Race, body mass index, and severity of lung injury are independently associated with the need for elevated P plateau. Selecting a lower initial tidal volume for nonwhite patients and patients with higher disease severity may reduce the frequency of the need to increase P plateau [4, 7, 8]. Since the P plateau represents the sum of PEEP and driving pressure, both high PEEP and high driving pressure can be the cause of lung barotrauma. The need for high driving pressure has shown to be frequently associated with increased mortality in patients with ARDS. At first, a pressure above 16 cm H_2O considered a dangerous value of driving pressure. Somewhat later, experts began to consider the magnitude of the driving pressure at the level of 14 cm H_2O as dangerous. So far, the research results are contradictory. In those who survived and those who did not survive severe ARDS, the drive pressure often differed by only 1 cm H_2O. Therefore, we do not believe that the value of this indicator is the main tool for managing ventilation in patients with ARDS. Currently, intensive care specialists most often use a driving pressure value in the range of 8-13 cm H_2O [5, 6, 9].

We performed invasive controlled ventilation using a tidal volume of 6 ml/predicted body weight (PBW). In our study, in 60 patients with pulmonary contusion and grade 1 ARDS, we used a PEEP value of 9-11 cm H_2O and a driving pressure of 9-10 cm H_2O. The P value of the plateau reached 18-21 cm H_2O, respectively. The FiO_2 value was 0.5-0.6. The value of the target peripheral arterial oxygen saturation (SpO_2%) was 94-95%. FiO_2 increase in dynamics was not required. The PMB calculation was as follows:

$$\textit{For females: } PBW\ (kg) = 45.5 + 0.91 * (height\ [cm] - 152.4) \quad (1)$$

$$\textit{For males: } PBW\ (kg) = 50 + 0.91 * (height\ [cm] - 152.4) \quad (2)$$

As the oxygenation index increased and the condition of the patients improved, we decreased the PEEP and FiO_2 values. At the same time, we did not change the values of the driving pressure. Pulmonary compliance increased and we could use a gradual increase in tidal volume. The condition of all patients improved. After the end of invasive ventilation, we transferred all our patients with ARDS-1 to spontaneous breathing without difficulty.

In 40 patients with pulmonary contusion and signs of ARDS grade 2, we used invasive controlled ventilation with higher PEEP, driving pressure and P plateau. We gradually increased PEEP from 5 cm H_2O to (10-12) cm H_2O. This PEEP value did not require a reduction in tidal volume. Driving pressure initially reached 11-12 cm H_2O. The P plateau reached 21-24 cm H_2O. Peak pressure was limited to 30 cm H_2O. In 5 patients who did not survive, we applied PEEP 14 cm H_2O and a driving pressure of 13-14 cm H_2O. The P plateau reached 26-27 cm H_2O. These activities were not successful, despite the fact that FiO_2 at a certain stage reached 0.8-1.0. The decrease in driving pressure in these patients to a level of 9-

10 cm H_2O, as well as the P-plateau values with it, did not improve the oxygenation index. Thus, mortality in patients with signs of ARDS 2 severity was 12.5%. We found that it was no higher than that reported by our colleagues who are working on a similar problem [1, 3, 10].

Conclusion. Controlled mechanical ventilation in patients with ARDS cannot perform using only one parameter. Specialists should adjust the values of tidal volume, PEEP, driving pressure, plateau pressure, focusing on changes in the oxygenation index, blood gas tension and pulmonary compliance. The Murray scale provides a reliable basis for the initial selection of the required ventilation parameters.

References:

1. Bellani G., Laffey J.G., Fan E., Brochard L., Esteban A., Gattinoni L., van Haren F., Larsson A., McAuley D.F., Ranieri M., Rubenfeld G., Thompson B.T., Wrigge H., Slutsky A.S. & Pesenti A. (2016) Epidemiology, Patterns of Care, and Mortality for Patients With Acute Respiratory Distress Syndrome in Intensive Care Units in 50 Countries. *JAMA.* 315(8), 788 – 800. doi:10.1001/jama.2016.0291
2. Tignanelli C.J., Hemmila M.R., Rogers M.A.M. & Raghavendran K. (2019) Nationwide Cohort Study of Independent Risk Factors for Acute Respiratory Distress Syndrome After Trauma. *Trauma Surg Acute Care Open*. 4(1), Article e000249. doi:10.1136/tsaco-2018-000249
3. Tominaga N, Hayakawa M. & Yokobori S. (2022) Blush in Lung Contusions Is not Rare and Has a High Risk of Mortality in Patients with Blunt Chest Trauma. *Front. Med*. 9, Article 858511. doi:10.3389/fmed.2022.858511
4. Ganie F.A., Lone H., Lone G.N., Wani M.L., Singh S., Dar A.M., Wani N., Wani S.N., & Nazzer N. (2013) Lung Contusion: A Clinico-Pathological Entity with Unpredictable Clinical Course. *Bull Emerg Trauma.* 1(1), 7–16. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4771236/
5. Ahn H.J., Park M., Kim J.A., Yang M., Yoon S., Kim B.R., Bahk J-H., Oh Y.J. & Lee E-H. (2020) Driving Pressure Guided Ventilation. *Korean J Anesthesiol.* 73(3), 194–204. doi: 10.4097/kja.20041
6. Aoyama H., Yamada Y. & Fan E. (2018) The Future of Driving Pressure: a Primary Goal for Mechanical Ventilation? *Journal of Intensive Care.* 6, Article 64. https://jintensivecare.biomedcentral.com/articles/10.1186/s40560-018-0334-4
7. Sosio S. & Bellani G. (2019) Plateau Pressure during Pressure Control Ventilation. *AboutOpen: Intensive Car.* 6(1), 76–77. DOI: 10.33393.abtpn.2019.297
8. Prescott H.C., Brower R.G., Cooke C.R., Phillips G. & O'Brien J.M. (2013) Factors Associated with Elevated Plateau Pressure in Patients with Acute Lung Injury Receiving Lower Tidal Volume Ventilation. *Crit Care Med.* 41(3), 756 – 764. doi: 10.1097/CCM.0b013e3182741790
9. Amato M.B.P., Meade M.O., Slutsky A.S., Brochard L., Costa E.L.V., Schoenfeld D.A., Stewart T.E., Briel M., Talmor D., Mercat A., Richard J-C.M., Carvalho C.R.R. & Brower R.G. (2015) Driving Pressure and Survival in the Acute Respiratory Distress Syndrome. *The New England Journal of Medicine.* 372(8), 747–755. https://www.nejm.org/doi/full/10.1056/nejmsa1410639
10. Máca J., Jor O., Holub M., Sklienka P., Burša F., Burda M., Janout V. & Ševčík P. (2017) Past and Present ARDS Mortality Rates: A Systematic Review. *Respiratory Care.* 62(1), 113–122. DOI: https://doi.org/10.4187/respcare.04716