Göteborg, 2021

Aspects of lung mechanics during mechanical ventilation

Akademisk avhandling

Som för avläggande av medicine doktorsexamen vid Sahlgrenska akademin, Göteborgs universitet kommer att offentligen försvaras i lokal Arvid Carlson, Academicum, Medicinaregatan 3, fredagen den 26 mars 2021 klockan 09:00

av

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Avhandlingen baseras på följande delarbeten

I. Gudmundsson M, Perchiazzi G, Pellegrini, M, Vena A, Hedenstierna G, Rylander C. Atelectasis is inversely proportional to transpulmonary pressure during weaning from ventilator support in a large animal model. *Acta Anaesthesiol Scand* 2018; 62:94-104

II. Gudmundsson M, Persson P, Perchiazzi G, Lundin S, Rylander C. Transpulmonary driving pressure during mechanical ventilation - validation of a non-invasive method. *Acta Anaesthesiol Scand* 2020; 64:211-215

III. Gudmundsson M, Pellegrini M, Perchiazzi G, Hedenstierna G, Benzce R, Rylander C. Increasing the time constant by applying expiratory resistance – an experimental feasibility study. *Manuscript 2020*

IV. Gudmundsson M, Erbring V, Lundin, Rylander, C Persson P. The effect of prone position on transpulmonary pressure measured with high-resolution manometry catheter. *Manuscript 2020*

SAHLGRENSKA AKADEMIN
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Aspects of lung mechanics during mechanical ventilation

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Abstract

Background: One of the most common diagnosis in the intensive care unit is acute respiratory failure. In its most severe form it is called acute respiratory distress syndrome and often requires mechanical ventilation. The main challenge for physicians is to provide mechanical ventilation that treats the hypoxia that can be of different etiology without damaging the lung.

Method: In paper I computed tomography scans were acquired in ten anesthetized surfactant depleted pigs. The volume of gas and atelectasis were correlated with transpulmonary pressure as the pressure support and PEEP were lowered. In paper II a non-invasive method for measuring transpulmonary driving pressure was validated in 31 mechanically ventilated intensive care patients. In paper III external expiratory resistors were added to the expiratory limb of the ventilator while calculating expiratory time constant, respiratory compliance, driving pressure and intrinsic PEEP in 12 anesthetized pigs. In paper IV transpulmonary pressure was calculated from esophageal pressure in supine and prone position in 10 anesthetized lung healthy patients.

Results: Gradual decrease in transpulmonary pressure causes a proportional increase in atelectasis and decrease in gas content while the work of breathing increases. There is a good statistical agreement between the conventional and the non-invasive method for measuring transpulmonary driving pressure. Increasing the expiratory resistance elongates the expiratory time constant and increases intrinsic PEEP in healthy lungs. There is a great variability in esophageal pressure in the part of the esophagus 22 – 44cm from the nostrils in both supine and prone position. Depending on method the transpulmonary pressure either increases or decreases when patients are turned in prone position.

Conclusion: There is no transpulmonary pressure threshold, where atelectasis with desaturation or cyclic collapse suddenly occurs during gradual decrease in the ventilator support. The PEEP-step method is comparable to the traditional esophageal balloon method for measuring transpulmonary driving pressure. The application of expiratory resistors could be useful during weaning from mechanical ventilation. The mean end-expiratory esophageal pressure changes which affect the calculation of transpulmonary pressure but uncertainties about the use of absolute esophageal pressure remains.

Keywords: Acute respiratory failure, Acute respiratory distress syndrome, Mechanical ventilation, Transpulmonary pressure, Expiratory time constant, Esophageal pressure.

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