Chest Physical Therapy in Patients With Acute Exacerbation of Chronic Bronchitis: EfTectiveness of Three Methods

Andrea Bellone, MD, Rosaria Lascioli, CRT, Stefania Raschi, MD, Laura Guzzi, CRT, Roberto Adone, MD

ABSTRACT. Bellone A, Lascioli R, Raschi S, Guzzi L, Adone R. Chest physical therapy in patients with an acute exacerbation of chronic bronchitis: effectiveness of three methods. Arch Phys Med Rehabil 2000;81 :558-60.

Objective: To compare the short-term effects of postural drainage (PD), oscillating positive expiratory pressure (using the FLUTTER device), and expiration with the glottis open in the lateral posture (ELTGOL) on oxygen saturation, pulmonary function, and sputum production in patients with an acute exacerbation of chronic bronchitis.

Design: A prospective, randomized study.

Setting: A clinical ward.

Patients: Ten patients with chronic bronchitis exacerbation received PD, FLUTTER, and ELTGOL by the same respiratory therapist at about the same time of day on separate days and in random order.

Main Outcome Measures: Oxygen saturation and pulmonary function were measured before, immediately after, and 15 minutes and 1 hour after each treatment. Improvement in sputum production was measured by total sputum wet weight immediately after and for 1 hour after treatment.

Interventions: PD consisted of positioning the patients in a posture that allows bronchial drainage by gravity. FLUTTER is a device that is claimed to combine oscillating positive expiratory pressure with oscillations of the airflow. ELTGOL is an airway clearance technique that uses lateral posture and different lung volumes to control expiratory flow rate to avoid airway compression. The total time spent for treatments was 30 minutes.

Results: All techniques were well tolerated, and oxygen saturation and pulmonary function did not change significantly during and after treatments. Thirty minutes after the beginning of treatment, sputum production increased significantly with all techniques, but during the 1 hour after the end of treatment, it was significantly larger with FLUTTER (from 15.0 ±8.6g to 19.0± 9.3g, $p < .01$) and ELTGOL (from 17.0± 7.0g to 20.6 ±6.9g, $p < .02$) than wlth PD (from 15.5± 4.0g to 17.5 ±3.7g, NS).

Conclusions: All three treatments were safe and effective in removing secretions without causing undesirable effects on oxygen saturation, but FLUTTER and ELTGOL techniques were more effective in prolonging secretion removal in chronic bronchitis exacerbation than was the PD method.

Key Words: Chest physiotherapy; Positive expiratory pressure; Expiration with the glottis open in lateral posture; Postural drainage; Chronic bronchitis exacerbation; Sputum recovery; Oxygen saturation; Rehabilitation.

From the Department of Respiratory Medicine, Passirana Hospital, Rho-Milano, Italy.

Submitted February l, 1999. Accepted in revised fOTm October 18, 1999.

The authors have chosen not to select a disclosure statement.

Reprint requests to Andrea Bellone, MD, Via Moncalvo 31,20146 Milano, Italy.

0003-9993/00/8105-5449$3.00/0

doi: 1 0.1 053/rnr.20oo.4414

CHRONIC BRONCHlTIS is characterized by symptoms of cough and expectoration, and, as a consequence, the incidence of respiratory infection is high.1 Many patients with chronic bronchitis develop varying degrees of fixed airway obstruction. When an acute respiratory tract infection is present, the mucociliary clearan.ce is impaired, and airway obstruction and oxygen saturation worsen.2

Chest physiotherapy includes several techniques aimed at removing bronchial secretion. One of these techniques involves a commercial device (FLUTTERa) that uses oscillating positive expiratory pressure that varies between 10 to 20cmH20.3,4 This device is said to combine a self-regulated oscillating positive expiratory pressure, due to a steel ball, with oscillation of the airflow. Another technique is a maneuver of slow expiration with the glottis open in lateral posture (ELTGOL, from the French, l'expiration lente totale glotte ouverte en decubitus lateral). This is an airway clearance treatment that uses lateral posture and lung volumes from functional residual capacity (FRC) to residual volume (RV); the aim of this technique is to control expiratory flow rate to avoid airway compression and paroxysmal cough.5.6 Postural drainage (PD) is widely used for many pulmonary disorders with increased production of sputum7-9; it is recommended in chronic obstructive pulmonary disease (COPD) when patients produce more than 30mL/day of sputum. This therapy, however, requires assistance from another person and has been associated with a decrease in oxygen saturation, suggesting the need for improved secretion removal techniques.lO,U No studies to date have determined which of these three techniques is superior for improving oxygen saturation, pulmonary function, or sputum production. The aim of this study was to compare the short-term effects for improved secretion removal of three different techniques with regard to oxygen saturation, pulmonary function, and sputum production during an acute exacerbation of chronic bronchitis.

METHODS

Patient population and study design. We studied 10 patients with a history of chronic bronchitis, ie, cough daily and expectoration for at least 3 consecutive months for the last 2 years, who were known to produce more than 30mL of sputum per day. Patients were affected by an acute exacerbation of chronic bronchitis. An acute exacerbation was defined as the appearance of mucopurulent or purulent sputum and increasing cough, and one or more of the following symptoms: temperature of >38°C, general malaise, increased dyspnea, increased mucus production, or thickness or increased difficuity in expectoration. The treatment of patients did not change during the 3 days of study. All patients gave their written consent to the study. Each patient received FLUTTER, ELTGOL, and PD by the same respiratory therapist at about the same time of day on separate days and in random order. The study was approved by the local ethics committee.

Techniques of secretion removal. Treatment A included breathing through a commercial device (FLUTTER VRPI a), which consists of a mouthpiece as the main part, a circular cone, a high-density stainless-steel baIl, and a perforated protective coyer, through which air flows. The patient, in sitting posture, inhales through the nose and exhales through the device; during each exhalation, the steel baIl is subjected to an oscillating movement, which is transmitted to the bronchial tree. The frequency of the oscillations are considered to correspond to the spectrum of the lung resonance frequencies, and can be modulated by changing the inclination of the device.3.4 Treatment B included a technique for airway drainage consisting of maneuvers of slow expiration with the glottis open in lateral posture (ELTGOL). The first step of this technique involves the patient learning to relax. Once this is accomplished, the patient breathes from FRC to RV in lateral postures. Expiratory low rate is controlled to avoid airway compression.5,6 Treatment C included PD and manual chest percussion; PD consisted of placing the patient in different positions while the therapist manually clapped and vibrated various areas of the chest wall to increase secretion removal from a particular segment of the lung.7-9 The total time spent for treatments was 30 minutes. Sputum was collected 15 minutes after the beginning of treatment, immediately after, and for 1 hour after treatment. Total sputum wet weight was recorded to the nearest gram. One hour before the beginning of treatments, while patients were seated in our department, sputum was collected to quantify the spontaneous production of sputum.

Physiologie evaluation. After 3- to 4-day training sessions for both techniques under the supervision of a physiotherapist, patients were randomly assigned to receive either FLUTTER, ELTGOL, or PD at their first visit, and then received the alternate treatments during their second and third visits. Patients who, at the time, were receiving bronchodilator therapy at home received a bronchodilator 1 hour before each treatment session. During treatments, the arterial oxygen saturation (Saoz) was monitored continuously with a pulse oximeterb; forced expiratory volume in 1 second (FEV 1) was measured by a Pony spirometer" and recorded as percentage of predicted value. Measurements of Saoz and FEV 1 were obtained before, immediately after, 15 minutes after, and 1 hour after each treatment.

Data analysis. Results are expressed as mean (standard deviation). Data were analyzed through repeated-measures analysis of variance (ANOVA). Within-treatment comparison measurements were assessed as averaging data and performing the *t* test for paired data. Differences were tested for significance at ex = .05.

RESULTS

The 10 male patients ranged from 47 to 64 years old (mean, 57.5 ::': 6.0yrs). AlI techniques used were weIl tolerated by patients. There were no significant differences in Saoz and FEV 1 during treatments and until 1 hour after either treatment. Sputum production increased significantly 30 minutes after the beginning of treatment with either technique: from 9.5g (5.2g) to 15.0g (8.6g), $p < .01$, after FLUTTER; from 1O.3g (3.6g) to 17.0g (7.0g), $p < .01$, after ELTGOL; and from 9.3g (3.2g) to 15.5g (4.0g), $p < .01$, after PD. One hour after the end of treatments, sputum was increased from 15.0g (8.6g) to 19.0g (9.3g), $p < .01$, after FLUTTER; from 17.0g (7.0g) to 20.6g (6.9g), $p < .02$, after ELTGOL; and from 15.5g (4.0g) to 17.5g (3.7g), not significant, after PD. Sputum recovery was similar with FLUTTER, ELTGOL, and PD. The repeated-measures ANOVA showed a nonsignificant treatment-time interaction ($p > 0.2$), except for the factor time ($p < .01$).

DISCUSSION

ln this study, all treatments resulted in a substantial, immediate improvement in mucus clearance by patients with chronic bronchitis exacerbation; there were no significant changes in pulmonary function test and Saoz values either during or following PD, FLUTTER, or ELTGOL.

The benefit of chest physiotherapic techniques to enhance expectoration in patients with cystic fibrosis has been weIl documented.1°,l1 Previous studies1Z-14 showed that PD may produce a worsening of Saoz, suggesting the need for improved secretion removal techniques. The open question is whether these techniques may be useful in pulmonary disorders with increased sputum production such as chronic bronchitis. A previous study has suggested undesirable side effects of chest physiotherapy on pulmonary function and gas exchange in COPD patients and in acutely ill patients.15 ln addition, PD has been shown to be effective in patients with cystic fibrosis,9,10 but its role in patients with chronic bronchitis is controversial. ln our study, these therapeutic modalities were assessed during an acute exacerbation; in spite of this, aIl techniques were weIl tolerated. This affirms that aIl techniques are safe and effective.

While the passive effect of gravit y on the clearance of airway secretion (ie, PD) has been suggested to be ineffective,16 we evaluated 2 alternatives to PD that are reported to work in a modality different from PD. FLUTTER should inhibit the precocious collapse generally observable in unstable respiratory tracts of patients with chronic airway limitation by using a positive expiratory pressure; ELTGOL should allow the infralateral pulmonary clearance by breathing at pulmonary volumes from FRC to RV in comfortable omolateral posture. ln our study, the total amount of sputum was greater, though not significantly, with FLUTTER and ELTGOL compared with PD; in addition, these techniques were more effective than PD in prolonging sputum cleàrance: FLUTTER might modify viscoelastic properties of secretions (tixotropic effect17) or introduce air bubbles on mucus, thus making it able to float,18 while
ELTGOL might regenerate surfactant properties because of lung expansion and compression due to maneuvers of breathing at different volumes. 19

ln conclusion, we suggest that aIl 3 treatments are effective in acutely removing secretions without causing any undesirable effect on oxygen saturation in patients with chronic bronchitis exacerbation. Because the techniques other than PD allow patients to do their treatment by themselves, they might represent a valid alternative to PD and should be considered very attractive first choices of chest physiotherapy in the treatment of exacerbated chronic bronchitis. Furthermore, FLUTTER and ELTGOL are more effective than PD in prolonging the secretion removal effect, suggesting a more homogeneous drainage of the bronchial tree. Further studies will be needed to verify the long-term effects of these treatments, particularly with respect to quality of life and compliance.

References

1. Camner P, Mossberg B. Airway mucus clearance and mucociliary transport. ln: Moren F, Dolovich MB, Newhouse MT, Newman SP, editors. Aerosol in medicine. Principles, diagnosis and therapy. Amsterdam: Elsevier; 1993. p. 247-60.
2. Aikawa T, Shimura S, Sasaki H, Takishima T, Yaegashi H, Takahashi T. Morphometric analysis of intraluminal mucus in airways in chronic obstructive pulmonary disease. Am Rev Respir Dis 1989;140:477-82.
3. Swift GL, Rainer T, Saran R, Cambell lA, Prescott RJ. Use of Flutter VRP 1 in the management of patients with steroiddependent asthma. Respiration 1994;61: 126-9.

4. Girard Jp, Terki N. The Flutter VRPl: a new personal poeket therapeutie deviee used as an adjunet to drug therapy in the management of bronehial asthma. J Invest Allergol Clin Immunol 1994;4:23-7.
5. Postiaux G, Lens E, Alsteewns G. L'expiration lente totale glotte ouverte en deeubitus lateral (ELTGOL): nouvelle monouvre pour la toilette bronchique objectivee par videobronchographie. Ann Kinesither 1987;14:341-50.
6. Postiaux G, Lahaye GM, Lens E, Chapelle P. Le drainage postural en question. Kinesither Sci 1985;238:13-45.
7. May DB, Munt PN. Physiologie effects of chest percussion and postural drainage in patients with stable chronic bronchitis. Chest 1979;75:29-32.
8. Mazzocco MC, Owens GR, Kirilloff LH, Roger RM. Chest percussion and postural drainage in patients with bronchiectasis. Chest 1985;88:360-3.
9. Mortensen J, Falk M, Groth S, Jensen C. The effects of postural drainage and positive expiratory pressure physiotherapy on traeheo bronchial clearance in cystic fibrosis. Chest 1991; 100: 1350-7.
10. Rossman CM, Waldes R, Sampson D, Newhouse MT. Effect of chest physiotherapy on the removal of mucus in patients with cystic fibrosis. Am Rev Respir Dis 1982; 126: 131-5.
Il. Webber BA, Hodson ME. Effect of chest physiotherapy on oxygen saturation in patients with eystic fibrosis. Thorax 1990;45:77-83.
12. Giles DR, Wagener JS, Accurso FJ, Butler-Simon N. Short effects of postural drainage with clapping vs autogenic drainage on oxygen saturation and sputum recovery in patients with cystic fibrosis. Chest 1995;108:952-4.
13. McDonneli T, McNicholas WT, Fitzgerald MX. Hypoxemia during chest physiotherapy in patients with cystie fibrosis. Ir J Med Sci 1986; 155:345-8.
14. Wollmer P, Ursing K, Midgren B, Eriksson L. Inefficieney of chest percussion in the physical therapy of ehronie bronchitis. Eur J Respir Dis 1985;66:233-9.
15. Connors AF, Hammon WE, Martin *Rl*, Rogers RM. Chest physical therapy. The immediate effect on oxygenation in aeutely il1 patients. Chest 1980;78:559-64.
16. Postiaux G. La kinesitherapie respiratoire guidee par l'auscultation pulmonaire. Kinesither Sci 1984;220: 13-67.
17. King M. Role of mucus viscoelasticity in clearance by cough. Eur J RespirDis 1987;71 Suppl:165-72.
18. Renseh H, Von Seefeld H, Gebhardt KF. Stop and go particle transport in the peripheral airways. Respiration 1983;44:346-50.
19. Postiaux G, Lens E, Alsteewns G, Portelange P. Efficacite de l'expiration lente totale glotte ouverte en deeubitus lateral (ELTGOL) sur la toilette en pheripherie del'arbre traeheobronchique. Ann Kinesither 1990; 17:87-9.

Suppliers

a. Varioraw, Aubonne, Switzerland.
b. MiniOX V; MSA, 121 Gamma Drive, RIDC Industrial Park, Pittsburgh, PA 15238-2937.
c. Cosmed, Via dei Piani di Monte Savello, 37, PO Box 3, Pavona di Albano, Rome, 1-00040, Italy.