Literature List
Volume-Controlled Ventilation
Mandatory Minute Volume (VC-MMV)

November 2017
# Mandatory Minute Volume Literature List

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<td><em>Ann Chir Gynaecol Suppl.</em>. 1982; 196:64-7</td>
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Background:
Mandatory minute ventilation (MMV) is a novel ventilator mode that combines synchronized intermittent mandatory ventilation (SIMV) breaths with pressure-supported spontaneous breaths to maintain a desired minute volume. The SIMV rate is automatically adjusted to maintain minute ventilation.

Objective:
To evaluate MMV in a cohort of infants without parenchymal lung disease alternately ventilated by MMV and SIMV.

Design/Methods:
Neonates >33 weeks' gestational age and electively intubated for medical or surgical procedures were enrolled. Exclusionary criteria included: nonintact respiratory drive or active pulmonary disease. Infants were randomized to receive 2 hours of either SIMV or MMV and then crossed over to the other mode for 2 hours. Ventilator parameters and end-tidal CO(2) (etCO(2)) were measured via inline, mainstream monitoring and recorded every minute.

Results:
In total, 20 infants were evaluated. No statistically significant differences were found for overall means between etCO(2), minute volumes, peak inspiratory pressure (PIP), or positive end expiratory pressure (PEEP). However, there was a significant difference in the type of ventilator breaths given and in the mean airway pressure. Additionally, there was a statistically significant negative trend in MMV over time compared to SIMV, although this was subtle and could have been due to extreme cases.

Conclusions:
Neonates with an intact respiratory drive can be successfully managed with MMV without an increase in etCO(2). While this mode generates similar PIP and PEEP, the decrease in mechanical breaths and the mean airway pressure generated with MMV may reduce the risk of some of the long-term complications associated with mechanical ventilation.
Spontaneous minute ventilation is a predictor of extubation failure in extremely-low-birth-weight infants.

Objectives:
To validate the percentage of time spent below a target value of spontaneous expiratory minute ventilation (< 125 ml/min per kg) during a 2-h period of continuous positive airway pressure (CPAP) via an endotracheal tube (ETT) as a predictor of failed extubation in preterm infants.

Methods:
Forty-one infants intubated for at least 24 h, with birth weight between 500 and 1000 g, who were clinically stable and at ventilator setting compatible with an extubation attempt, were studied during a 2-h period of ETT CPAP. Dynamic lung compliance and total lung resistance were measured during a period of quiet breathing, while tidal volume (Vt), respiratory rate and the corresponding spontaneous expiratory minute ventilation values were calculated for the complete recording period of 2 h using a customized computer program. The time each patient spent below the target spontaneous expiratory minute ventilation value was reported as a percentage of the total recorded time (% spontaneous expiratory minute ventilation < 125 ml/min per kg). Extubation failure was defined as the need for reintubation within 72 h.

Results:
Eleven out of 41 babies (26.8%) experienced failure of extubation (failure group) while 30 infants (73.2%) were successfully extubated (success group). There were no significant differences in dynamic lung compliance and lung resistance between the two groups, but the mean values of respiratory rate and spontaneous expiratory minute ventilation were significantly lower in the failure group than in the success group: 43 (37-56) breaths/min and 240 (160-353) ml/min per kg vs. 53 (28-67) breaths/min and 309 (223-434) ml/min per kg, respectively (p = 0.0129 and p = 0.0039). Moreover, the babies in whom extubation failed spent a longer time below the target value of spontaneous expiratory minute ventilation when compared with successfully extubated babies (p < 0.0001). Percentage of time spent with spontaneous expiratory minute ventilation < 125 ml/min per kg had a larger area than transcutaneous (Tc)PCO2, TcPO2 and pulse oxymetry saturation (SpO2) under the receiver operator characteristic curves.

Conclusion:
The measurement of spontaneous expiratory minute ventilation prior to extubation could be useful in identifying those babies who are not ready for spontaneous ventilation.
**Introduction:**
Computer-controlled minute ventilation (CCMV) continuously adjusts the ventilator rate to changes in spontaneous respiratory drive and pulmonary mechanics to maintain a preset total minute ventilation. Different from most biological systems, the variability of the respiratory system can be easily influenced in an attempt to improve its function. In controlled, as well as in assisted mechanical ventilation, the variability of tidal volume and/or respiratory rate may be modulated externally by the mechanical ventilator to reproduce certain characteristics of spontaneous breathing in healthy subjects. Because mechanical ventilation represents a common intervention in intensive care and emergency medicine, interest in modes that can enhance the variability of the respiratory pattern has increased in recent years.

**Hypothesis:**
We hypothesized that CCMV would maintain ventilation and oxygenation with fewer mechanical breaths than conventional intermittent mandatory ventilation in very low birth weight infants.

**Methods:**
Very low birth weight infants in clinically stable condition who were undergoing mechanical ventilation were enrolled. The number of mechanical breaths, total and mechanical expiratory minute ventilation, mean airway pressure, oxygen hemoglobin saturation by pulse oximetry, and transcutaneous partial carbon dioxide and partial oxygen tensions were obtained during intermittent mandatory ventilation and CCMV (45 to 60 minutes) and compared by paired t test.

**Results:**
Fifteen infants were studied. Birth weight (median, range) was 700 gm (550 to 1205 gm), gestational age 26 weeks (23 to 34 weeks), age 21 days (3 to 50 days). When switched from intermittent mandatory ventilation to CCMV, the number of mechanical breaths was reduced (15 +/- 2.8 to 8.6 +/- 2.9 breaths per minute, p < 0.001), leading to lower airway pressure (3.97 +/- 1.00 to 3.45 +/- 1.00 cm H2O, p < 0.001) and lower expiratory minute ventilation generated by the mechanical ventilator (116 +/- 31 to 65 +/- 28 ml/min per kilogram, p < 0.001), while total expiratory minute ventilation remained unchanged. Mean transcutaneous partial carbon dioxide and oxygen tensions, oxygen hemoglobin saturation, and the time spent within different oxygen hemoglobin saturation ranges did not differ between both ventilatory modes.

**Conclusion:**
CCMV maintained adequate ventilation and oxygenation with lower mechanical ventilatory support than IMV. CCMV may reduce barotrauma and chronic lung disease during long-term use.

**Abstract:**
This study evaluates mandatory minute volume (MMV) weaning in patients with pulmonary pathology. When weaning criteria were fulfilled, 22 patients were randomised to MMV and 18 to a control intermittent mandatory ventilation (IMV) group. With IMV weaning the ventilator rate was decreased by two breaths per minute at 3-4 hourly intervals during daylight hours. In the MMV group a target of 75% of the ventilator minute volume was set. All weans were considered complete four hours after the cessation of mechanical support, and were deemed successful if no further ventilation was required. The success rate was 86% in the IMV and 89% in the MMV group. MMV weaning was rapid (4.75 +/- 1.5 hrs) and proved less demanding on the ICU staff by providing a safe trial of spontaneous respiration, while retaining the facility for partial ventilation.
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<td>Higgs BD, Bevan JC</td>
<td>Mandatory minute volume, a new concept in weaning from mechanical ventilation.</td>
<td>Br J Anaesth. 1979 Dec; 51(12):1181-4</td>
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**Abstract:**
A short review is given of the current methods of mechanical ventilatory support. New technology makes it possible to combine mandatory ventilation with spontaneous respiration in order to improve circulation and also to minimize the patient's dependence on a ventilator. One new modality, extended mandatory minute ventilation (EMMV) combines the advantages of mandatory ventilation with full utilization of any spontaneous respiration and is believed to have certain advantages over intermittent mandatory ventilation (IMV). The EMMV is explained and certain characteristics are emphasized.

**Abstract:**
The new concept of mandatory minute volume (MMV) is described. The system provides a preset minute volume to the patient, who breathes spontaneously from it as much as he is able, the remainder being delivered to him via a ventilator. The necessary apparatus has been constructed and has the additional facility of PEEP and/or CPAP up to a level of 15 cmH2O pressure. With possible exceptions, the apparatus allows simpler and more direct control over the patient's PaCO2 than with the IMV system and it ensures, without adjustment, a constant minute volume of fresh gas breathed by the patient, despite minute-to-minute changes in his ability to breathe. Use of the system in conjunction with two commonly used ventilators is described. It should not be difficult to build the facility for MMV into new versions of artificial ventilators.