Respiratory Medicine (2015) 109, 297–307

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/rmed

REVIEW

Positive expiratory pressure – Common clinical applications and physiological effects

Monika Fagevik Olsén [a,b,c,*], Louise Lannefors [d], Elisabeth Westerdahl [e,f]

[a] Department of Physical Therapy and Occupational Therapy, Sahlgrenska University Hospital, Sweden
[b] Department of Physical Therapy, Sahlgrenska Academy at Gothenburg University, Gothenburg, Sweden
[c] Department of Gastrosurgical Research & Education, Sahlgrenska Academy at Gothenburg University, Gothenburg, Sweden
[d] Cystic Fibrosis Centre, Rigshospitalet, Copenhagen University Hospital, Copenhagen, Denmark
[e] Department of Medical Sciences, Clinical Physiology, Uppsala University, Uppsala, Sweden
[f] School of Health and Medical Sciences, Örebro University, Sweden

Received 27 June 2014; accepted 2 November 2014
Available online 12 November 2014

KEYWORDS
Breathing exercises;
Physiology;
Positive expiratory pressure

Summary
Breathing out against resistance, in order to achieve positive expiratory pressure (PEP), is applied by many patient groups. Pursed lips breathing and a variety of devices can be used to create the resistance giving the increased expiratory pressure. Effects on pulmonary outcomes have been discussed in several publications, but the expected underlying physiology of the effect is seldom discussed.

The aim of this article is to describe the purpose, performance, clinical application and underlying physiology of PEP when it is used to increase lung volumes, decrease hyperinflation or improve airway clearance.

In clinical practice, the instruction how to use an expiratory resistance is of major importance since it varies. Different breathing patterns during PEP increase or reduce expiratory flow, result in movement of EPP centrally or peripherally and can increase or decrease lung volume. It is therefore necessary to give the right instructions to obtain the desired effects. As the different PEP techniques are being used by diverse patient groups it is not possible to give standard instructions. Based on the information given in this article the instructions have to be adjusted to give the optimal effect. There is no consensus regarding optimal treatment frequency and number of cycles included in each treatment session and must also be

* Corresponding author. Department of Physiotherapy, Sahlgrenska University Hospital, 413 45 Gothenburg, Sweden. Tel.: +46 31 3421195; fax: +46 31 3424341.
E-mail address: monika.fagevik-olsen@vgregion.se (M. Fagevik Olsén).

http://dx.doi.org/10.1016/j.rmed.2014.11.003

individualized.

In future research, more precise descriptions are needed about physiological aims and specific instructions of how the treatments have been performed to assure as good treatment quality as possible and to be able to evaluate and compare treatment effects.

Contents

Introduction

Breathing against an expiratory resistance, also known as positive expiratory pressure (PEP), is prescribed for patients who have e.g. pulmonary disease or neurological disorders or who will undergo surgery [1—4]. The resistance is used for different purposes based on different physiological explanatory models with many types of devices. Although the applications differ, the patient is instructed to exhale against a resistance created in a device [5—8] or against pursed lips [9—11], generating an increased positive expiratory pressure. Three common indications for PEP are to increase lung volume (Functional Residual Capacity (FRC) and Tidal Volume (VT)), to reduce hyperinflation and to improve airway clearance [12—14].

Breathing against an expiratory resistance was first described among patients with chronic obstructive pulmonary disease (COPD) using pursed lips breathing (PLB), controlling the effect with pressure achieved by the lips as the resistance and the effort of the expiration [9,10]. A device for PEP, the 'blow bottle', was later introduced [15,16]. The patient exhales through a tube inserted into a bottle of water. The level of the water column, the lumen diameter, the length of the tube, the breathing pattern and the force of expiration are factors that influence the pressure achieved [17].

The first commercial PEP equipment (PEP/RMT set®) was developed in Denmark at the end of the 1970s. The purpose was to develop a device for airway clearance therapy in patients with hyper secretion, for reversing atelectasis and for decreasing the risk of pulmonary complications after surgery [1,5,6,18]. Since then, many different, either flow or pressure regulated PEP devices, have been developed. In the flow regulated devices, such as PEP/RMT set® and Pari PEP®, nipples, tubes or holes with a small lumen diameter create the flow resistance. Increased positive pressure is achieved with the augmented expiratory flow against this resistance, either by breathing with slightly active expirations, the PEP technique [5], or by forced vital capacity (FVC), the so called High-pressure PEP (HiPEP) technique [7]. In the pressure regulated devices such as Threshold PEP®, the exhalation is performed against a spring, where a certain pressure must be achieved to open the valve which closes completely as soon the pressure is less than set value. There are also pressure regulated devices that create an oscillating PEP and flow (OscPEP), such as Flutter®, Acapella® and RC Cornet®. The HiPEP, pressure regulated devices and OscPEP are used solely for airway clearance purposes. The resistance may be applied by masks over mouth and/or nose (nPEP) or by mouthpieces.

Some of the breathing techniques or devices are well known in clinical practice and have been evaluated in clinical studies, while others rare and seldom assessed in clinical trials. Despite widespread use of PEP, the underlying physiological explanation for the different techniques has not been comprehensively summarized, and we therefore found it essential to elucidate this.

The aim of this article is therefore to describe the purpose, performance, clinical application and underlying physiology of PEP when it is used to increase lung volumes (FRC and VT), decrease hyperinflation or improve airway clearance. As there is no consensus regarding the accepted physiologic rationale explaining how PEP achieves its proposed aims this is a brief overview of the field of knowledge based on physiological literature and articles and clinical practice.

PEP to increase lung volume

Breathing against an expiratory resistance is used as treatment in many patient groups to increase lung volumes