

## **Lung compliance, airway resistance, and work of breathing in children after inhalation injury.**

[Mlcak R](#), [Cortiella J](#), [Desai M](#), [Herndon D](#).

Shriners Burns Institute, Galveston, Texas 77550, USA.

Pathophysiologic changes associated with inhalation injury make mechanical ventilation in children a challenge. Decreased lung compliance and increased airway resistance after inhalation injury may lead to elevated airway pressures and barotrauma. Previous studies have shown significant decreases in the incidence of pneumonia and death in adult patients with inhalation injury treated with high-frequency percussive ventilation (HFPV) as compared with conventional mechanical ventilation (CMV). No studies to date have compared lung compliance, airway resistance, or work of breathing in children being treated with HFPV versus CMV. The purpose of this study was to evaluate lung compliance, airway resistance, and work of breathing in pediatric patients with inhalation injury who required mechanical ventilation. Ten children with bronchoscopically identified inhalation injury requiring mechanical ventilation were studied. Five children received CMV and five children received HFPV. All patients were treated according to our standard inhalation injury protocol. Based on our data and patient population, children receiving ventilation with the HFPV have a significant decrease in the work of breathing as compared with CMV.

PMID: 9404988 [PubMed - indexed for MEDLINE]

Crit Care Med. 1984 Sep;12(9):769-73.

[Related Articles, Links](#)

## *Gas exchange during conventional and high-frequency pulse ventilation in the surfactant-deficient lung: influence of positive end-expiratory pressure.*

[Jibelian G](#), [Lachmann B](#).

*High-frequency pulse ventilation (HFPV) was compared to conventional ventilation (CV) in a model of severe respiratory failure induced by serial lung lavages with warm saline in 8 mongrel dogs. Before the lavage, during HFPV at 4 Hz with a pulse volume (PV) of 125 ml, mean PaO<sub>2</sub> was 107 torr and mean PaCO<sub>2</sub> was 34 torr. After the last lavage, during CV at an inspired oxygen fraction FIO<sub>2</sub> of 1.0 and a tidal volume (VT) of 535 ml, the PaO<sub>2</sub> averaged 60 torr and PaCO<sub>2</sub> was 45 torr. At an FIO<sub>2</sub> of 0.21, 20 cm H<sub>2</sub>O of positive end-expiratory pressure (PEEP) was applied to prevent hypoxemia. The resulting PaO<sub>2</sub> was 87 torr; PaCO<sub>2</sub> was 40 torr. Peak airway pressure (Ppa) rose from 21 to 51 cm H<sub>2</sub>O. When ventilation was switched to HFPV on room air, a PV similar to the control levels was associated with severe hypoxemia (PaO<sub>2</sub> less than 45 torr, PaCO<sub>2</sub> greater than 50 torr). As PV was increased PaO<sub>2</sub> improved, reaching 113 torr at a PV of about 470 ml. The corresponding mean airway pressure (Paw) was about 20 cm H<sub>2</sub>O. Thus, application of PEEP during HFPV at low PV did not improve PaO<sub>2</sub> even when measured Paw approximated 20 cm H<sub>2</sub>O. This suggests that HFPV with high PV is more effective than either CV*

*with PEEP, or HFPV with low PV and PEEP.*

*PMID: 6432439 [PubMed - indexed for MEDLINE]*

Trauma. 1988 Sep;28(9):1363-7.

[Related Articles, Links](#)

### ***High-frequency percussive ventilation in the management of elevated intracranial pressure.***

***Hurst JM, Branson RD, Davis K, Jr.***

*Department of Surgery, University of Cincinnati Medical Center, OH.*

*We evaluated 38 patients with combined head injury and respiratory failure requiring manipulation of mean airway pressure in order to achieve satisfactory oxygenation. All patients were initially maintained on conventional ventilatory support. When entry criteria were met, patients were transitioned to high-frequency percussive ventilation (HFPV) and cardiorespiratory variables were measured. HFPV resulted in a statistically significant decrease in intracranial pressures in patients when ICP remained greater than 15 mm Hg in spite of optimum medical management. Satisfactory oxygenation was obtained at approximately half the level of CPAP and peak inspiratory pressure as that on conventional ventilation. Thus HFPV provides an acceptable alternative method of ventilatory support in patients with combined head injury and respiratory failure.*

*PMID: 3418762 [PubMed - indexed for MEDLINE]*

J Trauma. 1989 Mar;29(3):350-4.

[Related Articles, Links](#)

### ***High-frequency percussive ventilation in patients with inhalation injury.***

***Cioffi WG, Graves TA, McManus WF, Pruitt BA Jr.***

*U. S. Army Institute of Surgical Research, Fort Sam Houston, Texas 78234-6200.*

*Inhalation injury complicated by bacterial pneumonia is now one of the primary causes of morbidity and mortality in patients with thermal injury. We have investigated the use of high-frequency percussive ventilation (HFPV) as a means of ventilatory support for these patients. We propose that high-frequency ventilation may decrease the incidence of pulmonary infection following inhalation injury and decrease the incidence of iatrogenic barotrauma caused by conventional ventilation. High-frequency ventilation was instituted initially as salvage therapy in a group of five patients. In each case, normocapnia or arterial pO<sub>2</sub> saturation of greater than 90% on a FIO<sub>2</sub> of 60% or less was achieved with high-frequency ventilation but not with conventional ventilation. A second group of ten patients was prospectively entered into a study on the use of HFPV in patients with inhalation injury. One patient was removed from the study, and one patient was unable to be ventilated because of severely noncompliant lungs. Eight patients with a mean age of 29 years and a mean burn size of 38% of the total body surface completed the protocol. All patients survived, two developed pneumonia, and one developed subcutaneous emphysema. These results suggest that HFPV is effective in the treatment of patients with severe inhalation injury.*

PMID: 2926848 [PubMed - indexed for MEDLINE]

[Related Articles](#), [Links](#)

Crit Care Med. 1989 Apr;17(4):364-6.

*High-frequency percussive ventilation compared with conventional mechanical ventilation.*

Gallagher TJ, Boysen PG, Davidson DD, Miller JR, Leven SB.

Department of Anesthesiology, University of Florida College of Medicine, Gainesville 32610-0254.

*In seven patients with severe respiratory distress, conventional mechanical ventilation and PEEP were used initially for respiratory support, which was changed to high-frequency percussive ventilation (HFPV) at the same level of airway pressure and FIO<sub>2</sub>. During both modes of ventilation, patients could breathe spontaneously via a low-threshold demand valve. With HFPV, PaO<sub>2</sub> improved significantly (p less than .01) compared with PaO<sub>2</sub> during conventional methods. Cardiac output was unaffected by the change to HFPV.*

PMID: 2495212 [PubMed - indexed for MEDLINE]

J Burn Care Rehabil. 1997 Nov-Dec;18(6):531-4.

[Related Articles](#), [Links](#)

**Lung compliance, airway resistance, and work of breathing in children after inhalation injury.**

Mlcak R, Cortiella J, Desai M, Herndon D.

Shriners Burns Institute, Galveston, Texas 77550, USA.

Pathophysiologic changes associated with inhalation injury make mechanical ventilation in children a challenge. Decreased lung compliance and increased airway resistance after inhalation injury may lead to elevated airway pressures and barotrauma. Previous studies have shown significant decreases in the incidence of pneumonia and death in adult patients with inhalation injury treated with high-frequency percussive ventilation (HFPV) as compared with conventional mechanical ventilation (CMV). No studies to date have compared lung compliance, airway resistance, or work of breathing in children being treated with HFPV versus CMV. The purpose of this study was to evaluate lung compliance, airway resistance, and work of breathing in pediatric patients with inhalation injury who required mechanical ventilation. Ten children with bronchoscopically identified inhalation injury requiring mechanical ventilation were studied. Five children received CMV and five children received HFPV. All patients were treated according to our standard inhalation injury protocol. Based on our data and patient population, children receiving ventilation with the HFPV have a significant decrease in the work of breathing as compared with CMV.

PMID: 9404988 [PubMed - indexed for MEDLINE]

Burns. 1998 Feb;24(1):34-8.

[Related Articles](#), [Links](#)



*The usefulness of combined high-frequency percussive ventilation during acute respiratory failure after smoke inhalation.*

[Reper P](#), [Dankaert R](#), [van Hille F](#), [van Laeke P](#), [Duinslaeger L](#), [Vanderkelen A](#).

*Burn Center Brussels, Queen Astrid Military Hospital, Brussels, Belgium.*

*Inhalation injury and bacterial pneumonia represent some of the most important causes of mortality in burn patients. We describe 11 severely burned patients with acute respiratory failure due to inhalation injury who did not respond adequately to conventional respiratory support. High-frequency percussive ventilation (HF $\dot{P}$ V) is a recent ventilatory mode, which combines the advantages of conventional ventilation with some of those of high-frequency ventilation. Seven patients developed pulmonary infection during the acute phase; one patient died of multiple organ failure on day 25. All the other patients survived; two developed bronchiolitis obliterans symptoms before discharge. No side-effects were noted and haemodynamic tolerance of HF $\dot{P}$ V was excellent. Our findings suggest that HF $\dot{P}$ V can improve pulmonary function and gas exchange in these catastrophic pulmonary failures following inhalation injury.*

PMID: 9601588 [PubMed - indexed for MEDLINE]

J Burn Care Rehabil. 1999 May-Jun;20(3):232-5.

[Related Articles](#), [Links](#)

*High frequency percussive ventilation in pediatric patients with inhalation injury.*

[Cortiella J](#), [Mlcak R](#), [Herndon D](#).

*University of Texas Medical Branch at Galveston, USA.*

*The objective of this study was to present data that showed high frequency percussive ventilation (HF $\dot{P}$ V) was superior to traditional mechanical ventilation for the treatment of children with inhalation injuries. Inhalation injuries continue to be the number one cause of death of patients with thermal injuries in the United States. Therapy for this condition has consisted of conservative pulmonary toilet and mechanical ventilation. Despite improvements in the management of burn injury, patients with inhalation injury develop pneumonia and pneumothorax, leading to adult respiratory distress syndrome. Unfortunately, inhalation injury that is complicated by pneumonia has been shown to increase mortality by 60% in these patients. Cioffi has shown that prophylactic use of HF $\dot{P}$ V in adult patients with inhalation injury has been a successful method of reducing the incidence of pneumonia and mortality. The effects of HF $\dot{P}$ V on the incidence of pneumonia, peak inspiratory pressures, and arterial partial pressure of oxygen/fraction of inspired concentration of oxygen (P/F) ratios were retrospectively studied in 13 children with inhalation injuries and*

compared with historic controls treated with conventional mechanical ventilation. All patients were treated with our standard inhalation injury protocol and extubated when they met standard extubation criteria. Patients ranged in age from 6 to 9 years, and most had burns covering greater than 50% of their total body surface areas. No deaths occurred in either group, but the patients who were treated with HFPV had no cases of pneumonia ( $P < .05$ ), better P/F ratios ( $P < .05$ ), lower peak inspiratory pressures, and less work of breathing ( $P < .05$ ) as compared with our control group. On the basis of our clinical experience and data, the use of HFPV seems to be an effective treatment for the reduction of pulmonary morbidity in pediatric patients with inhalation injuries.

PMID: 10342478 [PubMed - indexed for MEDLINE]

Chest. 1999 Aug;116(2):440-6.

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*High-frequency percussive ventilation improves oxygenation in patients with ARDS.*

*Velmahos GC, Chan LS, Tatevossian R, Cornwell EE 3rd, Dougherty WR, Escudero J, Demetriades D.*

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*STUDY OBJECTIVES:* To evaluate changes in respiratory and hemodynamic function of patients with ARDS and requiring high-frequency percussive ventilation (HFPV) after failure of conventional ventilation (CV). *DESIGN:* Retrospective case series. *SETTING:* Surgical ICU (SICU) and medical ICU (MICU) of an academic county facility. *MEASUREMENTS AND RESULTS:* Thirty-two consecutive patients with ARDS (20 from SICU, 12 from MICU) who were unresponsive to at least 48 h of CV and were switched to HFPV were studied. Data on respiratory and hemodynamic parameters were collected during the 48 h preceding and the 48 h after institution of HFPV and compared. Between the period of CV and the period of HFPV, the ratio of PaO<sub>2</sub> to the fraction of inspired oxygen (F(IO<sub>2</sub>)) increased ([mean+/-SE] 130+/-8 vs. 172+/-17;  $p = 0.027$ ), peak inspiratory pressure (PIP) decreased (39.5+/-1.7 vs. 32.5+/-1.9 mm Hg;  $p = 0.002$ ), and mean airway pressure (MAP) increased (19.2+/-1.2 vs. 27.5+/-1.4 mm Hg;  $p < 0.001$ ). The rate of change of PaO<sub>2</sub>/F(IO<sub>2</sub>) per hour was also significantly improved between the two periods. The same changes in PaO<sub>2</sub>/F(IO<sub>2</sub>), PIP, and MAP were observed when the last value recorded while the patients were on CV was compared with the first value recorded after 1 h of HFPV. This improvement was sustained but not amplified during the hours of HFPV. The patterns of improvement in these three parameters were similar in SICU and MICU patients as well as in volume-control and pressure-control patients. There were no changes in hemodynamic parameters. *CONCLUSION:* The HFPV improves oxygenation by increasing MAP and decreasing PIP. This improvement is achieved soon after institution of HFPV and is maintained without affecting hemodynamics.

PMID: 10453874 [PubMed - indexed for MEDLINE]

Crit Care. 1999;3(4):101-110.

[Related Articles, Links](#)

## *A new prototype of an electronic jet-ventilator and its humidification system.*

*Kraincuk P, Kepka A, Ihra G, Schabernig C, Aloy A.*

*Department of Anesthesiology and General Intensive Care, University of Vienna, Austria.  
alexander.aloy@univie.ac.at*

*BACKGROUND: Adequate humidification in long-term jet ventilation is a critical aspect in terms of clinical safety. AIM: To assess a prototype of an electronic jet-ventilator and its humidification system. METHODS: Forty patients with respiratory insufficiency were randomly allocated to one of four groups. The criterion for inclusion in this study was respiratory insufficiency exhibiting a Murray score above 2. The four groups of patients were ventilated with three different respirators and four different humidification systems. Patients in groups A and B received superimposed high-frequency jet ventilation (SHFJV) by an electronic jet-ventilator either with (group A) or without (group B) an additional humidification system. Patients in group C received high-frequency percussive ventilation (HFPPV) by a pneumatic high-frequency respirator, using a hot water humidifier for warming and moistening the inspiration gas. Patients in group D received conventional mechanical ventilation using a standard intensive care unit respirator with a standard humidification system. SHFJV and HFPPV were used for a period of 100 h (4days). RESULTS: A significantly low inspiration gas temperature was noted in patients in group B, initially (27.2 +/- 2.5 degrees C) and after 2 days (28.0 +/- 1.6 degrees C) (P < 0.05). The percentage of relative humidity of the inspiration gas in patients in group B was also initially significantly low (69.8 +/- 4.1%; P < 0.05) but rose to an average of 98 +/- 2.8% after 2 h. The average percentage across all four groups amounted to 98 +/- 0.4% after 2 h. Inflammation of the tracheal mucosa was found in patients in group B and the mucosal injury score (MIS) was significantly higher than in all the other groups. Patients in groups A, C and D showed no severe evidence of airway damage, exhibiting adequate values of relative humidity and temperature of the inspired gas. CONCLUSION: The problems of humidification associated with jet ventilation can be fully prevented by using this new jet-ventilator. These data were sustained by nondeteriorating MIS values at the end of the 4-day study period in groups A, C and D.*

*PMID: 11056732 [PubMed - as supplied by publisher]*

Am Surg. 2002 Oct;68(10):852-6; discussion 856.

[Related Articles, Links](#)

### *High-frequency percussive ventilation as a salvage modality in adult respiratory distress syndrome: a preliminary study.*

*Paulsen SM, Killyon GW, Barillo DJ.*

*Adult Burn Center, Department of Surgery, Medical University of South Carolina, Charleston 29425, USA.*

*Despite multiple advances in critical care patients with severe adult respiratory distress syndrome (ARDS) can exhaust the capability of conventional ventilation; this results in respiratory failure and death. High-frequency percussive ventilation (HFPPV), which was initially utilized for salvage of burn patients with smoke inhalation injury refractory to conventional ventilation, has evolved as a standard of burn care. Based on our experience with HFPPV in burn patients the burn team*

was consulted to provide salvage ventilation for non-burn surgical intensive care unit patients with refractory respiratory failure. Over a 14-month period ten patients with refractory ARDS from multiple causes were treated. Retrospective chart review was performed. Respiratory parameters were assessed before and 24 hours after initiation of HFPV. Mean values of fraction of inspired oxygen (FiO<sub>2</sub>), pH, partial pressure of O<sub>2</sub> in arterial blood (PaO<sub>2</sub>), partial pressure of CO<sub>2</sub> in arterial blood (PaCO<sub>2</sub>), HCO<sub>3</sub>, oxygen saturation in arterial blood (SaO<sub>2</sub>), PaO<sub>2</sub>/FiO<sub>2</sub>, and peak inspiratory pressure were compared. Significant improvement in oxygenation was reflected by increases in SaO<sub>2</sub>, PaO<sub>2</sub>, and the PaO<sub>2</sub>/FiO<sub>2</sub> ratio in the first 24 hours of HFPV. No significant increase in peak inspiratory pressure was documented by conversion from conventional ventilation to HFPV. No hemodynamic changes directly associated with HFPV were noted. Seven of ten patients failing conventional ventilation survived to hospital discharge after salvage therapy with HFPV. We advocate further studies of HFPV in non-burn patients with ARDS both as salvage therapy and as replacement for conventional ventilation for the initial treatment for ARDS.

PMID: 12412709 [PubMed - indexed for MEDLINE]

Burns. 2003 Sep;29(6):603-8.

[Related Articles, Links](#)



### ***High frequency percussive ventilation in burn patients: hemodynamics and gas exchange.***

***Reper P, Van Bos R, Van Loey K, Van Laeke P, Vanderkelen A.***

Critical Care Department, Queen Astrid Military Hospital, Bruinstreet, 1, 1120 B-, Brussels, Belgium. reper@smd.be

High frequency percussive ventilation (HFPV) is a recent ventilatory mode, which combines conventional cycles with high frequency percussions. HFPV was initially instituted as salvage therapy after acute respiratory failure following smoke inhalation injury achieving in each case a dramatic improvement of blood oxygenation, PaCO<sub>2</sub> and ventilatory pressures. This study investigates the influence of HFPV on hemodynamics, blood oxygenation and ventilatory parameters in eight stable ICU burn patients requiring artificial ventilatory support during a postoperative period following traumatic injury. Periods of 2h were analysed receiving conventional ventilation and HFPV with a high frequency of 400 and 800 cycles/min. Hemodynamic data were not significantly modified; peak inspiratory pressure was significantly lower under HFPV but mean airway pressure was unchanged. Blood oxygenation and CO<sub>2</sub> elimination were significantly improved under HFPV. No side effects were noted. These observations suggest that HFPV could improve pulmonary gas exchanges under lower peak pressures and without hemodynamic compromise. HFPV could represent an interesting alternative open lung strategy method to improve alveolar recruitment.

PMID: 12927989 [PubMed - indexed for MEDLINE]

*High frequency percussive ventilation (HFPV). Principles and technique.*

*[Article in English, Italian]*

[Lucangelo U](#), [Fontanesi L](#), [Antonaglia V](#), [Pellis T](#), [Berlot G](#), [Liguori G](#), [Bird FM](#), [Gullo A](#).

*Unit of Anesthesia and Resuscitation Department of, Perioperative Medicine Intensive Therapy and Emergency, University of Trieste, Trieste, Italy. u.lucangelo@fmc.units.it*

*In recent years, the usefulness of high frequency ventilation (HFV) has been clinically reassessed as an alternative to conventional mechanical ventilation (CMV). HFV has often been combined with or in some cases even completely replaced CMV in the attempt to reduce iatrogenic injury. High frequency percussive ventilation (HFPV) is a specific mode of HFV that has been successfully applied in the treatment of acute respiratory failure after smoke inhalation; it has also been more widely used in pediatric than in adult patients. This article gives an introduction to and a description of the basic principles of HFPV, a mode of ventilation which we found particularly versatile and reliable in our preliminary clinical experience with the maneuver.*

*Publication Types:*

- [Review](#)
- [Review, Tutorial](#)

PMID: 14735024 [[PubMed](#) - indexed for [MEDLINE](#)]



***High-frequency percussive ventilation: an alternative mode of ventilation for head-injured patients with adult respiratory distress syndrome.***

***Salim A, Miller K, Dangleben D, Cipolle M, Pasquale M.***

*Department of Surgery, Division of Trauma and Critical Care, University of Southern California Keck School of Medicine and the Los Angeles County-University of Southern California Medical Center, USA. asalim@surgery.usc.edu*

*BACKGROUND: Adult respiratory distress syndrome develops in up to 20% of patients with severe head injury. This complicates the treatment of head-injured patients because lung-protective strategies such as high positive end-expiratory pressure (PEEP) and permissive hypercapnia may increase intracranial pressure (ICP) and reduce cerebral perfusion pressure. The use of high-frequency percussive ventilation (HFPV) is an alternate mode of ventilation that may improve oxygenation for head-injured patients while also lowering ICP. METHODS: Clinical data were collected retrospectively over a 1-year period. Patients were included if they had a severe traumatic brain injury with a Glasgow Coma Score (GCS) of 8 or lower, a ventriculostomy drain for ICP measurement and cerebral spinal fluid drainage, and adult respiratory distress syndrome. Patients were switched from conventional mechanical ventilation to HFPV at the discretion of the attending trauma surgeon. Data for partial pressure of oxygen to fraction of inspired oxygen (PF) ratio, peak inspiratory pressure (PIP), ICP, partial pressure of carbon dioxide level (PCO<sub>2</sub>), PEEP, and mean airway pressure were compared before and then 4 and 16 hours after institution of HFPV therapy. RESULTS: A total of 10 patients met study criteria. Data were expressed as mean +/- standard error. There was an increase in PF ratio (91.8 +/- 13.2 vs. 269.7 +/- 34.6;  $p < 0.01$ ), PEEP (14 +/- 2.5 vs. 16 +/- 3.5), and mean airway pressure (20.4 +/- 4.8 vs. 23.6 +/- 6.8) 16 hours after institution of HFPV. There was a decrease in ICP (30.9 +/- 3.4 vs. 17.4 +/- 1.7;  $p < 0.01$ ), PCO<sub>2</sub> (37.7 +/- 4.1 vs. 32.7 +/- 1.1;  $p < 0.05$ ), and PIP (49.4 +/- 10 vs. 41 +/- 7.9;  $p < 0.05$ ) at 16 hours. Overall mortality was 10%. CONCLUSIONS: Therapy with HFPV produced a significant improvement in oxygenation with a concomitant reduction in ICP during the first 16 hours. This therapy may represent an important new method for the management of adult respiratory distress syndrome among head-injured trauma patients, although the long-term outcome of HFPV still needs evaluation.*

*PMID: 15454800 [PubMed - indexed for MEDLINE]*



*Effects of mechanical load on flow, volume and pressure delivered by high-frequency percussive ventilation.*

[Lucangelo U](#), [Antonaglia V](#), [Zin WA](#), [Fontanesi L](#), [Peratoner A](#), [Bird FM](#), [Gullo A](#).

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*High-frequency percussive ventilation (HFPPV) has proved its unique efficacy in the treatment of acute respiratory distress, when conventional mechanical ventilation (CMV) has demonstrated a limited response. We analysed flow ( $\dot{V}$ ), volume ( $V$ ) and airway pressure ( $P_{aw}$ ) during ventilation of a single-compartment mechanical lung simulator, in which resistance ( $R$ ) and elastance ( $E$ ) values were modified, while maintaining the selected ventilatory settings of the HFPPV device. These signals reveal the physical effect of the imposed loads on the output of the ventilatory device, secondary to constant (millisecond by millisecond) alterations in pulmonary dynamics.  $\dot{V}$ ,  $V$  and  $P_{aw}$  values depended fundamentally on the value of  $R$ , but their shapes were modified by  $R$  and  $E$ . Although peak  $P_{aw}$  increased 70.3% in relation to control value, mean  $P_{aw}$  augmented solely 36.5% under the same circumstances (maximum of 9.4 cm H<sub>2</sub>O). Finally, a mechanism for washing gas out of the lung was suggested.*

*PMID: 15351306 [PubMed - indexed for MEDLINE]*

**Comparison of intrapulmonary percussive ventilation and chest physiotherapy. A pilot study in patients with cystic fibrosis.**

[Natale JE](#), [Pfeifle J](#), [Homnick DN](#).

College of Human Medicine, Michigan State University, East Lansing.

**STUDY OBJECTIVE:** To compare the intrapulmonary percussive ventilator (IPV) to chest physiotherapy (P&PD) with respect to acute changes in (1) pulmonary function and (2) sputum physical properties in patients with cystic fibrosis (CF). **DESIGN:** Randomized crossover. **SETTING:** Community-based CF referral center. **PARTICIPANTS:** Nine nonhospitalized person (range, 7 to 40 years; median, 12.4 years) with moderate to excellent Shwachman scores. **INTERVENTIONS:** Three treatment regimens: (1) 2.5 mg albuterol delivered via IPV (internal percussive component activated); (2) 2.5 mg. albuterol delivered via IPV (internal percussive component inactivated), followed by P&PD; and (3) 2.5 mg albuterol delivered via updraft nebulizer, followed by P&PD. **MEASUREMENTS AND RESULTS:** Outcome measures included pulmonary function testing (PFTs) and quantitative and qualitative sputum analysis. Among the three treatment groups, there were no significant differences in the change in predicted PFTs 1 h or 4 h after treatment, nor in the volume of sputum expectorated in the first 4 or in the subsequent 20 h. Among patients receiving IPV, more serious disease was associated with greater improvement

in FEF25-75 1 h after treatment, but these differences disappeared by 4 h. There were no meaningful differences in viscoelastic characteristics of sputum expectorated after each treatments. Participants reported general satisfaction with no adverse effects while using IPV. CONCLUSIONS: This initial pilot study suggests (1) stable patients with CF tolerated one treatment of IPV without adverse sequelae, and (2) IPV was as effective as standard aerosol and P&PD in improving short-term PFT results and enhancing sputum expectoration.

Publication Types:

- [Clinical Trial](#)
- [Randomized Controlled Trial](#)

PMID: 8205878 [PubMed - indexed for MEDLINE]

Pediatr Pulmonol. 1996 Apr;21(4):246-9.

[Related Articles, Links](#)

***Persistent pulmonary consolidation treated with intrapulmonary percussive ventilation: a preliminary report.***

***Birnkrant DJ, Pope JF, Lewarski J, Stegmaier J, Besunder JB.***

*MetroHealth Medical Center and Department of Pediatrics, Case Western Reserve University, School of Medicine, Cleveland, Ohio, USA.*

*Intrapulmonary percussive ventilation (IPV) is a novel form of chest physiotherapy delivered by a percussive pneumatic device (IPV, Percussionaire, Sand Point, ID). There are few published reports about the use of IPV for diseases other than cystic fibrosis. We report our experience with three pediatric patients and one adult patient with persistent pulmonary consolidation refractory to conventional therapies. Three of the four patients had neuromuscular disease; one patient had segmental atelectasis due to aspiration. Three of the four patients showed clinical and radiographic improvement within 48 hours of starting IPV. The fourth patient experienced brief episodes of third-degree atrioventricular block, hypoxemia, and bradycardia during two IPV treatments. IPV was safely restarted and he slowly improved. We conclude that while IPV requires further clinical evaluation, it appears to be a safe and effective therapy for selected patients. However, close observation is essential during and after IPV treatments, especially in patients who have difficulty mobilizing or expectorating sputum.*

Publication Types:

- [Case Reports](#)

PMID: 9121855 [PubMed - indexed for MEDLINE]

***Persistent pulmonary consolidation treated with intrapulmonary percussive ventilation: a preliminary report.***

***Birnkrant DJ, Pope JF, Lewarski J, Stegmaier J, Besunder JB.***

*MetroHealth Medical Center and Department of Pediatrics, Case Western Reserve University, School of Medicine, Cleveland, Ohio, USA.*

*Intrapulmonary percussive ventilation (IPV) is a novel form of chest physiotherapy delivered by a percussive pneumatic device (IPV, Percussionaire, Sand Point, ID). There are few published reports about the use of IPV for diseases other than cystic fibrosis. We report our experience with three pediatric patients and one adult patient with persistent pulmonary consolidation refractory to conventional therapies. Three of the four patients had neuromuscular disease; one patient had segmental atelectasis due to aspiration. Three of the four patients showed clinical and radiographic improvement within 48 hours of starting IPV. The fourth patient experienced brief episodes of third-degree atrioventricular block, hypoxemia, and bradycardia during two IPV treatments. IPV was safely restarted and he slowly improved. We conclude that while IPV requires further clinical evaluation, it appears to be a safe and effective therapy for selected patients. However, close observation is essential during and after IPV treatments, especially in patients who have difficulty mobilizing or expectorating sputum.*

*Publication Types:*

- *Case Reports*

*PMID: 9121855 [PubMed - indexed for MEDLINE]*

*Smoke inhalation is a multilevel insult to the pulmonary system.*

*Lentz CW, Peterson HD.*

*North Carolina Jayca Burn Center, University of North Carolina Hospitals, Chapel Hill 27514, USA.*

*Inhalation injury represents an ongoing threat to patients with thermal injury. The magnitude of the disease severity is related to the multilevel insult to the pulmonary system. Asphyxiants present in inhaled smoke can compromise oxygen delivery, resulting in cell death. Also, early changes in the microcirculation of the lung parenchyma, related to polymorphonuclear cell activation and oxygen free radical production, are responsible for early pulmonary edema. Perhaps the most significant pathologic change caused by smoke inhalation is loss of the respiratory epithelium and the formation of tracheobronchial casts. The recent application of high-frequency flow interruption ventilation and intrapulmonary percussive ventilation has made the largest impact on improved survival in patients suffering from smoke inhalation.*

*Publication Types:*

- *Review*
- *Review, Tutorial*

*PMID: 9232369 [PubMed - indexed for MEDLINE]*

*Noninvasive clearance of airway secretions.*

*Hardy KA, Anderson BD.*

*Pediatric Pulmonary and Cystic Fibrosis Center, California Pacific Medical Center, San Francisco, USA.*

*Airway clearance techniques are indicated for specific diseases that have known clearance abnormalities (Table 2). Murray and others have commented that such techniques are required only for patients with a daily sputum production of greater than 30 mL. The authors have observed that patients with diseases known to cause clearance abnormalities can have sputum clearance with some techniques, such as positive expiratory pressure, autogenic drainage, and active cycle of breathing techniques, when PDPV has not been effective. Hasani et al has shown that use of the forced exhalatory technique in patients with nonproductive cough still resulted in movement of secretions proximally from all regions of the lung in patients with airway obstruction. It is therefore reasonable to consider airway clearance techniques for any patient who has a disease known to alter mucous clearance, including CF, dyskinetic cilia syndromes, and bronchiectasis from any cause. Patients with atelectasis from mucous plugs and hypersecretory states, such as asthma and chronic bronchitis, patients with pain secondary to surgical procedures, and patients with neuromuscular disease, weak cough, and abnormal patency of the airway may also benefit from the application of airway clearance techniques. Infants and children up to 3 years of age with airway*

clearance problems need to be treated with PDPV. Manual percussion with hands alone or a flexible face mask or cup and small mechanical vibrator/percussors, such as the ultrasonic devices, can be used. The intrapulmonary percussive ventilator shows growing promise in this area. The high-frequency oscillator is not supplied with vests of appropriate sizes for tiny babies and has not been studied in this group. Young patients with neuromuscular disease may require assisted ventilation and airway oscillations can be applied. CPAP alone has been shown to improve achievable flow rates that will increase air-liquid interactions for patients with these diseases or airway malacia. Use of positive pressure to maintain airway patency in these children allows cephalad clearance of secretions. Patients with segmental atelectasis, particularly related to asthma, may benefit from intrapulmonary percussive ventilator, positive expiratory pressure, or PDPV. Prevention of postoperative atelectasis is particularly well suited to positive expiratory pressure, which is not as painful as techniques using oscillations. Neurologically abnormal patients who are unable to cooperate with any active method are also treated using intrapulmonary percussive ventilator, PDPV, and suctioning, if necessary. Musculoskeletal abnormalities, muscular dystrophies, myasthenia gravis, poliomyelitis, or other similar diseases require stabilization of bellows function. Optimizing ventilation in patients with such abnormalities may require positive pressure ventilation either during sleep or continuously. Externally applied pressure, such as with the In-Exsufflator or the cyclically inflated pneumatic belt, can augment the patient's own efforts and is sometimes helpful. Normalizing the vital capacity and functional residual capacity typically helps to improve the ability to cough and clear secretions. Assisted cough devices or maneuvers are described in other papers by Bach and Hill. Not all patients who have weak muscles require nocturnal or continuous support, and may benefit from positive expiratory pressure mask treatments. Further studies are sorely needed for this population. Long-term controlled trials are urgently needed to help establish the best types of treatment for patients with CF and bronchiectasis. Such studies will become more complicated by the introduction of new treatments, such as DNase and other therapies that alter secretions, and may begin to change mucociliary or cough clearance. The selection of appropriate outcome measures is central to studying these questions, and it is unclear which are the most important. (ABSTRACT TRUNCATED)

Publication Types:

- [Review](#)
- [Review, Tutorial](#)

Respirology. 1998 Dec;3(4):235-40.

[Related Articles, Links](#)

***Benefit of in-phase chest wall vibration on the pulmonary hemodynamics in patients with chronic obstructive pulmonary disease.***

***Nakayama H, Shibuya M, Kaneko N, Yamada M, Suzuki H, Arakawa M, Homma I.***

*Second Department of Physiology, Showa University School of Medicine, Tokyo, Japan.*

**OBJECTIVE:** Chest wall vibration of contracting intercostal muscles (in-phase vibration, (IPV)) improves O<sub>2</sub> saturation in patients with chronic obstructive pulmonary disease (COPD). The purpose of this study was to investigate the effect of IPV on the pulmonary hemodynamics in patients with COPD. **METHODOLOGY:** Twelve patients with COPD (FEV<sub>1</sub>%, 43.7 +/- 14.4%) underwent pulmonary artery catheterization in the supine position; hemodynamic variables as well

as arterial and mixed venous gas tension were measured at baseline and after 15 min of IPV with IPV continued during the measurement. **RESULTS:** Mean pulmonary arterial pressure ( $P_{pa}$ , 21.3 +/- 5.0-19.1 +/- 4.8 mmHg and pulmonary vascular resistance ( $PVR$ , 294.6 +/- 196.0-228.5 +/- 101.7 dyne.sec.cm-5) decreased significantly, but there was no change in heart rate, cardiac index or systemic blood pressure.  $PaO_2$  increased (66.5 +/- 10.3-70.0 +/- 9.7 Torr) and  $PaCO_2$  decreased (46.6 +/- 8.9-45.0 +/- 10.1 Torr) significantly. Minute ventilation and tidal volume increased significantly in five out of the eight patients in whom ventilation was monitored throughout the study. **CONCLUSION:** IPV improves gas exchange and pulmonary circulation without affecting systemic circulation.

PMID: 10201049 [PubMed - indexed for MEDLINE]

1: Respir Care. 2002 Oct;47(10):1162-7.

[Related Articles, Links](#)

***A comparison of intrapulmonary percussive ventilation and conventional chest physiotherapy for the treatment of atelectasis in the pediatric patient.***

***Deakins K, Chatburn RL.***

*Department of Respiratory Care, University Hospitals of Cleveland, 11100 Euclid Avenue, Cleveland, OH 44106, USA.*

**OBJECTIVE:** Compare intrapulmonary percussive ventilation (IPV) to conventional chest physiotherapy (CPT) and determine their effects on improving atelectasis and static compliance in pediatric patients. **METHODS:** We conducted a retrospective study of 46 patients who received IPV therapy with the Percussionator IPV-1 ventilator at frequencies of 180-220 cycles/min and pressures of 15-30 cm H<sub>2</sub>O. Medicated aerosol therapy with albuterol 2.5 mg in 6 mL normal saline solution was delivered with each IPV treatment. Baseline and subsequent chest radiographs were evaluated by a pediatric radiologist. We used an ordinal scoring system to measure the degree of atelectasis to evaluate chest radiographs (4 = complete collapse, 0 = complete resolution). Then we conducted a prospective, randomized, controlled study of intubated and mechanically ventilated patients to compare changes in atelectasis and static compliance. Baseline and daily chest radiographs were evaluated using the same scoring system as in the retrospective pilot evaluation. Patients were ventilated in the volume-controlled, synchronized intermittent mandatory ventilation mode, with tidal volumes of 6-10 mL/kg. Patients were randomized to CPT (clapping and vibration) or IPV at frequencies of 180-220 cycles/min and pressures of 15-30 cm H<sub>2</sub>O (equal to the peak pressures on the ventilator), with 6 mL of normal saline solution via medicated aerosol. Both treatments were given every 4 h and lasted 10-15 min. Static compliance measurements were

calculated from exhaled tidal volumes and plateau pressures. **RESULTS:** In the retrospective study the median age of patients receiving IPV was 4.2 years and the median duration of IPV was 6.2 days. A change in atelectasis score from 3 to 1 ( $p < 0.001$ ) was seen. In the randomized, controlled trial the median age of patients was 3.1 years. Atelectasis scores before treatment were comparable between the CPT and IPV groups (median 2.0 for both groups,  $p = 0.530$ ). Atelectasis scores after treatment were unchanged in the CPT group (median 2.0,  $p = 0.421$ ) but improved in the IPV group (median 1.0,  $p = 0.026$ ). Treatment lasted an average of 6.2 days in the CPT group and 2.1 days in the IPV group ( $p = 0.018$ ). Neither group showed any change in static compliance following treatment. **CONCLUSIONS:** In the retrospective study a clinically important improvement in atelectasis was seen in patients who received IPV therapy. In the controlled, clinical trial the IPV group showed more clinically important improvement in atelectasis than the CPT group. IPV is a safe and effective method of alternative airway clearance and can be used on patients with artificial airways.

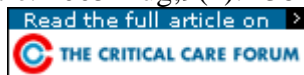
Publication Types:

- [Clinical Trial](#)
- [Randomized Controlled Trial](#)

PMID: 12354335 [PubMed - indexed for MEDLINE]

Crit Care. 2005 Aug;9(4):R382-9. Epub 2005 Jun 1.

[Related Articles, Links](#)



***Intrapulmonary percussive ventilation in acute exacerbations of COPD patients with mild respiratory acidosis: a randomized controlled trial [ISRCTN17802078].***

***Vargas F, Bui HN, Boyer A, Salmi LR, Gbikpi-Benissan G, Guenard H, Gruson D, Hilbert G.***

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**INTRODUCTION:** We hypothesized that the use of intrapulmonary percussive ventilation (IPV), a technique designed to improve mucus clearance, could prove effective in avoiding further deterioration in patients with acute exacerbations of chronic obstructive pulmonary disease (COPD) with mild respiratory acidosis. **METHODS:** The study was performed in a medical intensive care unit of a university hospital. Thirty-three patients with exacerbations of COPD with a respiratory frequency  $\geq 25$ /min, a  $\text{PaCO}_2 > 45$  Torr and  $7.35 \leq \text{pH} \leq 7.38$  were included in the study. Patients were randomly assigned to receive either standard treatment (control group) or standard treatment plus IPV (IPV group). The IPV group underwent two daily sessions of 30 minutes performed by a chest physiotherapist through a full face mask. The therapy was considered successful when both worsening of the exacerbation and a decrease in pH to under 7.35, which would have required non-invasive ventilation, were avoided. **RESULTS:** Thirty minutes of IPV led to a significant decrease in respiratory rate, an increase in  $\text{PaO}_2$  and a decrease in  $\text{PaCO}_2$  ( $p < 0.05$ ). Exacerbation worsened in 6 out of 17 patients in the control group versus 0 out of 16 in the IPV group ( $p < 0.05$ ). The hospital stay was significantly shorter in the IPV group

than in the control group (6.8 +/- 1.0 vs. 7.9 +/- 1.3 days,  $p < 0.05$ ). **CONCLUSION:** IPV is a safe technique and may prevent further deterioration in patients with acute exacerbations of COPD with mild respiratory acidosis.

PMID: 16137351 [PubMed - in process]

Respir Physiol Neurobiol. 2002 Jun;130(3):305-16.

[Related Articles](#), [Links](#)



***Effect of chest wall vibration on dyspnea during exercise in chronic obstructive pulmonary disease.***

***Fujie T, Tojo N, Inase N, Nara N, Homma I, Yoshizawa Y.***

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*To elucidate the effect of in-phase chest wall vibration (IPV) during exercise, 17 COPD male patients performed two constant-load exercise tests on a cycle ergometer with and without IPV. The Borg dyspnea score significantly decreased from IPV (-) to IPV (+) (from 13.6+/-2.9 to 12.5+/-2.9,  $P < 0.01$ ). IPV elicited a significant increase in  $\dot{V}(O_2)$  ( $P < 0.005$ ) and significant decreases in both  $\dot{V}E/\dot{V}(O_2)$  ( $P < 0.05$ ) and respiratory frequency ( $P < 0.05$ ), but it did not elicit any changes in  $\dot{V}E$ . The change in Borg score between IPV (+) and IPV (-) showed a significant positive correlation with % predicted  $\dot{V}(O_2, \max)$  ( $r = 0.71$ ) and  $FEV_1/FVC$  ( $r = 0.69$ ). Patients in the responsive group ( $n = 11$ ) showed significantly lower  $FEV_1$  ( $P < 0.05$ ) and higher  $\Delta N(2)/L$  ( $P < 0.01$ ) than patients in the non-responsive group ( $n = 6$ ). We conclude that IPV reduces dyspnea and improves respiratory efficiency during aerobic exercise in severe COPD.*

PMID: 12093627 [PubMed - indexed for MEDLINE]

Respir Care. 2002 Oct;47(10):1162-7.

[Related Articles](#), [Links](#)

***A comparison of intrapulmonary percussive ventilation and conventional chest physiotherapy for the treatment of atelectasis in the pediatric patient.***

***Deakins K, Chatburn RL.***

*Department of Respiratory Care, University Hospitals of Cleveland, 11100 Euclid Avenue, Cleveland, OH 44106, USA.*

**OBJECTIVE:** Compare intrapulmonary percussive ventilation (IPV) to conventional chest physiotherapy (CPT) and determine their effects on improving atelectasis and static compliance in pediatric patients. **METHODS:** We conducted a retrospective study of 46 patients who received IPV therapy with the Percussionator IPV-1 ventilator at frequencies of 180-220 cycles/min and pressures of 15-30 cm H<sub>2</sub>O. Medicated aerosol therapy with albuterol 2.5 mg in 6 mL normal saline solution was delivered with each IPV treatment. Baseline and subsequent chest radiographs

were evaluated by a pediatric radiologist. We used an ordinal scoring system to measure the degree of atelectasis to evaluate chest radiographs (4 = complete collapse, 0 = complete resolution). Then we conducted a prospective, randomized, controlled study of intubated and mechanically ventilated patients to compare changes in atelectasis and static compliance. Baseline and daily chest radiographs were evaluated using the same scoring system as in the retrospective pilot evaluation. Patients were ventilated in the volume-controlled, synchronized intermittent mandatory ventilation mode, with tidal volumes of 6-10 mL/kg. Patients were randomized to CPT (clapping and vibration) or IPV at frequencies of 180-220 cycles/min and pressures of 15-30 cm H<sub>2</sub>O (equal to the peak pressures on the ventilator), with 6 mL of normal saline solution via medicated aerosol. Both treatments were given every 4 h and lasted 10-15 min. Static compliance measurements were calculated from exhaled tidal volumes and plateau pressures. **RESULTS:** In the retrospective study the median age of patients receiving IPV was 4.2 years and the median duration of IPV was 6.2 days. A change in atelectasis score from 3 to 1 ( $p < 0.001$ ) was seen. In the randomized, controlled trial the median age of patients was 3.1 years. Atelectasis scores before treatment were comparable between the CPT and IPV groups (median 2.0 for both groups,  $p = 0.530$ ). Atelectasis scores after treatment were unchanged in the CPT group (median 2.0,  $p = 0.421$ ) but improved in the IPV group (median 1.0,  $p = 0.026$ ). Treatment lasted an average of 6.2 days in the CPT group and 2.1 days in the IPV group ( $p = 0.018$ ). Neither group showed any change in static compliance following treatment. **CONCLUSIONS:** In the retrospective study a clinically important improvement in atelectasis was seen in patients who received IPV therapy. In the controlled, clinical trial the IPV group showed more clinically important improvement in atelectasis than the CPT group. IPV is a safe and effective method of alternative airway clearance and can be used on patients with artificial airways.

*Publication Types:*

- [Clinical Trial](#)
- [Randomized Controlled Trial](#)

PMID: 12354335 [PubMed - indexed for MEDLINE]

: Soin De Respir. 2003 Jan;48(1):24-8.

[Articles Relatifs, Liens](#)

*Commentaire dans :*

- [Soin De Respir. 2003 Jan;48\(1\):20-1.](#)



*Une comparaison de l'efficacité de et la préférence thérapeutique pour le drainage et la percussion posturales, la ventilation par percussion intrapulmonaire, et la compression à haute fréquence de mur de coffre dans les patients hospitalisés de fibrose kystique.*

*[SM De Varekojis](#), [Douce FH](#), [Flucke RL](#), [Filbrun DA](#), [Tice JS](#), [McCoy KS](#), [Castille RG](#).*

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**INTRODUCTION :** Les patients de fibrose cystique (CF) ont des sécrétions bronchiques anormalement visqueuses qui causent l'obstruction des voies respiratoires, inflammation, et l'infection cela mène aux dommages de poumon. Pour augmenter le dégagement de voie aérienne et réduire l'obstruction des voies respiratoires, la thérapie bronchopulmonaire quotidienne d'hygiène est considérée comme essentielle. **OBJECTIF :** Comparez l'efficacité de et les préférences patientes concernant 3 méthodes de dégagement de voie aérienne : drainage et percussion posturale (PDL), ventilation par percussion intrapulmonary (IPV), et compression à haute fréquence de mur de coffre (HFCWC). **MÉTHODES :** Les participants étaient les patients hospitalisés de CF > ou = 12 ans de . L'efficacité a été évaluée en mesurant les poids secs-et-humides de crachat obtenus avec chaque méthode. Dans l'ordre aléatoire, chaque patient a reçu 2 jours consécutifs de chaque thérapie, journal livré de 3 fois pendant 30 minutes. Le crachat a été rassemblé pendant et pendant 15 minutes après chaque traitement, humide pesé, puis séché et encore pesé. Les participants ont évalué leurs préférences en utilisant un Likert-type balance. Des poids et les préférences moyens ont été comparés en utilisant l'analyse de la variance aux mesures répétées. Des préférences patientes ont été comparées en utilisant l'essai de Freidman. **RÉSULTATS :** Vingt-quatre patients ont été étudiés. Les moyens +/- les poids humides de crachat d'écart-type étaient 5.53 +/- 5.69 g avec PDL, 6.84 +/- 5.41 g avec IPV, et 4.77 +/- 3.29 g avec HFCWC. Les poids humides moyens de crachat ont différencié de manière significative ( $p = 0.035$ ). Les poids humides de crachat d'IPV étaient sensiblement plus grands que ceux de HFCWC ( $p < 0.05$ ). Les poids secs moyens de crachat n'étaient pas sensiblement différents. En ce qui concerne la préférence globale et aux sous-composants de la préférence, aucune des 3 méthodes n'a été préférée au-dessus des autres. **CONCLUSIONS :** HFCWC et IPV sont au moins aussi efficaces que PDL vigoureux et professionnellement administrés pour les patients hospitalisés de CF, et les 3 modalités semblaient également acceptables à eux. Un patient hospitalisé de CF devrait essayer chaque thérapie et choisir sa modalité préférée.

Types De Publication :

- [Épreuve Clinique](#)
- [Épreuve Commandée Randomisée](#)

PMID : 12556258 [ PubMed - classé pour MEDLINE ]

Respir Care. 2003 Jan;48(1):24-8.

[Related Articles, Links](#)

Comment in:

- [Respir Care. 2003 Jan;48\(1\):20-1.](#)



*A comparison of the therapeutic effectiveness of and preference for postural drainage and percussion, intrapulmonary percussive ventilation, and high-frequency chest wall compression in hospitalized cystic fibrosis patients.*

Varekojis SM, Douce FH, Flucke RL, Filbrun DA, Tice JS, McCoy KS, Castile RG.

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**INTRODUCTION:** Cystic fibrosis (CF) patients have abnormally viscid bronchial secretions that cause airway obstruction, inflammation, and infection that leads to lung damage. To enhance airway clearance and reduce airway obstruction, daily bronchopulmonary hygiene therapy is considered essential. **OBJECTIVE:** Compare the effectiveness of and patient preferences regarding 3 airway clearance methods: postural drainage and percussion (PDELP), intrapulmonary percussive ventilation (IPV), and high-frequency chest wall compression (HFCWC). **METHODS:** The participants were hospitalized CF patients  $\geq 12$  years old. Effectiveness was evaluated by measuring the wet and dry weights of sputum obtained with each method. In random order, each patient received 2 consecutive days of each therapy, delivered 3 times daily for 30 minutes. Sputum was collected during and for 15 minutes after each treatment, weighed wet, then dried and weighed again. Participants rated their preferences using a Likert-type scale. Mean weights and preferences were compared using analysis of variance with repeated measures. Patient preferences were compared using Friedman's test. **RESULTS:** Twenty-four patients were studied. The mean  $\pm$  SD wet sputum weights were 5.53  $\pm$  5.69 g with PDELP, 6.84  $\pm$  5.41 g with IPV, and 4.77  $\pm$  3.29 g with HFCWC. The mean wet sputum weights differed significantly ( $p = 0.035$ ). Wet sputum weights from IPV were significantly greater than those from HFCWC ( $p < 0.05$ ). The mean dry sputum weights were not significantly different. With regard to overall preference and to the subcomponents of preference, none of the 3 methods was preferred over the others. **CONCLUSIONS:** HFCWC and IPV are at least as effective as vigorous, professionally administered PDELP for hospitalized CF patients, and the 3 modalities were equally acceptable to them. A hospitalized CF patient should try each therapy and choose his or her preferred modality.

Publication Types:

- [Clinical Trial](#)
- [Randomized Controlled Trial](#)

PMID: 12556258 [PubMed - indexed for MEDLINE]

Soin De Respir. 2003 Oct;48(10):940-7.

[Articles Relatifs, Liens](#)



***Effet de ventilation par percussion intrapulmonary sur le dégagement de mucus dans les patients musculaires de dystrophie de duchenne : un rapport préliminaire.***

***Toussaint M, De Win H, Steens M, Soudon P.***

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**OBJECTIF :** Déterminer les effets de la ventilation par percussion intrapulmonary (IPV) sur le dégagement de mucus tracheostomized dedans les patients musculaires de dystrophie de Duchenne. **MÉTHODES :** Nous avons étudié 8 patients, 5 de qui a eu l'hypersécrétion de mucus ( $> 30$  mL/d). Dans randomisée, étude de pont nous avons comparé des techniques aidées de dégagement de mucus et sans à IPV. Il y avait 2 ordres de traitement et chaque patient a reçu 5 jours consécutifs de chaque ordre de traitement, fournis 3 fois par jour. Un ordre s'est composé (1) de la technique aidée de dégagement de mucus (AMCT, qui implique la technique expiratoire obligatoire et le manuel a aidé la toux), (2) suctioning endotrachéal, (3) administration de nébuliseur de 5 ml de 0.9% solution

de chlorure de sodium pendant 5 minutes, (4) une deuxième session d'AMCT, (5) suctioning endotrachéal, (6) 45 minutes après la fin du traitement de nébuliseur une troisième session d'AMCT, (7) suctioning endotrachéal. L'autre ordre de traitement était le même sauf qu'il a inclus IPV pendant le traitement du nébuliseur 5-minute. Les sécrétions rassemblées ont été pesées. La capacité essentielle a été mesurée par le passé, avant les traitements. La fréquence cardiaque, le taux respiratoire, la saturation d'oxyhemoglobine, l'anhydride carbonique extrémité-de marée, la résistance des voies respiratoires, et l'écoulement expiratoire maximal ont été mesurés avant et à 45 minutes après les traitements. Des valeurs moyennes ont été comparées en utilisant l'analyse de la variance aux mesures répétées. **RÉSULTATS** : Dans les patients présentant l'hypersécrétion le moyen +/- poids d'écart-type des sécrétions rassemblées était sensiblement plus haut avec IPV (6.53 +/- 4.77 g contre 4.57 +/- 3.50 g,  $p = 0.01$ ). La fréquence cardiaque, le taux respiratoire, la saturation d'oxyhemoglobine, l'anhydride carbonique extrémité-de marée, la résistance des voies respiratoires, et l'écoulement expiratoire maximal n'ont pas différé statistiquement entre les 2 traitements. **CONCLUSIONS** : IPV est une méthode sûre de dégagement de voie aérienne pour tracheostomized les patients musculaires de dystrophie de Duchenne, et cette étude préliminaire suggère qu'ipv augmente l'efficacité des techniques aidées de dégagement de mucus.

Types De Publication :

- [Épreuve Clinique](#)
- [Épreuve Commandée Randomisée](#)

PMID : 14525630 [ PubMed - classé pour MEDLINE ]

Arch Pediatr Adolesc Med. 2005 Jun;159(6):526-31.

[Related Articles, Links](#)



***Intrapulmonary percussive ventilation vs incentive spirometry for children with neuromuscular disease.***

***Reardon CC, Christiansen D, Barnett ED, Cabral HJ.***

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**BACKGROUND:** Pulmonary infections can be life threatening for children with neuromuscular diseases who have impaired ability to clear secretions. Intrapulmonary percussive ventilation (IPV) is a pneumatic device that delivers air and aerosol to the lungs at frequencies of 200 to 300 cycles per minute at peak pressures from 20 to 40 cm H<sub>2</sub>O. Anecdotal reports and pilot studies show its safety and effectiveness in mobilizing secretions in patients with cystic fibrosis. **OBJECTIVE:** To test the hypothesis that IPV used in a pulmonary program for adolescents with neuromuscular disease would reduce the number of days of antibiotic use for pulmonary infection. **METHODS:** A randomized, controlled study was conducted to compare efficacy of IPV with incentive spirometry (IS) in reducing number of days of antibiotic use in adolescents with neuromuscular disease. The secondary endpoints were the number of respiratory infections, hospitalizations, and school days missed. **RESULTS:** A total of 18 patients were enrolled (9 IPV, 9 IS). Antibiotic use was significantly higher with IS (24/1000 patient-days) compared with IPV (0/1000 patient-days), (incidence rate ratio, 43; 95% confidence interval, 6-333). The IS group spent more days hospitalized (4.4/1000 patient-days vs 0/1000 patient-days) than the IPV group (incidence rate

ratio, 8.5; 95% confidence interval, 1.1-67). The IPV group had 0 episodes of pneumonia or bacterial bronchitis compared with 3 events in the IS group, although this did not meet statistical significance. **CONCLUSION:** Intrapulmonary percussive ventilation as part of a preventive pulmonary regimen reduced days of antibiotic use and hospitalization for respiratory illness in adolescents with neuromuscular disease.

*Publication Types:*

- [Clinical Trial](#)
- [Randomized Controlled Trial](#)

**[PMID: Wada N, Murayama K, Kaneko T, Kitazumi E.](#)**

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An intrapulmonary percussive ventilator (IPV) improves airway clearance and lung function, and is useful for wide variety of respiratory disorders, such as cystic fibrosis, chronic obstructive pulmonary disease, aspiration pneumonia, and neuromuscular diseases. However, there are few reports on IPV use in patients with severe neurological impairment, scoliosis and thoracic deformity. They have poor mobility of the rib cage and difficulty in sputum expectoration. The use of IPV significantly improved persistent consolidation shown by chest computed tomography (CT) in one of such patients. The patient was a 33-year-old woman with severe spastic quadriplegia and tracheostomy and she was dependent on mechanical ventilation because of chronic restrictive respiratory failure. After fever and mild hypoxemia for one day, chest CT revealed consolidation of the left lower lobe. An IPV-I ventilator was used for 15 min once a week, with a stroke frequency of 250-300 cycles/min and pressure of 22 PSI. Mechanical ventilation was withheld during the IPV therapy. Chest physiotherapy was also done. According to the worsening of the consolidation on chest CT, the frequency of IPV was changed to once a day at day 23 and then to twice a day. Chest CT at day 44 showed further improvement. In patients with severe motor and intellectual disabilities, it is sometimes difficult to control progressive deterioration of pulmonary function and persistent atelectasis even with tracheostomy, mechanical ventilation, and conventional physiotherapy. Our results indicate that IPV may improve respiratory function and the quality of life in such patients.

Publication Types:

- [Case Reports](#)

PMID: 16026100 [PubMed - indexed for MEDLINE] DOI: 10.1186/1745-2975-9-159 [PubMed - indexed for MEDLINE]

: Crit Care. 2005 Aug;9(4):R382-9. Epub 2005 Jun 1.

[Related Articles, Links](#)



*Intrapulmonary percussive ventilation in acute exacerbations of COPD patients with*

*mild respiratory acidosis: a randomized controlled trial [ISRCTN17802078].*

*[Vargas F](#), [Bui HN](#), [Boyer A](#), [Salmi LR](#), [Gbikpi-Benissan G](#), [Guenard H](#), [Gruson D](#), [Hilbert G](#).*

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*INTRODUCTION: We hypothesized that the use of intrapulmonary percussive ventilation (IPV), a technique designed to improve mucus clearance, could prove effective in avoiding further deterioration in patients with acute exacerbations of chronic obstructive pulmonary disease (COPD) with mild respiratory acidosis. METHODS: The study was performed in a medical intensive care unit of a university hospital. Thirty-three patients with exacerbations of COPD with a respiratory frequency  $\geq 25$ /min, a PaCO<sub>2</sub> > 45 Torr and  $7.35 \leq \text{pH} \leq 7.38$  were included in the study. Patients were randomly assigned to receive either standard treatment (control group) or standard treatment plus IPV (IPV group). The IPV group underwent two daily sessions of 30 minutes performed by a chest physiotherapist through a full face mask. The therapy was considered successful when both worsening of the exacerbation and a decrease in pH to under 7.35, which would have required non-invasive ventilation, were avoided. RESULTS: Thirty minutes of IPV led to a significant decrease in respiratory rate, an increase in PaO<sub>2</sub> and a decrease in PaCO<sub>2</sub> ( $p < 0.05$ ). Exacerbation worsened in 6 out of 17 patients in the control group versus 0 out of 16 in the IPV group ( $p < 0.05$ ). The hospital stay was significantly shorter in the IPV group than in the control group (6.8 +/- 1.0 vs. 7.9 +/- 1.3 days,  $p < 0.05$ ). CONCLUSION: IPV is a safe technique and may prevent further deterioration in patients with acute exacerbations of COPD with mild respiratory acidosis.*

*PMID: 16137351 [PubMed - in process]*

1: Minerva Anesthesiol. 2003 Nov;69(11):841-8, 848-51.

[Related Articles, Links](#)

## **High frequency percussive ventilation (HFPV). Principles and technique.**

[Article in English, Italian]

[Lucangelo U](#), [Fontanesi L](#), [Antonaglia V](#), [Pellis T](#), [Berlot G](#), [Liguori G](#), [Bird FM](#), [Gullo A](#).

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In recent years, the usefulness of high frequency ventilation (HFV) has been clinically reassessed as an alternative to conventional mechanical ventilation (CMV). HFV has often been combined with or in some cases even completely replaced CMV in the attempt to reduce iatrogenic injury. High frequency percussive ventilation (HFPV) is a specific mode of HFV that has been successfully applied in the treatment of acute respiratory failure after smoke inhalation; it has also been more widely used in pediatric than in adult patients. This article gives an introduction to and a description of the basic principles of HFPV, a mode of ventilation which we found particularly versatile and reliable in our preliminary clinical experience with the maneuver.

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- [Review](#)
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PMID: 14735024 [PubMed - indexed for MEDLINE]



1: J Trauma. 2004 Sep;57(3):542-6.

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### **High-frequency percussive ventilation: an alternative mode of ventilation for head-injured patients with adult respiratory distress syndrome.**

[Salim A](#), [Miller K](#), [Dangleben D](#), [Cipolle M](#), [Pasquale M](#).

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**BACKGROUND:** Adult respiratory distress syndrome develops in up to 20% of patients with severe head injury. This complicates the treatment of head-injured patients because lung-protective strategies such as high positive end-expiratory pressure (PEEP) and permissive hypercapnia may increase intracranial pressure (ICP) and reduce cerebral perfusion pressure. The use of high-frequency percussive ventilation (HFPV) is an alternate mode of ventilation that may improve oxygenation for head-injured patients while also lowering ICP. **METHODS:** Clinical data were collected retrospectively over a 1-year period. Patients were included if they had a severe traumatic brain injury with a Glasgow Coma Score (GCS) of 8 or lower, a ventriculostomy drain for ICP measurement and cerebral spinal fluid drainage, and adult respiratory distress syndrome. Patients were switched from conventional mechanical ventilation to HFPV at the discretion of the attending trauma surgeon. Data for partial pressure of oxygen to fraction of inspired oxygen (PF) ratio, peak inspiratory pressure (PIP), ICP, partial pressure of carbon dioxide level (PCO<sub>2</sub>), PEEP, and mean airway pressure were compared before and then 4 and 16 hours after institution of HFPV therapy. **RESULTS:** A total of 10 patients met study criteria. Data were expressed as mean +/- standard error. There was an increase in PF ratio (91.8 +/- 13.2 vs. 269.7 +/- 34.6; p < 0.01), PEEP (14 +/- 2.5 vs. 16 +/- 3.5), and mean airway pressure (20.4 +/- 4.8 vs. 23.6 +/- 6.8) 16 hours after institution of HFPV. There was a decrease in ICP (30.9 +/- 3.4 vs. 17.4 +/- 1.7; p < 0.01), PCO<sub>2</sub> (37.7 +/- 4.1 vs. 32.7 +/- 1.1; p < 0.05), and PIP (49.4 +/- 10 vs. 41 +/- 7.9; p < 0.05) at 16 hours. Overall mortality was 10%. **CONCLUSIONS:** Therapy with HFPV produced a significant improvement in oxygenation with a concomitant reduction in ICP during the first 16 hours. This therapy may represent an important new method for the management of adult respiratory distress syndrome among head-injured trauma patients, although the long-term outcome of HFPV still needs evaluation.

PMID: 15454800 [PubMed - indexed for MEDLINE]

1: Minerva Anestesiol. 2003 Nov;69(11):841-8, 848-51.

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## ***High frequency percussive ventilation (HFPV). Principles and technique.***

*[Article in English, Italian]*

***Lucangelo U, Fontanesi L, Antonaglia V, Pellis T, Berlot G, Liguori G, Bird FM, Gullo A.***

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*In recent years, the usefulness of high frequency ventilation (HFV) has been clinically reassessed as an alternative to conventional mechanical ventilation (CMV). HFV has often been combined with or in some cases even completely replaced CMV in the attempt to reduce iatrogenic injury. High frequency percussive ventilation (HFPV) is a specific mode of HFV that has been successfully applied in the treatment of acute respiratory failure after smoke inhalation; it has also been more widely used in pediatric than in adult patients. This article gives an introduction to and a description of the basic principles of HFPV, a mode of ventilation which we found particularly versatile and reliable in our preliminary clinical experience with the maneuver.*

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**1 :** *Minerva Anesthesiol. 2003 Nov;69(11):853-7, 858-60.*

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## ***Ventilation par percussion à haute fréquence (HFPV). Rapports de cas.***

*[ article en anglais, italien ]*

***Lucangelo U, Fontanesi L, Antonaglia V, Antolini F, Berlot G, Liguori G, Gullo A.***

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*Le traitement de l'échec respiratoire aigu est toujours une issue chaude dans la pratique en matière journalière de soin intensif: en années de derniers les techniques à haute fréquence de ventilation ont été utilisées comme thérapie pour le syndrome respiratoire de détresse d'adulte (ARDS) et l'échec respiratoire aigu (ARF). Nous nous sommes appliqués la ventilation par percussion à haute fréquence (HFPV) à 3 patients affectés par ARDS ou ARF, qui ne se sont pas améliorés après 24 heures de ventilation mécanique conventionnelle (CMV). Tout notre patient a subi 12 heures de HFPV, et a montré une amélioration d'échange respiratoire et de formation image radiologique. Même si la pathogénie d'ARF était tout à fait différente, dans tout le patient nous n'avons enregistré une bonne réponse et aucune complication.*

*Types De Publication :*

- *Rapports De Cas*

PMID : 14735025 [PubMed - classé pour MEDLINE ]

: Crit Care Med. 2005 Sep;33(9):2155; author reply 2155-6.

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*High-frequency percussive ventilation.*

*Lucangelo U, Antonaglia V, Gullo A, Zin WA.*

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Minerva Anestesiol. 2003 Nov;69(11):841-8, 848-51.

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*High frequency percussive ventilation (HFPV). Principles and technique.*

[Article in English, Italian]

*Lucangelo U, Fontanesi L, Antonaglia V, Pellis T, Berlot G, Liguori G, Bird FM, Gullo A.*

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Publication Types:

- [Review](#)
- [Review, Tutorial](#)

PMID: 14735024 [PubMed - indexed for MEDLINE]

**Persistent pulmonary consolidation treated with intrapulmonary percussive ventilation: a preliminary report.**

[Birnkrant DJ](#), [Pope JF](#), [Lewarski J](#), [Stegmaier J](#), [Besunder JB](#).

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Intrapulmonary percussive ventilation (IPV) is a novel form of chest physiotherapy delivered by a percussive pneumatic device (IPV, Percussionaire, Sand Point, ID). There are few published reports about the use of IPV for diseases other than cystic fibrosis. We report our experience with three pediatric patients and one adult patient with persistent pulmonary consolidation refractory to conventional therapies. Three of the four patients had neuromuscular disease; one patient had segmental atelectasis due to aspiration. Three of the four patients showed clinical and radiographic improvement within 48 hours of starting IPV. The fourth patient experienced brief episodes of third-degree atrioventricular block, hypoxemia, and bradycardia during two IPV treatments. IPV was safely restarted and he slowly improved. We conclude that while IPV requires further clinical evaluation, it appears to be a safe and effective therapy for selected patients. However, close observation is essential during and after IPV treatments, especially in patients who have difficulty mobilizing or expectorating sputum.

Publication Types:

- [Case Reports](#)

PMID: 9121855 [PubMed - indexed for MEDLINE]

*The intrapulmonary percussive ventilator and flutter device compared to standard chest physiotherapy in patients with cystic fibrosis.*

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*Stasis of viscid secretions in cystic fibrosis (CF) leads to chronic infection, inflammation, and lung destruction. Chest physiotherapy (CPT) has been used for many years to assist in the removal of these secretions. However, the need for independently administered CPT exists, particularly for adolescents and the older CF patient. Two devices, the intrapulmonary percussive ventilator (IPV) and the Flutter device (Flutter) have been promoted for this purpose. This study compares these*

*devices to standard, manual CPT. There was no difference in sputum quantity produced with any method studied. Transiently lower oxygen saturation was noted with standard CPT compared with the IPV and Flutter. Inconsistent but significant improvements in flow rates were noted with the two devices compared to standard CPT. Important trends to lower lung volumes, probably indicating decreased air trapping, were also noted with all three therapies at 1 and 4 hours after administration. There were no adverse effects with any treatment regimen. Larger and longer studies of these devices compared to standard CPT and with each other are warranted to assess their value for independent administration of CPT in CF patients and to determine long-term effects on maintenance of pulmonary function.*

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